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Organic Agriculture, Sustainability and Consumer Preferences

Terrence Thomas and Cihat Gunden

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1. Introduction¹

Scholars acknowledge that early man provided food for himself and his family via gathering what was available to him in his surroundings; he relied on nature for his sustenance. As hunter gatherers, man lacked the capacity to manipulate the environment to produce food beyond the amount that was available naturally. Consequently, there was minimal or no environmental impact, the human population remained small and in balance with nature; hunter gatherers' population could not expand beyond the available sources of food [1-3]. Over time, however, as hunter gatherers learn to cope with their environment and became more adept at gathering food, the population increased, leading to the next stage in the evolution of the food production system—the Neolithic revolution or the development of agriculture. The development of agriculture led to sedentary communities, increase in population size and the specialization of labor, all of which facilitated technological development, i.e., improved tools, dwellings and means for transporting water and materials. In sum, man learned and applied techniques for domesticating animals and plants, or put another way, agriculture was invented. Yet, at this early stage in the practice of agriculture, man's interaction with his sustenance base could be described as "give and take"; a relationship in which man essentially learned from his experience living in the environment, a sort of 'symbiotic' relationship with his sustenance base that resulted in little or no adverse environmental impact. Even when there was adverse impact, the population was small and technology environmentally benign, which allowed the sustenance base to recover. The invention of agriculture laid the foundation for the development of civilization, increase in knowledge and man's capability to manipulate the environment. It was not until the birth of modern science and its application to the development of

¹ This section of the chapter is drawn extensively on the work of [4-5].

techniques for producing goods and services that man acquired the capability to manipulate the environment for producing food to meet his needs. The birth of modern science, following the Enlightenment, nurtured a culture that promoted and reinforced the world view that man through the application of science would be able to master and manipulate the environment to meet his needs. Advances in science during this era (17th and 18th century) led to the Industrial Revolution and the progressive industrialization of agriculture.

Prior to the intensive application of science to agriculture, the production of food and fiber relied on what is now referred to as traditional methods, which included: crop rotation, organic manure from animals and cover crops, animal power, intensive use of labor on small farms and a conventional artisan approach to plant and animal improvement—agriculture relied heavily on natural process, i.e., the ecology in which it was nested. Thus, in terms of today's language food production was substantively organic. The industrial revolution transformed traditional agriculture with: (1) the application of farm machinery for land preparation, reaping, hauling, irrigating, land clearing, fertilizer, manure and pesticide application; (2) the development and application of fertilizers, insecticides and weedicides; (3) application of sophisticated irrigation systems; (4) the application of principles of genetics to plant and animal breeding and (5) the practice of monoculture. These technologies have led to staggering increases in crop and animal production and productivity, larger farms and fewer farms and farmers [1-2, 6] and increased negative impact on the sustenance base [1-2, 6-8]. Another phase of agricultural evolution involved the application of information technologies, biotechnologies and modern science-based business management practices to organize and operate food production systems, leading to further gains in efficiency and productivity. Striking features of this phase include the following: large corporate style farms, drastic decline in family farms and profound innovations in the application of biotechnologies to the improvement of plants and animals. The progressive evolution of man's food gathering and food production relationship with his sustenance base (the ecology or environment) is characterized by: (1) his increasing capacity to apply science in developing the technologies used to manipulate the sustenance base or the ecological capital to meet his needs for food and fiber; and (2) the progressive ecological impact of these technologies. Prior to the phase of intensive application of science to agriculture, food production could be described as nature-based with food production and population more or less in balance with nature.

2. The impact of agriculture on the environment²

Rachel Carson's seminal work "Silent Spring" documented the environmental impact of insecticide on the environment [9]. Other authors including [1-2, 6-8] have documented an increasing environmental impact of conventional industrial agricultural technologies. Among the major impacts are point and non-point pollution from fertilizers and pesticides use; deforestation; desertification; salinization; soil erosion and sediment deposition downstream; degradation of water aquifers, accumulation of toxic compounds, loss of biodiversity; and

² This section of the chapter is drawn extensively on the work of [4-5].

habitat fragmentation. The net effect of these impacts over time will be to reduce the capacity of the sustenance base to support increases in food production to meet the needs of future generations and the needs of those who currently suffer from hunger and malnutrition.

These concerns regarding health, as well as the environmental impacts and sustainability of conventional industrial agriculture have led to efforts directed at developing more sustainable alternatives as described by [10-13]. Alternatives, variously described as organic food production systems, community supported agriculture (CSA), community-based agriculture, and civic agriculture have begun to resonate and garner significant public support. These alternative approaches to food production are community-based food production systems. Community-based agriculture initiatives are nature-based and produce food in an environmentally sustainable manner [14-15]. Sustainable agricultural production systems practice crop rotation, no-till farming, diverse cropping patterns, use of organic matter or organically derived fertilizers, integrated pest management, biological control, cover cropping, timing of planting, leaving land in fallow, a variety of water conservation techniques and make optimum use of the natural biological cycles. The objective of a sustainable agricultural system is to forge a symbiotic relationship with the ecological capital and in the process learn to use the resources it provides without affecting the capacity of the ecological capital to support food production. This approach is tantamount to using a portion of the interest from an investment portfolio and ploughing back some earnings to ensure the continued productive capacity of the base investment capital. In contrast, conventional industrial agriculture views the ecology as primary capital input or raw material that is to be manipulated or consumed in the production process. The focus of sustainability in food production is to develop a food production system that mirrors or integrates with the natural ecology in which it exists. It is believed that such a system would achieve the highest degree of sustainability--the capacity to persist through time as a system of food production.

3. Sustainable agriculture the undergirding principle of organic agriculture³

What exactly is sustainable agriculture? Scholars and technocrats alike don't agree on a single definition, primarily because: (1) there is no way a single definition of the concept could be applied to cover the diversity of ecologies, cultural and economic conditions under which agriculture is practiced, and (2) there are several stakeholders, with a vested interest in the concept, who cannot agree on a single definition [16]. Essentially then, the practice of sustainable agriculture will be defined by local ecological and social conditions. Even though there is lack of agreement on a single definition of sustainable agriculture, there is general agreement that conventional agriculture or industrial agriculture is not sustainable for reasons mentioned above. For example, conventional agriculture depends increasingly on energy supplies from nonrenewable sources, depends on a narrow genetic base and intensive use of chemical

³ This section of the chapter is drawn extensively on the work of [4-5].

fertilizers and pesticides. In addition, it relies on subsidies and price support, has an increasing negative impact on the environment as evidenced by the loss of species, habitat destruction, soil depletion, consumption of fossil fuels and water-use at unsustainable rates, and contributes to air and water pollution and risks to human health [17].

Notwithstanding the difficulties involved in defining sustainable agriculture, given the threat posed by conventional agriculture, scholars still continue to work to define and clarify the concept. For example, Ikerd [18] proposed the following definition: "...capable of maintaining its productivity and usefulness to society over the long run...it must be environmentally-sound, resource conserving, economically viable and socially supportive, and commercially competitive" (p.30). In a later work Ikerd argued that sustainability should be thought of as a goal to be achieved rather than a static concept with a fixed definition. Even though Ikerd's view has considerable intuitive appeal, we believe that having a working definition clarifies what a concept represents and provides the information needed for identifying its constituent elements and distinguishing it from other concepts. Description of an object or thing provides insight into the nature of what that thing is and what it can do. Since what a thing can do depends on what it is, insights into its nature enables us to hypothesize about potential courses of action regarding that thing. Or, put another way, insights developed from clarifying the definition of a sustainable agricultural production system enables us to design courses of action to attain a sustainable food production system.

In this chapter, we draw on Ikerd's definition and the definition of sustainable development proposed by [19]. We define a sustainable agricultural production system as the practice of agriculture to produce food and fiber that meets the needs of the current population without compromising the capacity of the ecological capital, on which it depends, to support the needs of future populations. This means the nutritional, recreational and fiber needs of current populations must be met within the ecological limits of our natural resource base (ecological capital). The primary elements making up our definition are: (1) need, (2) time, (3) ecological capital, (4) equity, (5) population and (6) practice. From our perspective, the first element, "need" entails consuming resources to satisfy a physiological or physical requirement over time. Technically, a need is a necessity that is not satisfied in a single instance; it is a continuing requirement. In this sense, a sustainable agricultural system is one that is capable of persisting through time to meet current and future needs. The second element, "time" is a key concept, because sustaining anything means making sure that the particular thing persists through time. In the case of a sustainable agricultural system, it means managing our relationship with the ecological capital in such a manner that it will continue to meet our needs and the needs of future generations. The third element in our definition, "ecological capital," represents the resource base or the stock of natural assets that support life and food and fiber production. Our definition of ecological capital varies slightly from that offered by [1]. In our definition, we emphasize the biological base (the ecosystem) from which all natural services and goods are derived. Wright [1], on the other hand, defines it as the sum of goods and services provided by natural and managed ecosystems (agriculture) that are essential to human life and well-being. We chose to use the ecosystem or biological base because if the ecosystem is degraded

or depreciated, its productive capacity and ability to support food production through a managed ecosystem (agriculture) will be much reduced.

The fourth element, equity, refers to the necessity to manage the endowment of ecological capital to meet the needs of the current generation without damaging its capacity to provide for future generations. In the context of our definition, the principle of equity also implies observing rules of fairness in the production, distribution and marketing of food and in exploiting other goods and services provided by our endowment of ecological capital. Population, the fifth element, refers to the current generation who consumes the goods and services produced from ecological capital, as well as future generations who will be consuming future products and services from the ecological capital. The attainment of a sustainable agricultural production system depends on the size of the population whose needs are to be met, the consumption level of the population, and the type of technology used in the production process. The final element, practice, deals with not only the technology employed in the production process but also the political, economic and social factors that impinge on and shape the sustainable agricultural production system. Given our definition, the question becomes: what insights for action can we draw? From our perspective, there are four primary insights (our illustrations below draw on the work of [1]): First, the population or people whose needs are to be met by a sustainable agricultural production system may be viewed from a dual perspective. People are the beneficiaries of a sustainable agricultural production system. Second, people are agents who must be proactive in defining what a sustainable food production system should be.

If a sustainable food production system is to be more than a theoretical abstraction, agents-the beneficiaries-must be able to operationalize the system to produce sustainable benefits. In operationalizing the concept of a sustainable agricultural production system, both values and knowledge play a central role in this process. Knowledge tells us about the ecosystem and how it supports agricultural production and what sort of sustainable development is possible, while our system of values guides us in making a choice once our options have been made clear. In this sense, moving from abstraction to implementation will be guided by the process illustrated in Figure 1 below. As illustrated in Figure 1, a sustainable food production system must be economically feasible “meaning such a system must be affordable and economically efficient. The sustainable food production system must also be socially desirable “indicating that it must be in sync with the cultural disposition and values of the agents or people it will serve. Consistent with this view, [17], reject approaches to sustainability that focus on the description and development of sustainable farming practices regardless of the socio-productive characteristics of the farming systems in which they are applied. Finally, a sustainable food production system must be in harmony with the ecology which supports it. If the food production system is discordant with, or in any way detrimental to the ecology that supports it, such a food system will not be sustainable.

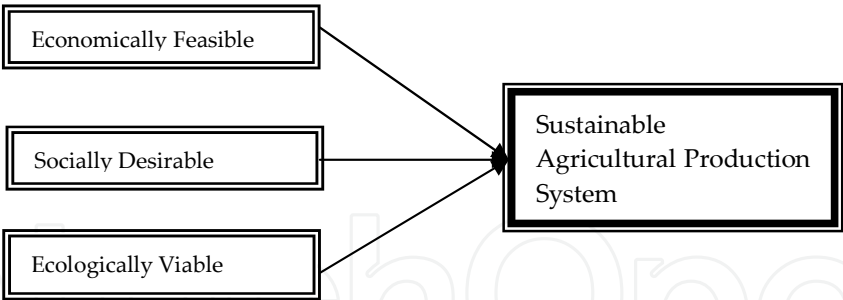


Figure 1. Sustainable food production system (adopted from [1])

4. Community and sustainable systems

Third, to make a food production system sustainable following the precepts depicted in Figure 1, the agents of such a system must act according to the framework illustrated in Figure 2. This is the point where community plays a vital role in crafting and managing a food production system to achieve sustainable objectives.

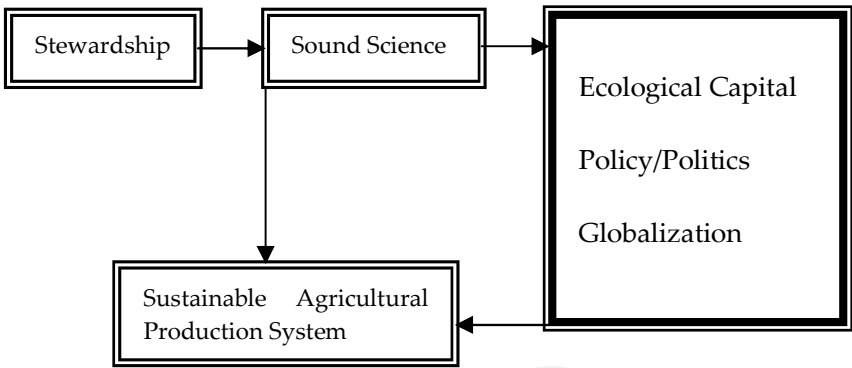


Figure 2. Framework for achieving a sustainable food production system (adopted from [1])

In Figure 2, stewardship entails employing ethical principles and values in choosing how sustainability is achieved. For example, sound-science provides knowledge about the ecosystem and the possibilities for supporting agricultural pursuits in a sustainable manner. It also informs us about how to make good decisions through policies and the political process. Science generates knowledge about specific sustainable practices and their efficacy. It tells us about the impact of globalization on the distribution of food, trade, and the spread of pollutants and diseases. In sum, science tells us what is and what is not possible. Good stewards must apply ethical standards and values to choose from among the possibilities that science generates in designing and implementing a sustainable agricultural production system, and in evaluating and adjusting the system to meet sustainable objectives. So then, the pivotal question becomes: Who gets to choose from among the possibilities that science generates?

Since food production in a sustainable system is inextricably linked to the local environment and the community's social and political infrastructure in which it exists, it follows that sustainable agricultural practices are defined by local ecological conditions and by the local social infrastructure which gives rise to the ethical values that guide stewardship. The connection of a sustainable food production system to ecological and social environments means that decisions concerning the design and development of sustainable agricultural production systems will have implications for everyone.

As a result, there will be several stakeholders with a vested interest in shaping the practice of sustainable agriculture. The reality is that citizens living in the same information rich environment as their leaders realize that the institutionalized bulwarks of authority are not omnipotent and that leaders are more or less ordinary people. Consequently, they assign less significance to the guidance of their leaders and institutions and have opted to become more reflective, proactive and self-regulating [20]. Implementing a sustainable agricultural production system in this context calls for collective action, because reflective and proactive citizens will insist on participating in the decision-making process. The support of diverse, reflective and proactive stakeholders is critical for ensuring that the values of stakeholders are reflected in defining and supporting the practice of sustainable agriculture.

Fourth, given that food systems depend on a healthy base of ecological capital regardless of their production technique, the sustainability of food systems can be conceptualized as existing on a continuum based on the level of integration with the natural ecosystem and the social environment in which it exists. At the high end of the continuum would be a production system that achieves the highest level of integration with the ecology and the social system in which it exists. And at the low end would be conventional/industrial agriculture. As indicated earlier, a sustainable system makes judicious use of available ecological capital by making optimal use of: biological cycles, the practice crop rotation, no-till farming, diverse cropping patterns, the use of organic matter or organically derived fertilizers, integrated pest management, biological control, cover cropping, timing of planting, leaving land in fallow and a variety of water and soil conservation techniques. To be sustainable, the food production system, as discussed earlier, must meet social and economic objectives within the limits of the ecology in which it exists. Sustainable food production must involve the community as consumers and stewards of the food production system. The system must also nurture and expand understanding of the interdependence of food production and the ecology which supports it. Considering that people are the agents and beneficiaries of a sustainable food system, communities must understand and accept that natural resources are finite, recognize the limits on economic growth, and encourage equity in resource allocation [17]. In other words, the drive for economic efficiency must be tempered by the need to preserve ecological capital and ensure social and economic equity. The trend toward large-scale Industrial profit driven farming has implications for the economic health of rural communities. For example, studies have demonstrated that independent hog farmers generate more jobs, more local retail spending, and more local per capita income than do larger corporate operations. Comparisons between conventional industrial agriculture and sustainable systems indicate that organic agriculture and sustainable systems are productive and economically competitive [17].

Given the concept of sustainable food system describe herein, we suggest that sustainable food systems exist on a continuum. The top end of the continuum would define a food production system that is nature-based and which achieves the highest level of integration with the ecology and social system in which it exists. We would label this highly ecologically and socially integrated food production system organic agriculture. Our conception of organic agriculture presented here is consistent with the definition proposed by Codex Alimentarius Commission which states that:

“Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystems health including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.” (Quoted in [21] pp.6)

At the low end of the continuum, displaying the lowest level of integration would be conventional industrial agriculture. Between these two extremes would be food production systems that manifest varying degrees of ecological and social integration or levels of sustainability. So then, organic agriculture is the ideal that we should work toward achieving as we strive to achieve a sustainable food system.

In today's market place there is a growing demand for organic products. And consumers seem willing to pay a premium price for products carrying organic quality labels. Questions that arise are how reliable are these quality labels and what level of confidence should consumers put in such labels? Usually the control process is carried out by independent certifiers who are guided by criteria promulgated by rule-making agencies. Certifiers must be vigilant and succeed in revealing departures from standards and opportunistic behavior in order for quality assurance labels to build up the reputation necessary to serve as a reliable quality signal. However, in the case of Potemkin attributes (where the desirable attribute is based on a process such as in organic production) there is the potential for quality statements to be made with little risk of disclosure of departures from standards, because consumer agencies, NGOs, and public authorities are usually not able to verify marketing claims or discover opportunistic behavior. What is needed to deter opportunistic behavior and identify departures from accepted standards is a quality monitoring protocol that covers the whole supply chain and ensures on-site inspections throughout the production process [22]. Another approach is to ensure stricter audit standards and rigorous training of certifiers, but these approaches are likely to increase the cost of certification and the resultant cost of organic products, which will drive down demand for products that are already offered to consumers at premium prices. In our view, a less expensive, organically-based and a more resilient approach would entail shortening the supply chain and fostering closer connection between producers and consumers. We envisage that the community and farmers would fulfill the role of active co-stewards (the community of consumers and producers) of the organic food production system. As co-stewards of an organic food production system, farmers and consumers would be organized in networks that exchange ideas, share experiences and information and work together to solve problems. In this situation, an effective self-monitoring protocol that is grounded in a culture

of trust and commitment to standards could emerge. The opportunity for farmers and consumers to interact as co-stewards would create an appreciation for the attributes that consumers' value, the relationship between these valued attributes, the production process and the price farmers are able to fetch for their product. On the other hand, consumers would get an appreciation for the process that produces the valued attribute. Over time, the "deep trust" that would develop between producers and consumers as a result of the co-creation of understanding of the role of consumer and farmer in meeting each other's need would lead to an effective monitoring system. This level of understanding could potentially lead to the identification of points of weakness in the process; whereupon, co-stewards would take action to modify existing protocols that would reduce the likelihood of opportunistic behavior.

The idea of entrepreneurial social capital espoused by [23] provides a conceptual basis for our proposed co-creation of an effective and inexpensive monitoring system. In the instance outlined above, co-stewards (the community of consumers and producers) have the potential to serve as a catalyst for mobilizing entrepreneurial social infrastructure (ESI). [23] Defines ESI as having three elements: symbolic diversity, resource mobilization and quality of networks. Symbolic diversity enables co-stewards to encourage participation, dissent, accept challenges to the status quo and embrace constructive controversy and critiques; it encourages people to focus on the process and the arguments instead of the personalities involved. It also encourages resource mobilization, which involves promoting local investment by residents in the community, equity in resource and risk distribution and collective investment in the community. Quality networks are encouraged by establishing horizontal and vertical linkages. Horizontal networking links co-stewards in similar circumstances and promotes learning by sharing experiences and information from different perspectives. Vertical linkages draw on resources of others operating in dissimilar circumstances, or in different systems. *It enables co-stewards to attract resources from private and public sources outside the community, for example, from entities with different levels of expertise and capacity relevant to the problem at hand (our emphasis).*

5. Assessing consumers preferences toward production system and consumers preferences for the attributes of fresh fruits and vegetables⁴

This next section will examine the attitude of consumers toward organic, sustainable and conventional production system and consumers preferences for the attributes of fresh fruits and vegetables. As discussed earlier, sustainable production lies between organic and conventional production system on our continuum described above. Thus, a sustainable agricultural production system is operationalized as employing good agricultural practices (judicious use of synthetic fertilizers and pesticides), integrated pest management and emphasizes the use of natural cultural practices and fertilizers and insecticides from natural sources as much as possible.

⁴ This section of the chapter is drawn extensively on the work of [24-25].

6. Measuring preferences for food production systems

The advent of specialized stores offering organic produce and products and the allocation of supermarket self-space to organic produce and products attest to the increasing demand for food and food products produced under alternative production systems. The emergence of alternative food production systems and the discussion in the public domain concerning the health, environmental and social benefits they offer vis a vis conventional production systems may have, at the very least, sensitized consumers about the opportunities that exist for making food purchasing decisions based on the type of production system and its perceived benefits. Additionally, the promotion of healthy eating habits and the need for increased consumption of fruits and vegetables [26-28], plus the well-publicized need for environmental conservation [19] amplify the salience and relevance of differences between the food production systems in terms of their health, environmental and socio-economic impact. Consequently, our objective here is to assess consumer attitudes toward food produced under the following food production systems – conventional agriculture, sustainable alternatives and organic along five criteria – contribution to environmental conservation, food safety, food quality, contribution to wellness and contribution to community economic development by using Analytic Hierarchy Process (AHP).

6.1. Data and methodology

The sample was designed following the protocol described by [29]. It was drawn proportionate to population size by county in Georgia, North Carolina and South Carolina. After specifying the sampling frame parameter, the required sample was purchased from Survey Sampling Inc. Data were collected from a random sample of 252 respondents, which represents a cooperation rate of 30 percent. Researchers designed and formatted an analytic hierarchy questionnaire to collect data via a telephone survey. Enumerators asked consumers to compare three food production systems: conventional, sustainable and organic in terms of which consumers would prefer farmers to use in producing the fresh fruits and vegetables that they purchase or consume; taking into consideration environmental, food safety, food quality, wellness, and community development issues.

This study employed Analytic Hierarchy Process (AHP) to derive a measure of an individual consumer's preference for production systems in terms of the selected criteria which is consistent with previous research conducted in the U.S. [30]. The AHP, which was developed by [31], is one of the most commonly applied multi-criteria decision-making techniques. AHP is a subjective tool for analyzing qualitative criteria to generate priorities and preferences among decision alternatives (For more detailed information about AHP, see [32-34]. The AHP model, illustrated in Figure 3, was used to assess consumers' preferences for production systems in terms of environment, food safety, food quality, wellness and community development.

Cluster analysis was used to separate consumers into groups by: age, education and employment status. The aim of cluster analysis is to classify observations into relatively homogeneous groups called clusters, such that each cluster is as homogeneous as possible with respect to the

clustering variables [35-36]. Researchers would then be able to determine if consumers' preferences for production systems varied by age, education or employment status. The Kolmogorov-Smirnov test was used to check whether the clustering variables were normally distributed and the Kruskal Wallis test was used to compare clusters.

Further analysis employing multidimensional scaling (MDS) was used to obtain "perceptual mapping of consumers' preferences for production systems. By transforming consumer judgments of overall preferences into distance represented in multidimensional space, MDS plots the three production systems and five criteria on a map such that those systems and criteria that are perceived to be very similar to each other are placed near each other on the map, and those systems and criteria that are perceived to be very different from each other are placed far away from each other on the map. In this way MDS provides a visual representation of the pattern of proximities (i.e., similarities) among the set of production system and the set of criteria employed in their assessment [36].

6.2. Results and discussion

Consumers were grouped into three clusters. The mean of the variables used in the analysis is presented by the clusters in Table 1. There were statistically significant differences among clusters on the variables age, education and employment. The mean age (40.85) is the lowest in Cluster 1 and the highest (80.35) in Cluster 3. Education level is the highest (4.94) in Cluster 1 and lowest in cluster 3 (2.41). Employment status changes from employed in Cluster 1 (2.13) to unemployed in Cluster 3 (2.97). Cluster 1 is labeled "Young professional", while the cluster 2 and cluster 3 are labeled "Older-technician" and "Oldest-unemployed" respectively.

Variables	Clusters			Kruskal Wallis Test	
	1	2	3	Chi-Square	Asymp. Sig
Age	40.85	63.48	80.35	191.962	0.000
Education*	4.94	4.32	2.41	29.596	0.000
Employment**	2.13	2.52	2.97	69.077	0.000

* 1: Less than high school, 11: Professional/doctorate degree; ** 1: Part time, 2: Full time, 3: Unemployed

Table 1. Cluster analysis by age, education and employment

Table 2 displays the number of consumers by the clusters. The data show that 52.1 percent of consumers are "young professional", 33.5 percent are "older-technician", while the "oldest-unemployed" accounts for 14.4 percent.

In the AHP Model, consumers were asked to assess conventional, sustainable and organic production systems, taking into account the ability of each to generate benefits related to environmental conservation, food safety, food quality, wellness and community economic development. The AHP model for assessing preferences for production systems in terms of

Clusters	Frequency	Percent	Cumulative Percent
Young professionals	123	52.1	52.1
Older technician	79	33.5	85.6
Oldest-unemployed	34	14.4	100.0
Total	236	100.0	

Table 2. Consumer distribution by clusters

these criteria is defined in Figure 3. The goal is to determine consumers’ preferences for food produced under three production systems using the following criteria: environmental conservation, food safety, food quality, wellness and community economic development. These criteria are the perceived benefits generated by each system. In the AHP model illustrated below, consumers are being asked to choose their preferred food production system from among the alternatives: conventional, sustainable and organic production systems based on environmental conservation, food safety, food quality, wellness and community economic development criteria.

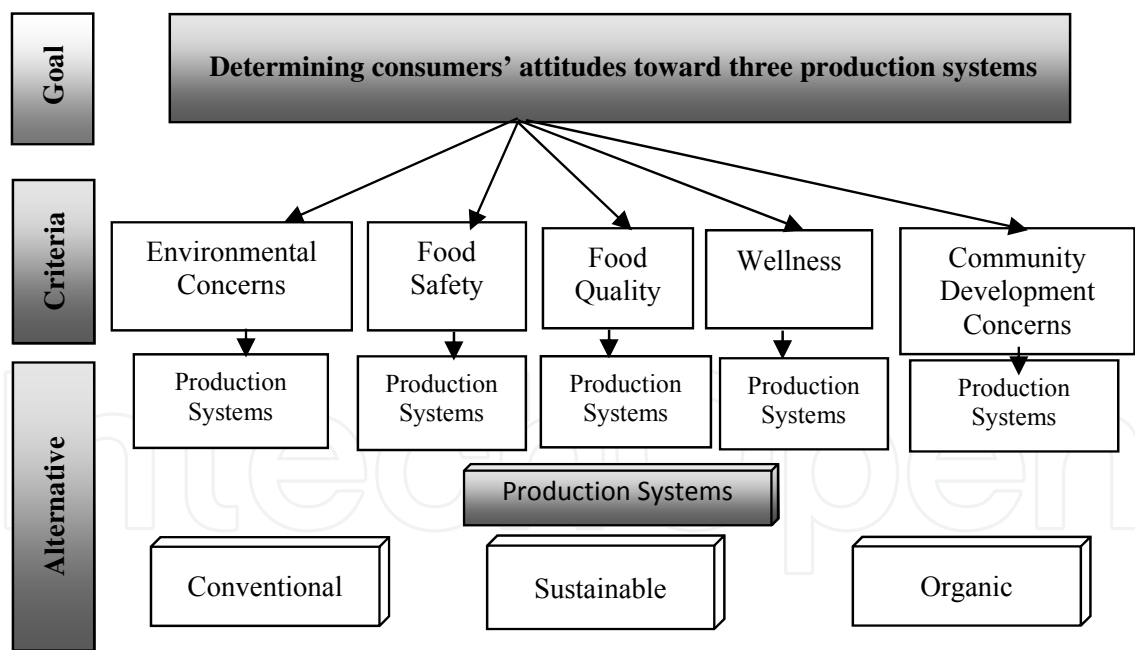


Figure 3. AHP model for consumer attitudes toward food production systems

Table 3 shows the results obtained by applying the AHP model. The last column in Table 3 indicates consumers’ average priority ratings for each criterion. The results indicate that consumers accorded priority in the following order to food safety (0.281) followed by wellness

(0.275), food quality 0.209), environmental concerns (0.144) and community development concerns (0.091). Consumers considered food safety and wellness to be more important attributes or features of a food production system than other attributes such as food quality and the capacity of the food system to contribute to community development or environmental quality. In each row of Table 3, the preference scores for each type of production systems are presented. The third column of Table 3 shows that organic agriculture is preferred, when considered alone, based on its perceived capacity to generate benefits associated with wellness (0.575), food quality (0.533), safety (0.530), environmental concerns (0.515) and community development (0.514). The average preference rating of 0.544 shown in the last row of Table 3 indicates that consumers prefer the organic production system over the sustainable alternative and conventional agriculture, which were assigned preference ratings of 0.274 and 0.182 respectively.

<i>Criteria</i>	<i>Conventional</i>	<i>Sustainable</i>	<i>Organic</i>	<i>Preference</i>
Environmental Concerns	0.203	0.282	0.515	0.144
Food Safety	0.186	0.284	0.530	0.281
Food Quality	0.195	0.272	0.533	0.209
Wellness	0.162	0.262	0.575	0.275
Community Development Concerns	0.209	0.278	0.514	0.091
<i>Final Decision</i>	0.182	0.274	0.544	

¹ Consumer preference scores are ranged between 0 and 1. The sum of each row, excluding the preference in the last column, is equal to 1.00.

Table 3. Consumers' attitudes toward food production systems by the criteria

Since consumers' preferences for the production systems of food may be influenced by their demographic traits and behaviors [37], demographic traits may be used, where heterogeneity in consumers preferences exists, to segment consumers into groups based on their demographic characteristics. Cluster analysis was employed using the variables: age, education and employment status to identify discrete groups of consumers based on their preferences. The results indicate that there are three distinct groups of consumers: young professionals, older-technician and oldest-unemployed. The preference ratings each segment assigns to the three production systems are shown in Table 4. These results show that there were no statistically significant differences among the consumer segments in their preferences for the food production systems. Table 5 indicates priorities each segment assigned to criteria used to assess the food production systems; young professionals accorded a higher priority to community development concerns than the other two groups.

Production Systems	Clusters			Kruskal Wallis Test	
	Young professionals	Older technician	Oldest-unemployed	Chi-Square	Asymp. Sig
Conventional	0.170	0.188	0.211	1.287	0.526
Sustainable	0.274	0.284	0.253	2.264	0.322
Organic	0.556	0.528	0.536	1.242	0.537

Table 4. Consumer attitudes toward food production systems for each segment

Criteria	Clusters			Kruskal Wallis Test	
	Young professionals	Older technician	Oldest-unemployed	Chi-Square	Asymp. Sig
Environmental Concerns	0.142	0.158	0.132	1.783	0.410
Food Safety	0.270	0.281	0.309	4.569	0.102
Food Quality	0.199	0.222	0.208	2.493	0.288
Wellness	0.292	0.261	0.277	1.135	0.567
Community Development Concerns	0.097	0.078	0.073	5.273	0.072

Table 5. Consumer attitudes toward the criteria generated by production systems for each segment

Figure 4 shows the consumers’ perceptual map derived from multidimensional scaling. The map illustrates the pattern of proximities for food production systems and the criteria consumers used to assign preference ratings. Kuskal’s stress value was used to measure goodness-of-fit. The stress value is a number on a scale from 0 (perfect fit) to 100 (the map captures nothing about the data). In general, researchers are looking for a stress value less than 20 [38]. In the MDS results, Kruskal’s stress value is 10 for this two dimensional model and $R^2=0.97$. Similar to factor analysis, there is a measure of difficulty in interpreting the conceptual mapping of consumers’ perception. To overcome this difficulty, researchers rely on their knowledge of the subject, existing theory and plausible rationale along with the weights associated with the stimulus coordinates to make good sense of the derived stimulus configuration [39]. The results indicate that consumers view organic production systems as quite dissimilar to the other production systems. Additionally, organic production is perceived as being associated with food safety and wellness, but not with environmental and community development benefits. On the other hand, consumers perceive a sustainable system of production to be associated with environmental and community development and food quality. Consumers see conventional as being dissimilar to organic and sustainable production systems and not associated with environment, community development, food quality, food safety and wellness. Consequently, the y axis is labeled as environmental /community development and the x axis as conventional production system. This means that moving from

left to right along the x axis the production system becomes more conventional, and moving along the y axis from top to bottom environmental sensitivity of the production system decreases.

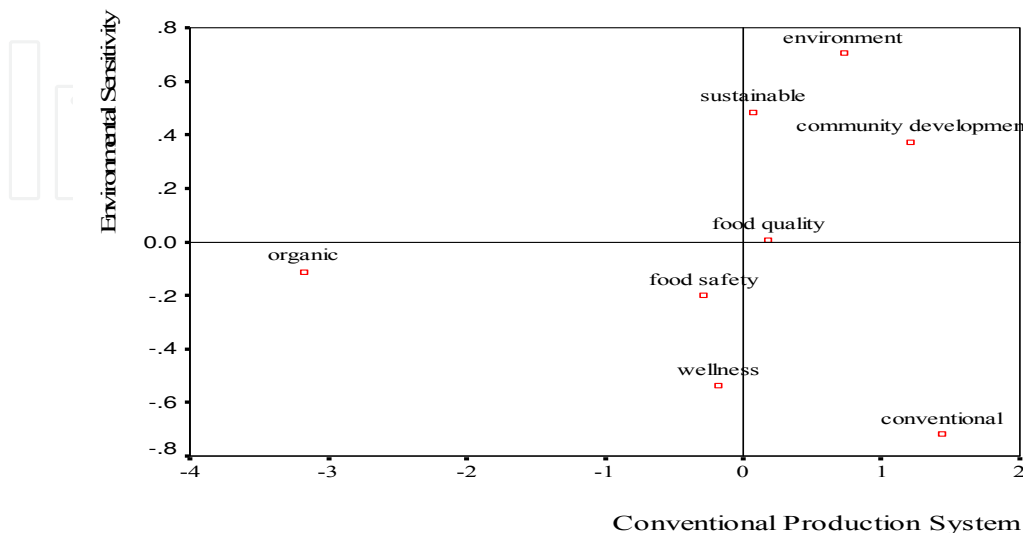


Figure 4. Perceptual mapping of consumers attitudes toward food production systems

6.3. Conclusion

Consumers accord the highest preference score to organic production, followed by sustainable and conventional production systems respectively. Moreover, in according higher priority to food safety and wellness, consumers appear to be more concerned with criteria that are more tangible in terms of the consequence for consumers' personal and immediate well-being. Since our findings indicate that consumers don't associate organic food production with benefits for environmental and community development, there is a need to design education programs that will convince consumers that there are socioeconomic and environmental benefits to be derived from organic production. However, education programs without community institutional support are not likely to succeed. Community members must be engaged as co-creators of initiatives that are intended to change attitudes and create awareness. We recall that proactive and reflective community members live in the same information rich environment as their leaders and those of us considered to be experts. Proactive and reflective citizens tend to assign less significance to leaders and experts, they insist on participating in the decision making process, they want to co-create programs that have implications for their livelihood. As a result, a truly sustainable food system (organic) must become embodied, and an intimate part of the lived experience of people and communities. After all, it is action that creates destiny. So if a sustainable food system is to become a part of our future, it has to become a way of life, and a pattern of living that is acted out as part of the everyday life story of communities [4].

7. Measuring preferences for food attributes

7.1. Data and methodology

The sample was designed following the protocol described by [29]. The sample was drawn proportionate to population size by county in Georgia, North Carolina and South Carolina. After specifying the sampling frame parameters, the required sample was purchased from Survey Sampling Inc. Researchers designed and formatted a Fuzzy Pair-wise Comparison (FPC) questionnaire to be compatible with the data collection protocol of Survey Monkey, and trained enumerators to use the questionnaire to collect the data. Enumerators asked consumers to make pair-wise comparisons of five food attributes: nutritional value, hygiene, taste, affordable price and freshness, in order to determine their preference for one attribute over the other. The selected attributes are consistent with the studies which have been done in the U.S. [30]. Data were collected from a random sample of 412 respondents.

In this study, FPC was used to derive a measure of an individual consumer's preferences for fresh fruit and vegetable attributes. The main reasons for using FPC are: 1) The FPC is similar to traditional pair-wise comparisons. Consumers are asked to compare the attributes one pair at a time. However, unlike the traditional pair-wise method, consumers are not forced to make a binary choice between two attributes. Consumers are permitted to indicate the degree of preference for one attribute over another, and response indicating indifference between attributes is permitted. 2) Unlike the other methods, the scale values are based on the respondent's entire set of paired comparisons. 3) FPC more accurately represents the natural range of response patterns that are possible. The consumer's fuzzy preference matrix R with elements can be constructed as follows [40]:

$$R_{ij} = \begin{cases} 0 & \text{if } i = j \forall i, j = 1, \dots, n \\ r_{ij} & \text{if } i \neq j \forall i, j = 1, \dots, n \end{cases} \quad (1)$$

In the FPC method, a measure of preference, μ can be calculated for each attribute by using the consumer's preference matrix R . The intensity of each preference is measured separately using the following equation:

$$\mu_j = 1 - \left(\sum_{i=1}^n R_{ij}^2 / (n-1) \right)^{1/2} \quad (2)$$

where μ_j has a range in the closed interval $[0,1]$. A larger value for μ_j indicates greater intensity of preference for attribute j . Consequently, fresh fruit and vegetable attributes are ranked from most to least preferable by evaluating the μ values. Then, Friedman and Kendall's W tests were

used to evaluate the relative importance of attributes and the extent of agreement among consumers with respect to two or more rankings. In identifying consumer preferences, researchers ranked the importance of the attributes following [37].

Cluster analysis was used to separate consumers into groups using the variables: age, education and employment status. Cluster analysis is a technique used for combining observations or objects (answer, person, opinion, etc.) into groups or clusters. The aim of cluster analysis is to classify observations into relatively homogeneous groups called clusters such that each cluster is as homogeneous as possible with respect to the clustering variables [35-36]. The Kolmogorov-Smirnov normality test was used to check whether the clustering variables showed normal distribution, and then the Kruskal Wallis test was used to compare different groups of clusters.

Multidimensional Scaling (MDS) was used to obtain a perceptual mapping of consumers' preferences for fresh fruit and vegetable attributes. Given a matrix of perceived similarities between attributes of fresh fruit and vegetables, MDS plots the attributes on a map such that those attributes that are perceived to be very similar to each other are placed near each other on the map, and those attributes that are perceived to be very different from each other are placed far away from each other on the map.

7.2. Results and discussion

In this study, consumers were grouped into three clusters. The mean of the variables used in the analysis is presented by clusters in Table 6. There were statistically significant differences among clusters on the variables; age, education and employment of consumers in the sample. The mean age (37.19) is the lowest in Cluster 1 and the highest (77.54) in Cluster 3. Education level is the highest (5.63) in Cluster 1, whereas Cluster 3 has the lowest level (3.87). Employment status changes from employed in Cluster 1 (2.06) to unemployed in Cluster 3 (2.89). Therefore, cluster 1 is labeled "Young professional", while the cluster 2 and cluster 3 are labeled "older-employed" and "oldest-unemployed", respectively.

Variables	Clusters			Kruskal Wallis Test	
	1	2	3	Chi-Square	Asymp. Sig
Age	37.19	58.15	77.54	339.960	0.000
Education ⁺	5.63	4.57	3.87	24.101	0.000
Employment ⁺⁺	2.06	2.33	2.89	92.656	0.000

⁺1: Less than high school, 11: Professional/doctorate degree; ⁺⁺1: Part time, 2: Full time, 3: Unemployed

Table 6. Cluster analysis by age, education and employment

Table 7 indicates the number of consumers by clusters. The data show that 47.7 percent of consumers are “older-employed worker”, whereas 34.8 percent are “young professional”, while 17.5 percent represent “oldest-unemployed”.

Clusters	Frequency	Percent	Cumulative Percent
Young professional	141	34.8	34.8
Older-employed worker	193	47.7	82.5
Oldest-unemployed	71	17.5	100.0
Total	405	100.0	

Table 7. Consumer distribution by clusters

Descriptive statistics for consumers’ pair-wise comparisons of the attributes of fresh fruit and vegetables obtained from the FPC model are presented in Table 8. The fresh fruit and vegetable attributes are ranked from most to least preferable using the reported degree of the consumers’ preferences. The results show that the fresh fruit and vegetable attribute most preferred by consumers is freshness with a preference rating of 0.579. Gao, et al. [37] reported a similar pattern of preference in their study on consumer preferences for fresh citrus. Consumers prefer the other food attributes in the following order: taste (0.452), hygiene (0.449), nutritional value (0.428) and affordable price (0.411). In this sample, consumers seem to value freshness, taste and hygiene over price and nutritional value. The Friedman test was used to see if there was a difference in the rankings of the fresh fruit and vegetable attributes.

Attributes	Mean	Standard deviation	Minimum	Maximum
Nutrition Value	0.428	0.122	0.024	0.929
Hygiene	0.449	0.142	0.049	1.000
Taste	0.452	0.128	0.049	0.868
Affordable Price	0.411	0.154	0.000	0.735
Freshness	0.579	0.159	0.150	1.000

Significant by Friedman test for $p < 0.01$; Kendall’s $W = 0.11$

Table 8. Descriptive statistics of consumer preferences towards fresh fruits and vegetable attributes

The Friedman test, which is significant ($\chi^2 = 177.71$; $p < 0.01$), confirms that some attributes are preferred over the others. Kendall’s W test was used to measure the degree of agreement

among consumers. The value of Kendall's W is 0.11, which indicates that the level of agreement among consumers in ranking the attributes is very low. A low level of agreement among consumers is an indication of the heterogeneity of consumers' preferences for the attributes of fresh fruits and vegetables.

Since consumers' preferences for the attributes of fruits and vegetables may be influenced by their demographic traits and behaviors [37], demographic traits may be used, where heterogeneity in consumers preferences exists, to segment consumers into groups based on their demographic characteristics. The present study employed cluster analysis using the variables: age, education and employment status to identify discrete groups of consumers based on their preferences. The results indicate that there are three distinct groups of consumers: young professionals, older-employed worker and oldest-unemployed. The results also showed that there was a statistically significant difference among the groups in their preferences for the freshness attribute of fruits and vegetables. Young professionals accorded a higher priority to freshness than the other two groups (Table 9).

Variables	Clusters			Kruskal Wallis Test	
	Young professional	Older worker	Oldest-unemployed	Chi-Square	Asymp. Sig
Nutrition Value	0.414	0.434	0.440	2.980	0.225
Hygiene	0.449	0.449	0.452	0.104	0.949
Taste	0.440	0.456	0.473	1.860	0.395
Affordable Price	0.395	0.413	0.436	1.909	0.385
Freshness	0.598	0.579	0.547	6.027	0.049

Table 9. Consumer preferences for fresh fruits and vegetable attributes by clusters

Figure 5 shows consumers' perceptual map with attribute positioning derived from multidimensional scaling (MDS) analysis of consumers' preferences for the attributes of fresh fruits and vegetables. In the MDS results, Kruskal's STRESS measure is 0.03863. A satisfactory measure should be less than 0.05 for a two dimensional model [39]. $R^2=0.99404$ shows that the model's goodness-of-fit is perfect. The analysis indicates that consumers perceive freshness as a distinct food attribute, which is quite separate from taste, hygiene, nutritional value and affordable price. On the other hand, consumers do not seem to perceive hygiene and nutritional value as distinct attributes, that is, consumers tend to accord the same level of priority to hygiene and nutritional value. Similarly, consumers tend to accord the same level of priority to taste and price.

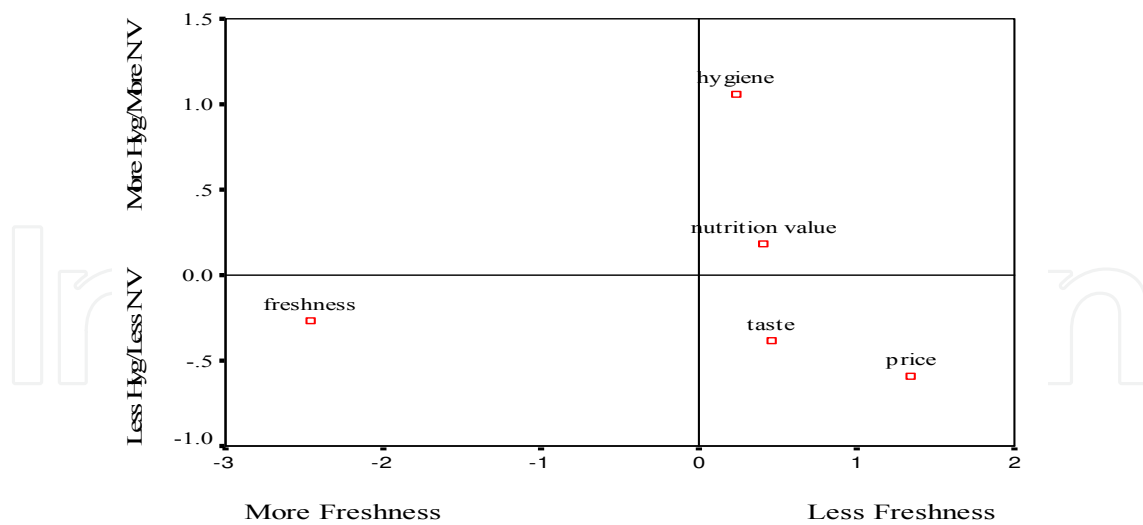


Figure 5. Perceptual mapping of consumers preferences for fresh fruit and vegetable attributes.

7.3. Conclusions

Consumers in making purchasing decisions pay more attention to freshness, taste and hygiene attributes of fresh fruits and vegetables than they do price and nutritional value, when these attributes are considered individually. However, multidimensional scaling shows that consumers tend to associate taste and price when making purchasing decisions, which may explain consumers’ love for inexpensive tasty fast food, especially in the case of low income consumers. These results indicate that consumers may not be using all the information available in selecting which food to purchase based on the preference ratings. Therefore, the need exists to educate consumers on the connection among the food attributes and their relevance to healthy eating habits and a healthier lifestyle, particularly the nutritional value attribute. Knowledge about the subgroups of consumers – young professionals, older-employed and oldest-unemployed –provides a basis for farmers, especially farmers supplying urban and suburban farmers’ markets, to tailor their products based on the needs of these groups of consumers, a strategy known as market segmentation. For example, the results indicate that the priority or preference of young professionals is for freshness. Extension should use this information to assist farmers to select and display their produce to promote freshness in order to sell more to the higher income young professionals. In summary, these results present extension with an opportunity to (1) assist farmers in marketing their produce in order to meet the needs of specific groups of consumers and (2) in developing a holistic education program, that teaches consumers to use information available on all the attributes: price, taste, hygiene and nutritional value in making purchasing decisions.

In sum, studies have shown that organic farming delivers more environmental benefits, in particular, it delivers more ecosystem services than conventional agriculture [41]. Additionally, contingent on the crop, soil and weather conditions, yield from organic agriculture is equal to that from conventional systems [42]. In the context of a sustainable food production system, organic agriculture goes further in meeting the condition of ecological feasibility (Fig

1), and the evidence seems to indicate that, with further advances in the development of organic technologies, it will become economically feasible. In terms of the third condition to be met-being socially acceptable-in striving for overall sustainability (Fig 1), evidence from our work shows that consumers prefer organic production systems over the alternative systems. Thus far, the future of organic production systems seems promising, but further research is needed to advance the development of organic technologies, disseminate these technologies, increase supply to reduce cost and make organic products affordable to a wider range of consumers, formulate supporting policies, and educate consumers on the value of organic food production systems in contributing to a sustainable food production system.

Author details

Terrence Thomas^{1*} and Cihat Gunden²

*Address all correspondence to: twthomas@ncat.edu

1 North Carolina Agricultural and Technical State University, Department of Agribusiness, Applied Economics and Agriscience Education, USA

2 Ege University, Faculty of Agriculture, Department of Agricultural Economics, Izmir, Turkey

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