

Sustainable Food Production & Diet: An Integrated Disciplinary Consideration

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Abstract

The idea of sustainability is becoming more, and more mainstream. It is becoming the subject of dialogue and decision making in institutions all around the world, from the United Nations, to international corporations; even institutions of education. It is because the ability of humanity to continue to live with “business as usual” is becoming increasingly challenging, and in some cases, impossible. This article explores fundamental aspects of sustainability in association with food production and diet from the perspectives of three different disciplines: geography, nutrition and health promotion/education. This is an area of sustainability that we are all invested in, whether we realize it or not. Each discipline has its own unique correlation within sustainable agriculture. Therefore, there are benefits to considering each one in association with sustainable food production and diet. Together, as each academic discipline is broached and upheld, they become important determinants in the pursuit and achievement of sustainability in our global food systems.

Sustainable Food Production & Diet: An Integrated Disciplinary Consideration

Introduction

Food means energy and life. For all living things, food and the energy it produces are basic sustaining needs. Humans commonly define food as any nutritive substance that is consumed with the purpose of nourishing the body and sustaining life. Generally, we humans must produce the food we require. The producing of this food requires the utilization of food itself as well as many other resources, especially several key natural resources, like water and soil for example. Water is indeed a very important finite resource, without which life on earth as we know it would not exist. This includes the food we need to nourish and maintain a healthy body and life. There is a definite relationship being described here. A relationship where one greatly depends on the other. Like a glove without a hand or a ship without a helm, neither can function as it should without the other.

Our planet includes many other materials within its boundaries that we consider resources. Resources that we need and utilize not only to maintain life, but in many ways, to improve and enjoy life. Since humankind's quality of life and our very existence depends on these many resources being continually available, it is important to consider how we are currently using these resources.

Are we utilizing these natural resources and producing the things we need to survive, such as food, in a sustainable way? Can we continue to supply food for the world's ever increasing population just the way we are? This paper will consider the importance of producing food for the world's growing population in a sustainable way while also defining what type of agriculture is un-sustainable. It will explore the concept of sustainable agriculture in producing nutritive food from the viewpoints of geography, nutrition and health promotion. It will integrate

these three disciplines in regards to the increasingly important goal of sustainable food production.

What is Sustainability?

What sustainability is or what it means for an action to be sustainable is not globally agreed upon. Many different ideas and concepts concerning what sustainability is have come to light in the last 20+ years. However, one of the first and classic definitions given to the concept of sustainability is from the Brundtland Report of 1987 where it was stated: “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” How well is mankind meeting the nutritional food needs and related health of the present populations? And are we currently compromising the ability of future generations to meet their own nutritional food needs and therein, their health?

A more recent definition of sustainability, one whose creators felt that the above definition was lacking, states: “sustainability is the ability to continue a defined behavior indefinitely” (thwink.org, 2014). The reasoning behind the views that the original definition is deficient rests upon the thought that it is more of a sentimentality that lacks practicality and measurability (thwink.org, 2014). The creators of this definition also assert that the original definition focuses attention and importance towards sustainable *development*, and an overriding priority in the concept of ‘needs’ is given to the poor. This more recent definition narrows the concept of sustainability. It also directly infers the importance of considering *environmental* sustainability as a priority in sustainable thinking and endeavors.

Why *environmental* sustainability over all other categories of sustainability? Because it affects our very existence. If an environmentally dependent behavior, such as producing adequate

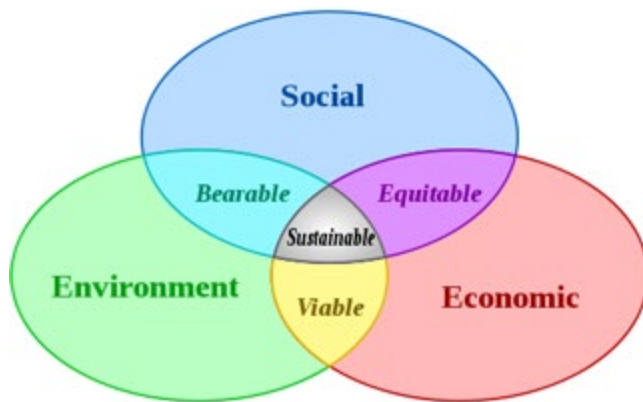
and nutritious food, becomes impossible through continued un-sustainable practices, life on earth becomes extremely challenging if not impossible. This sentiment about the fundamentality of environmental sustainability is conveyed directly by the creators of the above-mentioned sustainability meaning when they say "... if the environmental sustainability problem isn't solved, then no other problem will matter due to catastrophic collapse" (Finding and Resolving the Root Causes of the Sustainability Problems, 2014).

In addition to the depletion of the environmental resources needed for food production and the possible collapse of current agriculture systems, there are *immediate*, human health/nutrition, sustainability issues correlated with the environmentally dependent action of food production. These include things such as malnutrition, obesity, and chronic diseases and health issues such as type 2 diabetes, diverticulosis (an illness related to inadequate fiber consumption), heart disease, some cancers, hypertension and a host of other human health/nutrition health issues.

Industrialized, mainstream, and/or commercialized agriculture that encourages and gives incentives to mono-cropping, and fallow fields, that relies heavily on synthetic external inputs such as chemical fertilizers and pesticides (i.e. insecticides and herbicides), and focuses on caloric production rather than nutritive production (i.e. quantity over quality), is what is being addressed in this paper as unsustainable agriculture. This type of agriculture (i.e. commercial, industrial, etc.) is how much of the global food is being produced, and it is causing water contamination and depletion, soil degradation and erosion, habitat and biodiversity loss, air pollution that is contributing to climate change, and an insecure, under nourished, and ailing global food system.

If human civilization is to be able to produce food in a way that not only conserves but promotes the natural resources it requires, then it must do so in a way that is different from many of today's mainstream agricultural practices, it must be in a sustainable way. Namely, agriculture that conserves the environmental resources that are essential to its continuance while providing adequate nourishment. Otherwise, the continued practice of current global food production has an expiration date, and that is truly catastrophic.

Like any good and well-rounded idea, more than one perspective must be considered for



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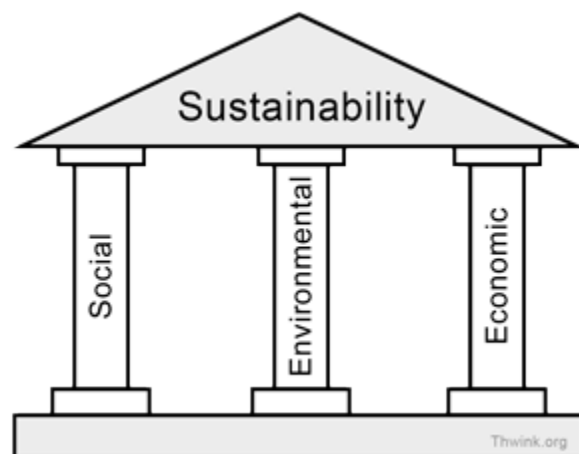
implementation of any kind to have certain success. It is common for sustainable models to include more than one area and discipline.

For example, The Three Pillars of Sustainability are shown below:

These visual illustrations show how important to one another and how

interrelated the sustainability problems and possible solutions are.

Similarly, this paper will take the topic of sustainable food production and diet and consider it from each of the three disciplines cited above in order to better understand how they interconnect and balance each other with respect to sustainable agriculture. It will highlight each individually as



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it pertains to the topic as well as relate how integrated these disciplines are in considering the issue of sustainable agriculture.

Sustainable Agriculture & Geography

The word geography has its roots in ancient Greece. First used in the 15th century, it literally means to write about the earth. In application to this report's topic, the following definition of geography is superlative "Geography is the study of the land and how we use it" (Vocabulary.com, n.d.). So, how do we humans use the land to produce the food we need to sustain life? Currently, approximately 40% of global land surface is devoted to some form of agriculture. Per ourworldindata.org, "the **agricultural area** is the sum of arable land, permanent crops, permanent meadows and pastures" (Roser, 2016). The Food and Agriculture Organization's (FAO) definition for arable land is: land under temporary agricultural crops, temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category. The category of arable land does not include land that could potentially be put into agriculture. Permanent crops are defined as follows: temporary and permanent crops; permanent crops are considered crops that are sown or planted once, and then occupy the land for some years and need not be replanted after each annual harvest. This category includes flowering shrubs, fruit trees, nut trees and vines, but excludes trees grown for wood or timber.

Again, according to the FAO, permanent meadows and pastures are defined as land used permanently (five years or more) to grow herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land). Out of the 40% of global land surface that is under some form of agriculture, some 12% is in cropland, and out of that 12%, over half, some 8% is dedicated to

animal feed. It is no wonder then, that agriculture is the number one driver of deforestation and land conversion. This is especially the case in many of the earth's tropic forests, where "agriculture has been noted as the major cause of forest loss, having been estimated to account for about 90 percent of all deforestation in the tropics" (Benhin, 2006, pg. 9). Crops such as soy beans and palm oil, and grazing for livestock are the reasons for such deforestation.

There is a lot of controversy about what constitutes sustainable agriculture from a geographical and environmental standpoint. Because the concept of sustainability is a social construct, and the value we put on certain aspects of agriculture in regard to the environment and natural resources is also a social construct there exists differing and conflicting ideas about what it is to globally produce food in a sustainable way. What might be sustainable at the local scale and farm may not necessarily be sustainable at the regional scale. For example, a "nature made" fertilizer of cow manure may seem sustainable, as there is a sufficient supply of it and it is economically sound for the farmer. In addition, it may even result in higher grain yields, so all is well. Not exactly. The sustainability experienced on the local scale may trickle down to create an environmental sustainability problem in the form of degradation to the natural resource of water; resulting in pollutants associated with the fertilizer that can contaminate groundwater, damage fresh water lakes and create "dead zones" in coastal waters (Robertson, 2015).

Food Production and Water

The above scenario regarding the non-sustainable impacts of mainstream, commercialized agricultural practices on water quality is just one of many. Excess nitrogen used in agriculture fertilizers, both chemical and natural (i.e. animal manure), have disturbed the natural biogeochemical nitrogen cycle of earth ecosystems, resulting in stratospheric ozone depletion, soil acidification, eutrophication (excessive nutrients that have collected in a body of

water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen), and nitrate pollution of ground and surface waters (Kanae, Hirabayashi, Yamashiki, & Takara, 2011). An article published in the *Journal Water Research* agrees with the connection between agricultural inputs and the degradation of the natural, finite resource of water. “Water quality degradation associated with nitrate leaching from agricultural soils is an important environmental issue worldwide” (Kanae, Hirabayashi, Yamashiki, & Takara, pg., 2573). For example, here in the U.S., agriculture is cited as a leading cause of groundwater pollution. Forty-nine of fifty states recognized that nitrate was the principal groundwater contaminant, followed closely by the pesticides (FAO, 2009).

Besides the degradation and sometimes outright contamination of water resources, it is the simple usage of water in regards to agriculture that is of serious concern and is locally and globally unsustainable. Agriculture is responsible for some 69% of the world’s fresh water withdrawals” (Food and Agriculture Organization of the United Nations [FAO], 2016).

Many of these fresh water resources are being withdrawn faster and at a greater amount than they are being replenished. For example, in the Pakistani province of Punjab, farmers are pumping groundwater at a rate 30% higher than is being recharged. Because of this, water tables are dropping by three to six feet a year. In California, groundwater is being pumped at an average of 15% more than the rains can replenish. That is an overdraft of 1.3 million acre-feet of groundwater a year! This same situation of water overuse for agricultural purposes continues throughout the world (Pearce, 2006). The largest bodies of water in the world, our oceans, are by no means exempt from being subject to unsustainable food production or an unsustainable food source, as some 80% of the world’s fisheries are in some form of collapse (FAO, 2016).

A significant consideration in the usage of the finite natural resource of water for agricultural purposes is in the livestock sector. For instance, “Nearly one-third of the total water footprint of agriculture in the world is related to the production of animal products” (Mekonnen & Hoekstra, 2012 p. 401), which can be less sustainable than plant-based products to produce. For example, 1 kilogram of beef, which is just a little over 2 lbs., takes on average 15,414 liters, or 4,072 gallons of water from start to grill. It is interesting to note that the same kilogram of vegetables (often referred to as row crops) takes on average 322 liters, or 85 gallons of water from seed to grill, or start to stomach, if you prefer. And although it will be addressed in greater detail under the nutrition “pillar” portion of this paper, it is important to understand that caloric content yielded from 1 kilogram of meat or 1 kilogram of veggies is the same.

Food Production and Emissions

Agriculture is also an important contributing factor in climate change through both greenhouse gas emissions and deforestation for agricultural purposes. In fact, according to Stanford researcher Holly Gibbs, “for every million acres of forest that is cut releases the same amount of carbon into the atmosphere as 40 million cars do in a year (Bergeron, 2010). EPA estimates from 2010 put “agriculture, forestry, and other land use” annual global emission outputs at 24%. It is also noted in the EPA report that “Greenhouse gas emissions from this sector come mostly from agriculture (cultivation of crops and livestock) and deforestation” (U.S. Environmental Protection Agency [EPA], 2012). The Food and Agriculture Organization of the United Nations (FAO) released for the first time in 2014 its own global estimates of greenhouse gas emissions from this same sector of agriculture, forestry and other land use (AFOLU). Those estimates concluded that this sector is annually, and globally responsible for the emissions of some 10 billion tons of greenhouse gases. Interestingly, “Nearly two-thirds of greenhouse gas

emissions from agriculture are sourced to the livestock sector” (FOA, 2016). In simple terms, that is the animal agriculture sector of food production.

Other estimates put annual global greenhouse gas emissions from the agriculture sector at an even higher amount, approximately 32%, again acknowledging that fact that a very large portion of the emissions come from animal agriculture (Winebarger, L. 2012). And although the animal agriculture sector contributes only about 9% of total annual carbon dioxide emissions, it contributes a whopping 37% of annual methane admissions; a gas that has 21 times the global warming potential of carbon dioxide, and 65% of annual nitrous oxide emissions.

Water and atmosphere are not the only environmental resources of concern when it comes to global food production. Soil degradation and erosion as well as biodiversity loss are among other potential environmental hazards associated with food production.

Food Production and Land

The most important direct drivers of biodiversity loss are: habitat change; climate change; invasive alien species; overexploitation; and pollution. Today’s commercialized and industrial agriculture and in particular, animal agriculture, contributes either directly or indirectly to all these drivers of biodiversity loss, from local to global levels (FAO, 2009).

Food Production and Sustainable Options?

Deforestation and overgrazing, soil degradation and erosion, water degradation and depletion, climate change and biodiversity loss are some of the most serious environmental hazards associated with food production. It is becoming increasingly clear that many current agriculture practices are not sustainable and that the need for swift, corrective, and innovative education, plans, procedures, and implementations are required.

Food Production: How We Grow. G. Philip Robertson, a distinguished professor at Michigan State University's W.K. Kellogg Biological Station and Department of Plant, soil and Microbial Sciences stated in his article entitled *A Sustainable Agriculture?* "Research over the past few decades have taught us that there is no single prescription" (2015, p. 81) Non-sustainable food production is a very complex issue. Therefore, sustainable food production is in turn a very complex solution. No easy fixes, no "one size fits all" philosophies.

However, Robertson noted that sustainable systems need to stand on at least two principles: that they be resource conservative and that they "rely more on internal ecosystem services than on external inputs" (2015, p. 81). He highlights the fact that resource conservation in regards to agriculture, conserves or even encourages the resources required for food production such as soil, water, and biodiversity. These are the vital resources required to grow both animal and plant based foods that are presently being compromised by external inputs such as fertilizers, herbicides and pesticides. Instead, sustainable agriculture, among other things, seeks internal ecosystem services for solutions to pests and soil nutrients.

For example, crop and landscape diversity within agriculture can provide habitat and food for insects and birds that eat and suppress crop pests, which is currently being done by means of external inputs, namely pesticides. Another example of internal rather than external inputs is winter cover crops. These crops are grown on winter fields that are fallowed, which helps prevent erosion and create moisture retentive soils and thus reduce water requirements. The winter cover crop is then killed prior to growing the main crop that next spring. This method can also put organic matter into the soil, suppress weeds, and reduce off-season nitrate leaching, and phosphorus runoff (Robertson, 2015).

Food Production: What We Grow. Possible sustainable food production ideas and solutions are not only about how we grow, but what we grow. All food items deemed acceptable for human consumption do not require the same inputs, whether internal (ecosystem services) or external. Different crops require more water, land area, and nutrients than others. Not all crops require the same geographical location. For example, bananas will not grow well or at all in the same geographical location that wheat will grow. It is obvious that sustainable agriculture requires that certain crops should only be grown in certain areas; areas that local climate and resources will not only support but conserve, rather than deplete and then move on with ‘business as usual.’

Although there is not one universal answer and practice to the sustainability of food production, conserving the resources needed for continued agriculture is an important guiding principle. You cannot grow a fish in a bed of sand, nor should we try. To grow/raise the right crop in the right place, it is important to consider the resources required to produce that crop. This is where food matters. This is where we must consider and compare the yield with the usage. For example, The Food and Agriculture Organization of the United Nations reports “Livestock is the world’s largest user of land resources, with pasture and land dedicated to the production of feed representing almost 80% of the total agricultural land” (FAO, 2014). Additionally, “Nearly 60% of the world’s agricultural land is used for beef production, yet beef accounts for less than 2% of the calories that are consumed throughout the world” (Union for Concerned Scientists, 2012), What does this imply exactly? This means that the resource usage far exceeds the yield. It means that pound for pound and calorie for calorie of food produced, plant crops are far more resource conservative and therefore sustainable to produce than animal crops. In fact, environmental scientist and ecologist Jonathan Foley suggests that the gap between current crop production and

future crop production needs of feeding 9.1 billion people could be bridged in part by “shifting the protein sources from meat and dairy to grain” (Robertson, 2015, p. 84).

We have the potential to produce enough food for the world’s increasing population in a way that is environmentally sustainable. With the right research and innovation, correlated with the right education and incentives for directing human expectations and consumption, along with the right plans for implementation, environmentally sustainable food production today and tomorrow can happen. It is essential that we conserve and protect our physical environment that we depend on, and live in. But what about ourselves? Can food production that is sustainable from an environmental platform also be sustainable for and even promote human health?

Sustainable Agriculture and Nutrition

What’s good for the goose is good for the gander. As it turns out, what is more sustainable for the earth is more sustainable for humankind, in several ways. This portion of the article will specifically address nutrition.

What is Nutrition?

Many dictionaries define this term rather plainly as the process of taking in food substances. The World Health Organization takes this simple definition a bit farther. “Nutrition is the intake of food, considered in relation to the body’s dietary needs. Good nutrition – an adequate, well balanced diet combined with regular physical activity – is a cornerstone of good health. Poor nutrition can lead to reduced immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity” (World Health Organization [WHO], 2016). What is the world’s current state of nutrition? Do current major food crops promote health? Per the World Health Organization, “In 2014, more than 1 in 3 (39%) adults worldwide aged 18 years and older were overweight” and in 2014 it was estimated that more

than half a billion adults were classified as obese (WHO, 2016). In addition, the global incidence of diabetes has risen from “108 million in 1980 to 422 million in 2014” (WHO, 2016).

In the United States, it is estimated that “117 million people—have one or more preventable, chronic diseases, many of which are related to poor quality eating patterns and physical inactivity. Lifestyle has a significant influence on the development of many chronic noncommunicable diseases (NCD), and what we eat is a major part of the lifestyle factor. In fact, according to an article published by the *Journal of Medical Clinics of North America*, “suboptimal nutrition ranks highest among lifestyle risk factors for NCDs globally and in the United States and has been identified as the most important preventable NCD risk factor” (Kimokoti & Millen, 2014, p. 1186). Nutrition and health are very interrelated. Simply put, what we eat influences how we feel, it influences our overall well-being.

Rates of these chronic, diet-related diseases continue to rise, and they come, not only with increased health risks, but at a high economic cost. In 2008, the medical costs linked to obesity were estimated to be \$147 billion. In 2012, the total estimated cost of diagnosed diabetes was \$245 billion, including \$176 billion in direct medical costs and \$69 billion in decreased productivity” (Office of Disease Prevention and Health Promotion, [ODPHP], n.d). These heavy statistics are part of the Secretaries’ message of the new 2015-2020 Dietary Guidelines for the American People. Obesity, diabetes, heart disease, and certain types of cancer have been very closely linked to what we eat, both nationally and globally.

Nutrition: Variety, Density and Amount

Number two on the five listed on the 2015-2020 U.S. dietary guidelines states this: “Focus on variety, nutrient density, and amount. To meet nutrient needs within calorie limits, choose a variety of nutrient-dense foods across and within all food groups in recommended amounts”

(ODPHP, n.d). So, in the same manner, the nutrition portion of this article will focus on nutritional *variety, density, and amount*, considering each separately as it relates to sustainable food production and nutrition.

Focus on Variety. Why focus on variety? Because consuming a variety of food equates to consuming a variety of nutrients including, complex carbohydrates, (the body's preferred form of fuel/energy) essential amino acids, essential fatty acids, vitamins, minerals and important antioxidants. Consuming a variety of foods means producing a variety of crops. "... Our current systems of agriculture have not been designed for the production of a diversity of nutrient-dense foods" (Jones & Ejeta, 2015, p. 228). According to this same article, only three food crops (rice, corn and wheat) provide nearly 2/3 of global dietary energy intake. In addition, the article also brings out that "agriculture has become an engine, not for producing food, but for generating animal feed, biofuels and industrial ingredients for processed food products ..." (Jones & Ejeta, 2015, p. 228). More than 7000 species of plants have been identified as edible and have been cultivated. Interestingly though, on average, both nationally and globally we cultivate less than 40 of them.

Are we really producing a variety of foods? This fact is no less true when it comes to animal agriculture and meat consumption. Genetic traits from certain breeds have been and are being lost. These include breeds that are well adapted to harsh environments and less susceptible to disease (FAO, n.d.). And here in the United States, there goes under-consumed and under-cultivated, many types of meat that are more sustainable than what is trendy and considered socially acceptable. For example, rabbit meat, goat meat and mussels.

Monterey Bay Aquarium's Seafood Watch Program helps "consumers and businesses choose seafood that's caught or farmed in ways that support a healthy ocean, now and for future

generations. Our recommendations indicate which seafood items are "Best Choices" or "Good Alternatives," and which ones you should "Avoid" (Seafood Watch, 2016). Therefore, this program can help in identifying a great option for sustainable seafood, "farmed mussels are a "Best Choice" and one of the most sustainable seafoods you can buy!" (Seafood Watch, 2016). In fact, mussels "... can actually *reduce* water pollution" (Berkeley Wellness, 2016). Mussels are also nutritiously sustainable, as they have decent levels of heart-healthy omega-3 fats at 500 to 1,000 milligrams per 3 ounces (Berkeley Wellness, 2016). This heart healthy nutrient is a major reason that the 2015-2020 Dietary Guidelines recommends eating 8 or more ounces per week of seafood. So, farmed mussels are an excellent example of seafood that uphold both the nutritional and environmental aspect of sustainability.

Production of these types of animals are much less intensive than beef, mutton, or farmed salmon, as in they use less resources and energy from start to finish and emit less greenhouse gases. In addition, they are a healthy form of animal protein and in some cases, they may even be a *healthier* form of animal protein. For instance, "Compared to meats of other animal species, rabbit meat has lower cholesterol contents and high levels of protein with essential amino acids, especially in the *L. dorsi* muscle, which also has a high digestibility value" (Zotte & Szendrő, 2011, p. 328). Although dietary cholesterol is no longer limited or tied to chronic disease, in the 2015 Dietary Guidelines, the following encouragement, was made by the Institution of Medicine regarding dietary cholesterol "as recommended by the IOM, individuals should eat as little dietary cholesterol as possible while consuming a healthy eating pattern" (2015-2020 Dietary Guidelines for Americans, 2015, p. 32). One of the main reasons for this is because foods that are high in dietary cholesterol also tend to be high in saturated fatty acids; a macronutrient that can be correlated with chronic disease. Rabbit meat is low in saturated fat as compared with many

other land animal meats. It is a good source of other nutrients as well, such as phosphorus and selenium. In addition, rabbit meat has a very low sodium content, especially when compared to meats such as beef and/or pork (Zotte & Szendrő, 2011).

Even though there are forms of animal protein that are both environmentally and nutritiously more sustainable than others, after considering the heftier impact animal agriculture, in general has on the environment, especially when compared to plant based agriculture, it is important to realize that it would be *more* sustainable, both environmentally and nutritiously, if individuals, families, societies, and the world would consume less meat. It is therefore more nutritiously and environmentally sustainable to consume the bulk of our daily calories from a variety of *plant* based foods.

Focus on Density. We are admonished to focus on nutrient-*density*. In other words, foods that contain a plethora of essential nutrients. Focusing on nutrient dense foods should encourage the production and the consumption of fruits, vegetables, pulses, and ancient grains. So many of which, are extremely underutilized and in some parts of the world not cultivated and consumed at all. In fact, an article in the *International Journal of Environmental Research and Public Health* had this to say concerning underutilized plants as food crops “Modern agricultural systems that promote cultivation of a very limited number of crop species have relegated indigenous crops to the status of neglected and underutilized crop species (NUCS)” (Chivenge, Mabhaudhi, Modi, & Mafongoya, 2015 p. 5685). Many of these neglected and underused species are better suited to grow where common staple crops are currently being produced. In the face of water scarcity, soil degradation, continued population expansion and climate change, research of these uncommon crops and food sources are giving hopeful potential in negating food insecurity and undernourishment (Chivenge et al., 2015). NUCS are indeed a more environmentally sustainable

agriculture crop. “Unlike most staple crops, NUCS are often well–adapted to local growing conditions, which are often marginal and harsh, thus offering sustainable food production” (Chivenge et al., 2015, p. 5689). And even more noteworthy, these multitudes of plant species are not only better suited and more sustainable for certain environments, they are also nutrient-dense.

These species could provide excellent and sustainable nutrition for the human body. For example, *Amaranthus* species, *Portulaca oleracea*, *Vigna subterranean*, lambsquarters, and pearl millet just to name a few, a very miniscule drop in what really is an endless sea of sustainable food production potential, for the environment and most definitely for human nutrition and health. Consider in greater depth the pearl millet; “millets are often referred to as a “high-energy” cereal as they contain higher oil content than maize grains; their protein and vitamin A content are also higher than maize. The fact that millets contain vitamin A, a major deficiency in staple diets, makes it a suitable crop for combating nutritional challenges ...” (Chivenge et al., 2015, p. 5694). But do not expect local grocery stores to get this from their mill source and market it on shelves. This is because, according to Chivenge et al, “it is only grown commercially as forage for animal consumptions in some areas” (2015, p. 5693). And even at that, it is only grown in Sub Sahara Africa. If you live in the U.S., there is little to no chance of putting this cereal/grain on the dinner table.

The plant *Portulaca oleracea*, better known as purslane, can typically be found and regarded as a “nuisance weed” growing in any flower and common veggie garden. Sadly, horticulture and botany experts and extension services often recommend using glyphosate, a well-known herbicide to “get rid of it.” This very drought tolerant, grow just about anywhere annual, is a very nutrient-dense food. Its nutritional attributes include “... potassium

(494 mg/100 g) followed by magnesium (68 mg/100 g) and calcium (65 mg/100 g) and possesses the potential to be used as vegetable source of omega-3 fatty acid. It is very good source of alpha-linolenic acid (ALA) and gamma-linolenic acid (LNA, 18: 3 w3) (4 mg/g fresh weight) of any green leafy vegetable” (Uddin et al., 2015, p. 1). This little succulent also possess healthful antioxidants. “Purslane (*Portulaca oleracea*) deserves special attention from agriculturalists as well as nutritionists” (Chan et al., 2015, p. 1).

Vigna subterranean, commonly called bambara groundnut is a legume, this is a great benefit to growing in less than desirable and fertile soils, as it is a legume and a nitrogen fixer. This means that the bambara groundnut can replenish the nitrogen in the soil, an important macronutrient in botany. Its nutrition potential for humans is no less impressive as it is a great source of the human macro-nutrient, protein. In fact, an article by Chivenge et al, had this to say about the protein content of the bambara groundnut “It’s protein content (16%–25%) is comparable, and in some instances, superior to other established legumes, making it a good complement for cereal-based diets” (Chivenge et al., 2015, p. 5696).

Then there is the amazing amaranths plant, locally often referred to as pigweed. This plant that is often regarded as a bothersome weed is a powerhouse of nutrient-dense leafy greens. “The protein content in the weedy species of amaranth is comparable to the World Health Organization standards. In addition, amaranth is also a rich source of dietary fiber and lipids rich in unsaturated fatty acids as well several minerals, vitamins and bioactive compounds” (Chivenge et. Al., 2015, p. 5698).

There are also many forgotten fruits and berries that are highly nutritious and more sustainable to produce than many common commercially (North America) cultivated fruits. These include berries such as saskatoon berries, commonly known as service berry

(Amelanchier), which contains valued amounts of many micronutrients including riboflavin, manganese, calcium, magnesium, iron, vitamin C, vitamin E and biotin. In addition, serviceberry contains polyphenol antioxidants similar to that of blueberries (Eat The Planet, n.d.).

Other underutilized berry and fruit plant species that have a place in sustainable food production and diet are: huckleberries, gooseberries, currants, cloudberry, salalberries, crowberries, buffalo berries, fly honeysuckle, and crabapples. There are many other small fruits and trees that are an important part of earth's underutilized plant biodiversity. For example: *Moringa oleifera*, "also known as the 'miracle tree', which has a drought tolerance trait as well as highly nutritious leaves" (Kahane et al., 2013), Custard apple (*Annona squamosa* L.), Indian gooseberry (*Phyllanthus emblica* L.), which is said to be "one of the richest sources of natural ascorbic acid (Vitamin C)" (FOA, n.d.), Indian jubilee (*Zizyphus mauritiana*), tamarind (*Tamarindus indica*), and neem (*Azadirachta indica* A. Juss), just to name a few. Besides being nutrient-dense, these plants are also considered to be drought tolerant and able to thrive in poor soils and marginal lands: attributes of the complexities of the coming future (2050) of feeding some 9 billion people in the face of climate change and stressed and diminishing natural resources required for agriculture.

Focus on Amount. Consider now the 3rd admonishment from the second of five 2015-2020 Dietary Guidelines: "Focus on . . . *amount*". It is suggested that in order "to meet nutrient needs within calorie limits, choose a variety of nutrient-dense foods across and within all food groups *in recommended amounts*" (ODPHP, n.d.). After considering how sustainable food production, both environmentally and nutritionally is correlated and even in harmony when it comes to variety and nutrient density, the same consideration of *amount* begs to be likewise explored. So then, what about the admonishment of amount?

Nutrients to Increase. American's have been continually encouraged and even implored to increase the amount of vegetables, fruits, whole grains, legumes, basically whole foods, that we consume and include as part of a healthy eating pattern. It is because these food groups contain important macronutrients, vitamins, minerals, antioxidants, and phytochemicals, whose nutrient potential is just recently been and is being discovered.

An important dietary component that American's have been repeatedly advised to increase their intake of is fiber. The "Western" diet's pattern of low fiber consumption is thought by some to play a role in chronic diseases such as diverticulitis (Thompson, 2016). Research supports fiber's role in negating other chronic diseases as well. An article entitled, *The Link between Dietary Fibre and Human Health*, advocates the health potential of consuming adequate amounts of fiber "dietary fibre appears to have a direct effect on decreasing the risk for heart disease," and "Overall the data indicate that high fibre and low GI diets can be beneficial for management and prevention of type 2 diabetes" (Kendall, Esfahani, & Jenkins, 2010). Where can adequate and healthy amounts of fiber be found? They can be found in most whole, plant based foods, including many of the plant based food varieties highlighted in the nutrient density portion of this paper.

For example, the whole grain of amaranth has an average of 5g of fiber per 1 cup (United States Department of Agriculture, [USDA] 2016). It is recommended that the average adult get approximately 25-30 grams of fiber per day. Another way to look at the fiber intake recommendation is 1.4 grams per 100 calories consumed. A cup of amaranth contains approximately 250 calories a cup, and 5 grams of fiber, that's an average of 2 grams of fiber per 100 calories. Millets contain an average of 2.5 grams of fiber per 100 calories. Fruits, vegetables, and whole grains, as far as fiber is concerned, is where it's at, and these underutilized plant

varieties are clearly excellent sources of fiber. The American and “Western” diet has not only played a role in the development of chronic disease, but also in the surge of the occurrence of them. These diets of the 20th and 21st centuries have been increasingly based on calories, refined sugars, and highly processed foods rather than on nutrient dense, whole, plant based foods, and there is a notable parallel between these diets and the development and increase of chronic diseases (Ludwig, 2011). Consequently, what about *decreasing the amount* of foods? Has there been any admonishment to decrease the consumption of certain foods?

Substances to decrease. When evaluating current American eating patterns against current recommended eating pattern, page 38 of the new Dietary Guidelines 2015-2020 handbook had this to say about current U.S. calorie consumption, “in addition, the eating patterns of many are too high in calories,” and although caloric assessment needs are highly individual, “the high percentage of the population that is overweight or obese suggests that many in the United States overconsume calories (2015-2020 Dietary Guidelines for Americans, 2015). Refined, added sugars are also recommended as a food that should be limited and/or decreased. The new Dietary Guidelines 2015-2020 advises that consumption of these refined, added sugars make up less than 10% of our daily calorie intake.

American’s are also advised to decrease the amount of processed foods (refined, added sugars are often a major ingredient in processed foods) that are allowed to make up daily caloric content. How central to sustainable nutrition is this admonishment of decreasing the amount of highly processed/processed foods we consume? It is very central, as it has a major impact on nutrition-based health outcome (and environmental, as we have already seen). This is because a diet focused on highly processed/processed foods has been shown to promote chronic diseases through a variety of mechanisms including: high energy density (i.e. high calorie intake), large

portion size, low content of fiber and vital micronutrients, poor-quality dietary fat (i.e. partially hydrogenated oils/fats), high glycemic load, and high-intensity, artificial flavoring (Ludwig, 2011). It is applicable to note that corn, one of the major agriculturally cultivated and focused on crops, is a key component/ingredient in many of the processed-grocery store shelf-food items. "The lack of diversity in the diet, though, is an overlooked factor: 80% of processed food is made up of just four ingredients -- corn, wheat, soy and meat," (Chan, 2016). This type of food production and consumption is neither nutrient dense, variant, or "in recommended amounts." In many cases switching production from corn to any number (thousands) of underutilized crops would uphold this article's three symbolic pillars of sustainability: Geography/environmental, nutrition, and health promotion (which is to be discussed in depth in the next portion of this article).

The New 2015 Dietary Guidelines for the American People admonishes an increase of most all the 5 food groups (i.e. vegetables, whole grains, etc.). However, one of the food groups that has been identified as being consumed at or above recommended amounts is meat, especially processed meats. Consuming meat above recommended amounts is one of the reasons that the Dietary Guidelines 2015-2020 encourages consuming less meat and meat products. The other reason is this: "Strong evidence from mostly prospective cohort studies but also randomized controlled trials has shown that *eating patterns* that include lower intake of meats as well as processed meats and processed poultry are associated with reduced risk of CVD in adults" (ODPHP, n.d.). Decreasing meat consumption is a recommendation that may reduce the risk of other NCD's including diabetes, cancers such as colorectal, and gastrointestinal diseases such as diverticulitis. A recent study conducted on the link between diet and diverticulitis found "... that the biggest single risk factor was high intake of red meat. Increased animal protein

intake is one of the most striking differences between underdeveloped and industrialized nations along with the fall in dietary fiber” (Spiller, 2015). Hundreds of scientific research studies, like this one, resonate the advice of increasing consumption of whole, plant based foods and decreasing consumption of highly processed/processed foods and animal based protein, particularly red and processed meats.

There is indeed much evidence to support the fact that the amount of processed foods and of meat in general could and should be overall decreased, both in production and consumption and as part of a sustainable food system. To continue to increase consumption of these food items, and thus increase production of them is unsustainable. It is unsustainable from an environmental/natural resource standpoint, and it is unsustainable from a human health and nutrition standpoint. So how do or how can the consumers and policy makers, those powerful enough to effect and make change, receive the education they deserve and need in order to play an integral role in sustainable agriculture and diet?

Sustainable Agriculture in Health Promotion

What is Health Promotion?

The standard definition of health promotion is as follows: “any planned combination of educational, political, environmental, regulatory, or organizational mechanisms that support actions and conditions of living conducive to the health of individuals, groups, and communities” (Joint Committee on Terminology, 2012, p. 19). Words that are synonymous with the concept of promotion include raise, advance, advertise, and elevate. Health promotion is to raise awareness about health-related issues, to advance health understanding and knowledge through research and to assess needs and plan programs to address those health needs. Health promotion specialists should be a reliable source of health-related information. They have the

goal of implementing procedures that achieve and elevate individual, group, and community health outcomes. They must also seek to evaluate programs for how well they are functioning to advance health knowledge, behavior change, and overall quality of life.

Sustainable agriculture and nutrition are by far some of the most pursued health-related issues today. In consideration of the important role health promotion plays in sustainable food production and diets, there are two main themes that this portion of this paper will examine: the determinants of sustainable agriculture and diets and the processes that can promote changes towards the foods that are grown and consumed, both locally and globally. But first, it is pertinent to consider and understand why health promotion has such an important role in sustainable food production and sustainable nutrition implementation.

Why Sustainability Needs Health Promotion

Consumers are the primary consideration of the goals and health objectives of Healthy People 2020, the World Health Organization (WHO), The Food and Agriculture Organization of the United Nations (FAO), and many other nutrition and health promoting organizations throughout the world. This is because consumers are some of the most powerful voices that can influence the world's environmental and nutritional concerns associated with current unsustainable food production. Therefore, the consumer needs credible resources, information, and education in the matter of sustainable agriculture and nutrition, so this is the way health promotion becomes and is one of the three pillars that sustainable agriculture must be held up on.

Health promotion is fundamental to the process and implementation of a sustainable food system. If the public, who is the consumer, does not know about current unsustainable agricultural practices and probable future consequences thereof, and they are unfamiliar with sustainable agricultural innovations, then how can the fundamentals of a food system: the

producers and the consumers, move towards sustainable agriculture and a positive health outcomes for all?

The WHO's bulletin declares that the "second of the new sustainable development goals commits Member States to end hunger, achieve food security and improve nutrition and promote sustainable agriculture" (Jones & Ejeta, 2015). Healthy People 2020 echoes the idea on a smaller scale: that promoting and achieving objectives in regards to health through nutrition and the promoting of healthful diets needs to incorporate increasing household food security and eliminating hunger. Food security, (whether on an international or individual scale) improved nutrition, the promotion of healthful diets, and ending hunger all include sustainable food production. Sustainable agriculture and diets, in-turn, involve awareness and practical solutions, which is obtained through education, namely through health promotion research and program implementation. The health of our environment and natural resources as well as our physical well-being and nutrition, is a fluent continuum. One must uphold and support the other, and both are going to rely heavily on health promotion's collaborated education plans, programs, and implementations. Governmental and non-governmental organizations created to address health-related issues are calling upon the health promotion profession as part of the food sustainability solution.

Organizations Recognize Health Promotion's Role in Sustainability

In September of 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development. This outline incorporates a set of 17 new Sustainable Development Goals, also referred to as SDGs (Piscopo, 2015). Objective 12.2 of the new Sustainable Development Goals specifies the significance of the role of the consumer and the need for health promotion in the field of sustainable nutrition and agriculture. The objective notes that education

efforts need to help individuals and families to select foods that not only meet their nutritional needs, but also foods that can be sustainably traced and sustainably produced (Piscopo, 2015).

A 2015 article by the *Journal of Nutrition Education and Behavior* presented research that showed how nutrition education contributes to reaching sustainability goals. Some of the journal's articles (2015) contained the following:

Focus on studies from different countries and with different cultural groups to show the link between food-related behaviors, food environments, and health outcomes. Other articles emphasize how adopting a socio-ecological approach to exploring phenomena and using well-designed process evaluation methods can offer solid data to refine theoretical frameworks and inform prospective interventions and recommendations for policies. (Piscopo, 2015)

The role of research and health promotion as it seeks to access and advance existing information is one of the first steps in planning programs and effecting policy and procedure. In fact, to that end, the *Journal of Nutrition education and Behavior* held a workshop on qualitative research where practitioners and researchers alike received training in best methods in order to improve the health promotion field's research and program planning skills. Best practices in procedures, program implementation, and policies that address sustainable agriculture and its determinants, absolutely involves the work of health education specialists. Creditable organizations and authorities realize that the efforts and skills of the health education profession are key in the goal and support of sustainable food production.

bulletin from WHO had this to say concerning the global agenda for nutrition and health in regard to the importance of agriculture and food systems: "The public health and nutrition communities also need to more fully integrate food systems approaches into the training of

health professionals, into the goals and designs of the respective programmes, as well as into policy advocacy efforts ...” (Jones & Ejeta, 2015). One of the ways the World Health Organization sees this being accomplished is to readjust the goals of agriculture to address human health by meeting dietary guidelines. Agriculture needs to take a more nutritive approach rather than a caloric approach. This means emphasis needs to be realigned to be concentrated on *what* is being produced, and not solely on *how much* is being produced. This kind of change in the focus of local, regional, and global food systems requires implementation of some of the major responsibilities of the health promotion profession: to assess needs, to plan, and to administer and manage.

The U.S. Office of Disease Prevention and Health Promotion (ODPHP), a national governmental health-associated organization views health education as one of the essential processes in promoting sustainable diets. The overview of the Nutrition and Weight Status topic under the Healthy People 2020 relates that there is strong scientific evidence behind their health and nutrition objectives. However, the creators of this program and its health objectives recognize that just having knowledge backed by scientific evidence is not enough to affect a high percentage of behavioral change, in any health-related issue, especially one that so universally affects individual, free will: what we put into our bodies. Sustainable agriculture involves more than just having information on nutrition and on environmental and human health. It involves other integral aspects of a person’s daily life, and it should be addressed at multiple levels. These levels include behavioral, cultural, environmental, economic, and policy. Sustainable food production and diet education programs need to be designed with these multiple levels in mind.

Having considered the integral role of health promotion in conceiving and applying sustainability in the food that is grown and consumed, the determinants of sustainable agriculture

and nutrition must also be considered. This is because for health education programs, procedures and policies to be successful, they must reflect the determinants of sustainable food production and nutrition.

The Determinants of Sustainable Agriculture & Diets

Health education must recognize and consider the determinants of sustainable agriculture and diet. Simply, what causes sustainable agriculture and diet? Healthy People 2020 reflects recognition of the determinants of sustainable diets when conveying in their objectives that to successfully change diet there must be health promotion that educates and addresses the issue from multiple sustainable food production and consumption determinants. These elements of sustainable agriculture and nutrition include: individual behaviors as well as the culture of a society, policies, both locally and globally, education, economics, and health outcomes for both humans and the environment.

Health promotion should create programs and procedures that support needed changes in individual behaviors and cultural traditions, policies, economics and environments, in settings such as schools, worksites, health care organizations, and communities. (ODPHP, 2016). Healthy People 2020 lists numerous sub factors that influence healthy sustainable diets. These sub factors reflect the many facets of the main determinants of sustainable agriculture and nutrition. Such sub factors include: knowledge, attitudes, skills, social support, societal and cultural norms, food and agricultural policies, and economic price systems. Let's consider in greater depth, the main determinants of sustainable agriculture and diet.

The Determinant of Individual Behavior and Culture

How can these things be causes of sustainability in food production, diet and nutrition? A community norm, or a society's culture can play important roles in and can be either a negative

or positive determinant where our topic is concerned. For example, vegetarian diets in India are the cultural norm influenced by Hindu religious beliefs (Johnston, Fanzo & Cogill, 2014). On an individual spectrum, a person may have grown up in a culture where fruits, vegetables and grains were scarce, for example, the Inuit People of North America. This could result in individual behavior consuming a diet that is high in animal products, even if the individual changes demographic situations where a plant-based diet is readily available. Individual behaviors are generally deeply reflecting of our personal attitudes and beliefs, which are sub factors of sustainable foods and diets. We typically arrive at these attitudes and beliefs based on the cultural norms and traditions of the society and family we grew up in. Clearly, behavior and culture are strong determinants of sustainable agriculture and diet.

The Determinant of Health: Human and Environmental

How and what we grow is strongly influenced by health. Human health is directly and indirectly influenced by agriculture. Food production directly influences human health by its ability to provide adequate nourishment (Johnston, Fanzo & Cogill, 2014). This is a major determinant of sustainable agriculture. Consider this: as this paper deliberated on aspects of sustainable food production from a physical environment and nutrition standpoint, it was made clear that more equals more and less equals less. In other words, what is more sustainable from an environmental standpoint, repeatedly lends to more nutrient dense, healthier foods. Therefore, as we produce foods that yield negative health outcomes, both for humans and the earth, sustainable agriculture's determinant of health becomes negative. It becomes a determinant of unsustainability rather than sustainability. Human, economic, and environmental health are all indirectly influenced by sustainable agriculture (Johnston, Fanzo & Cogill, 2014). And the sub factors of knowledge, attitudes, social support, societal and cultural norms, food and agricultural

policies, and economic price systems all influence the determinant of health outcome and it must be seriously considered when creating health education programs, best practices and policy towards sustainable agriculture and diet.

The Determinant of Education

Education is a fundamental element in the promotion of anything. This is no less the case when it comes to our topic. Education is one of the first ways in which health promotion advocates for an objective. In imparting knowledge and information about sustainable food choices, education program creators should keep in mind these five lessons: The importance of keeping food label information consistent across the many different products and brands, facts and figures need to be interpreted for the consumer, the information should be scientific-evidence based and verifiable, link informative labeling to broader government objectives and messages, and the support and early ‘buy-in’ of the food companies is integral to avoiding proliferation of systems and to ensure a consistent approach (Davies, 2011). Empowering consumers with the sub-determinants of knowledge and skills to make sustainable choices easier is a first-step determinant of sustainable food production and diet.

The Determinant of Economics

Food production affects the economic determinants of sustainable diets (Johnston, Fanzo & Cogill, 2014). There is a direct link between income and the purchase of foods that have a greater variety and nutritional value. The vast majority of people are not able to grow their own food: they must purchase it. The affordability of food is another main determinant of sustainable agriculture and diet. If the food stuffs that have been deemed sustainable, both environmentally and nutritiously are economically unattainable for both an individual and a population, than the determinant of economics becomes a cause of the continuation of unsustainable consumption and

production. For example, if highly processed foods that contain unhealthful ingredients like high fructose corn syrup, or partially hydrogenated oils continue to be within the price point that an individual, family and community can afford, then that is what gets purchased and consumed. It therefore becomes what the food producers continue to produce.

Another example of the determinant of economics is current government subsidies in the United States. These subsidies enable farmers to "... produce large quantities of cheap staple and ultra-processed foods at 40-60% below the cost of local production ...” (Johnston, Fanzo & Cogill, 2014, pg. 422). This creates a scenario like that of the above example. These less healthy foods with higher carbon emissions (because they are imports), are cheaper than locally produced foods, which are generally healthier (Johnston et. al, 2014). With this, and with all the other main and sub determinants is where policy comes in.

The Determinant of Policy

Policy tends to be the most powerful of all the determinants. Consumers or the determinant of behavior and culture, have a strong influence. But, policy has the power to change the behavior determinant. And although the consumer can sway and change policy, often times it is greater odds that policy can and will change the consumer or behavioral factor of sustainable agriculture. Another reason that the determinant of policy is so profound is because it not only affects but creates regulations, procedures and programs, which can influence and change all other major determinants of sustainable agriculture. In fact, policy may just be the single most important ally in the pursuit of sustainability; “policymakers are the key to promoting actions that will advance sustainable diets” (Johnston et. al, 2014, pg. 426). In addition, policy and those set in the capacity to make regulation, have the authority to set targets, goals, limitations, monetary incentives, and other types of guidance that affect not only food production, but also

marketing, accessibility, and affordability (Johnston et. al, 2014), all of which directly and indirectly influence the other main determinants of sustainable food production and diets. Here is where the reiteration and culmination of the importance of health promotion in regards to sustainable food production comes. Policy needs health promotion, because there is a need for policymakers to better understand the determining factors and processes that comprise a sustainable diet. They need to understand and consider correlations between individual behaviors, societal cultural traditions, human and environmental health, education, economics, and how the decisions they make affect the sustainability of a diet (Johnston et. al, 2014,).

What are some of the processes, research, education and programs that have been implemented and what outcomes have been achieved? The next part of this paper will examine various programs and their associated outcomes.

Sustainable Agriculture & Diet Educational Programs: Assessed, Implemented and Evaluated

School Based Programs

Food for Life Partnership Program (FFLP) is a program that is made up of a group of charities that share a want to promote food-based environmental learning in schools. The invent of this partnership and program grew out of a concern that “obesity and the climate change impact of food” could not be successfully addressed without reconnecting people, especially young ones, to their environment. Specifically, to educate them on how their food is produced. They also needed to regain the skills and knowledge needed to be proactive about what they eat (Weitkamp, E., Jones, M., Salmon, D., Kimberlee, R., & Orme, J. 2013). In the program, schools are encouraged to work towards either Bronze, Silver or Gold awards. From 2007–201 some 3,600 primary, secondary and special schools signed up to take part in the FFLP program.

Education research suggests that gardening activities at school, home and the community can encourage children to eat more fruits and vegetables. There is also evidence that experience based gardening education promotes environmental awareness.

However, food sustainability education is not without its obstacles and challenges. Among these are the complexities of the issue, not easily connected learning objectives, and contested and controversial subject. Other educational challenges involve the fact that some aspects of sustainable agriculture “are value driven and these values may conflict with deeply held values within the school’s wider community,” creating an area of conflict with parents, districts, faculty and possibly others. Discussions that are age sensitive must be well-planned out to avoid any unnecessary ethical situations. For example, “discussion of such conflicts are a valuable part of education, but perhaps more suited to older primary school and secondary school children, where a greater depth of discussion can be developed” (Weitkamp, E., Jones, M., Salmon, D., Kimberlee, R., & Orme, J. 2013, p. 1138). For the younger school-age children, even just being aware of the importance of food production sustainability is an integral part to the issue’s continued thesis, antithesis and resulting synthesis.

Community Based Programs

A research study and program implementation that has had a proven measure of success when it comes to health and nutrition education on the community level is community gardening. Getting people involved in these gardens has been seen as having several positive health benefits including improved access to food and thus nutrition, improved mental health, and increased community development through education. One such study explicitly focused on the health impacts of community gardens. Of note, is the interest presented by people not directly involved in the study, passers-by often asked where they could find a plot (to participate in the gardens.)

In fact, the interest was such that most of the gardens had waiting lists for planting areas (Wakefield, Yeudall, Taron, Reynolds, & Skinner, 2007). Some of the ways in which this health promotion research and program affected participants include: switching to eating more vegetables, becoming part of a healthy community while still feeling connected to their culture by growing greens from their country, feeling some of their financial disparity in regards to attaining healthy food items, lighten and seeing the benefit of spending time and money on the community gardens as a way of promoting a healthy society. (Wakefield et al, 2007).

Policy Change Programs

In early December of 2016, the International Symposium on Sustainable Food Systems for Healthy Diets and Improved Nutrition was held. It was set to explore policies and program opportunities for influential food systems that deliver foods for a healthy diet, focusing on concrete country experiences and challenges. The target audience included government officials with policy-making and program-design mandates from agriculture, nutrition, health, and other relevant sectors. The audience also included legislators and non-state actors from civil society as well as private sector research/academic institutions. Among the main themes of the symposium were policy and procedure implementations for increasing access to healthy diets and policies as well as for empowering consumers, through educational programs, to choose healthy diets (WHO, 2016). This recent symposium shows the power and necessity of policy in creating sustainable agriculture and diets, as well as the important role of the regulatory sectors in meeting sustainability objectives.

Non-Governmental Organization's role in Sustainability Education

An article published by Climate Change in 2013 suggested that there is a continued need for non-governmental organizations (NGOs) to create public education campaigns to help promote

national-level policies to reduce meat consumption as part of an effort to address many of the environmental factors (i.e. GHG emissions, pollution, and natural resource depletion) of continued unsustainable food production and consumption (Laestadius et al, 2014). After a qualitative research study was conducted to understand how and to what extent non-governmental organizations in the U.S., Canada, and Sweden have worked to educate consumers on reducing and altering meat consumption, the research determined that almost all the NGOs examined had no formal campaigns or education programs to reduce meat consumption (Laestadius et al, 2014). NGOs have the power to promote both local and national policy. They also have the power to educate and endow the consumer into action to do the same. There is a clear and important role NGOs play in sustainable agriculture and diet educational campaigns and policy promotion and a continued need for them to do so.

With food production sustainability and environmental procedure implementation, there is “no one size fits all” solution. Likewise, health promotion as it relates to sustainable agriculture cannot be approached with a “one size fits all” program. Different audiences call for different health promotion techniques and considerations. Further research and program evaluation is needed if “best” education practices, organizational policies, and individual behaviors regarding sustainable food production and nutrition are to be successfully effected and employed. Even so, one key theme emerges from this closer look at individual health promotion programs regarding sustainability; health education that includes experience-based learning has the power to motivate change. One reason for this is because it has the power to affect and to change attitudes. Individual, societal, and institutional behaviors that are influenced by attitudes tend to be strong and enduring. Health education must not just tell them, it must show them.

Health Promotion that has the Power to Change Sustainable Agriculture and Diet Determinants

There are many techniques an educator may use to impart knowledge. Learning the facts and information about a subject is very important if one is to even attempt to make decisions in regards to the subject. But besides facts and numbers, there is a type of teaching/learning process that imparts, not only knowledge, but has the potential to sway or even completely change a person's attitudes and belief system. This is sometimes called the Direct-Experience Principle (Heberlein, 2012).

This teaching/learning technique is based on the idea that attitudes that are built on direct experiences are stronger, more central and harder to change. They are also more tied to our behavior. "If we can give people direct experience, their attitudes will likely change," (thus their behavior will likely change) "and the changes will likely persist" (Heberlein, 2012 pg. 163). This was made apparent by examining the community participant's attitudes in response to the direct experience based learning program of the community garden. The Food for Life Partnership Program (FFLP) also showed how experience based education programs change attitudes and behavior, as it was found that gardening activities at school, home and the community can encourage children to eat more fruits and vegetables.

At Arizona State University's School of Sustainability, experience based learning is part of their academic program. Experience based learning, sometimes referred to as problem- and project-based learning (PPLB) is the idea of educating students in real-world settings. This style of education allows the student to address "real" problems. PPLB has the potential to produce education programs that promote changes in attitudes and behaviors of both teachers and those

they seek to educate in sustainability issues of all topics including sustainable agriculture and nutrition (Wiek, Xiong, Brundiers, & Leeuw, 2014).

Conclusion

The integrations of the academic disciplines of geography/environmental studies, nutrition and health promotion and how important they are in consideration of the issue of sustainable food production and nutrition have been thoroughly examined.

There are other disciplines that could and should be considered as well in working towards truly sustainable agriculture that involves conservation of natural resources, food security, a nutritive focus and programs to impart its importance and teach skills. But the evidence suggesting that geography, nutrition, and health promotion are integral disciplines to the problem and therefore must be part of the solution, is great. Individuals, groups, and societies the world over need to move towards securing sustainable ways and practices in consideration of local, regional and global food production. They need to do so in ways that conserve and enable continued use of our earth and its natural resources. They need to do so in ways that also provide increased nutrition over increased calories. And, they need to know the whys and the how's of accomplishing this. The ability to produce enough food to feed future populations of over 9 billion affects us all, each and every one. It is time to get the thesis and antithesis going so that a synthesis of solutions can be reached and a sustainable future might be attained in food production and nutrition; a defined behavior that is essential to all life on earth.

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