EVALUATING NUTRITIONAL AND BEHAVIORAL HEALTH AND VEGETABLE CULTIVARS AS PART OF A NATIVE AMERICAN GARDENING PROJECT

by

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Abstract

Due to health and nutritional disparities, prevalence of obesity and related diseases among American Indians is found to be higher than the U.S. general population. To promote a healthy lifestyle, the long term goal of this project is to increase fresh fruit and vegetable availability through gardening for the Prairie Band Potawatomi Nation (PBPN) tribe in Kansas. In achieving this ultimate goal, two studies were conducted with the objectives of: 1) Evaluate the nutritional and behavioral health indicators for the residential population of the tribe and identify key constraints of gardening activity in the reservation; and 2) Conduct vegetable cultivar trials comparing different open pollinated (OP) and hybrid cultivars of tomato (*Lycopersicon lycopersicum*), pepper (*Capsicum annum*) and eggplant (*Solanum melongena var. esculentum*) to identify best yielding cultivars.

Three surveys were conducted to assess the residential population with respect to gardening activity, fruit and vegetable consumption, health status, physical activity and socioeconomic status, using convenience samples. Cultivar trials comparing 6 pepper, 3 eggplant, and 5 tomato cultivars were conducted in 2012 and 2013 growing seasons.

PBPN respondent group revealed significant health disparities compared to the general U.S. and Kansas populations. A higher proportion of this group was in poverty which had strong correlations with land ownership, gardening experience, and attendance to gardening workshops. "No knowledge" and "no space" were identified as key gardening constraints.

Hybrid *Jetstar* was the best tomato cultivar identified, while *Cherokee Purple* was the best yielding OP cultivar. No difference in performance was observed among the three eggplant cultivars tested. Sweet pepper hybrids *Flamingo* and *Alliance* outperformed OP *California Wonder* which was moderate in production. OP chili pepper cultivars *Anaheim 118* and hybrid *Chili G76* outperformed hybrid *Charger*.

Identified best yielding cultivars could be distributed among tribal members to support in-place gardening initiatives. Gardening limitations of "no land" and "no knowledge" could be mitigated by increasing participation at the community garden and attendance for gardening workshops. Strategic approaches should be implemented to attract people in poverty to engage in gardening and increase gardening activity in the reservation for nutritional, health and economic benefits.

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Dedication

To my loving parents, Gamini Galgamuwa and Sunethra Galgamuwa for their endless love, support and motivation throughout my life.

Chapter 1 - Review of Literature

Obesity Epidemic in United States

Incidence of obesity among both adults and children has become a major public health concern in the United States (Adams et al., 2005). According to the latest National Health and Nutrition Examination Survey (NHANES) 2009-2010, more than one-third (35.7%) of adults and 16.9% of children and adolescents aged 2-19 years were obese in the U.S. This accounts for over 78 million adults and about 12.5 million children and adolescents (Ogden et al., 2012). Obesity has become a wide spread epidemic in the country, where 32 states report an adult obesity prevalence of more than 25% in 2008, compared to no states reporting this level in the early 1990s (United States Department of Agriculture and United States Department of Health and Human Services [USDA & HHS], 2010).

In epidemiological studies overweight and obesity is defined based on Body Mass Index (BMI), which correlates with amount body fat (Ogden et al., 2012). These two categories of "overweight" and "obese" represent the ranges of body weights greater than the healthy weight for a given height (Centers for Disease Control and Prevention [CDC], 2012). For adults, BMI is determined by adjusting body weight for height, whereas age and gender is considered in classifying children as overweight or obese (Barlow, 2007; Ogden et al., 2012).

Several studies conducted over the years have found significant associations between obesity and a host of chronic diseases such as type 2 diabetes, hypertension, high cholesterol levels leading to cardiovascular diseases (CVD), asthma and arthritis (Flegal et al., 1998; Mokdad et al., 2003; Must et al., 1999). Estimating the population attributable fraction, Flegal et al. (2005) estimated 112, 000 deaths in United States attributable to obesity in 2000, where he concluded that obesity is associated with increased mortality.

Based on National Health Expenditure Accounts (NHEA) data, Finkelstein et al. (2009), revealed annual medical spending attributable to obesity for the U.S. could be around $147 billion in 2008. They further recognized that obese people spent $1,429 more (42% higher), for medical care relative to normal weight people in 2006. A major portion of these costs are generated from treating chronic diseases and disorders promoted by obesity, such as diabetes and cardiovascular diseases (Finkelstein et al., 2009; Roehrig et al., 2009).

Due to the strong correlation of obesity with other health disorders, many researchers have conducted studies to track the trends and prevalence of adult obesity in the U.S. and identify populations that are prone to obesity. Analyzing NHANES survey data, a significant change wasn't observed during the period of 1960 to 1980 (Flegal et al., 1998). This was followed by a period of increase during the last two decades of the 20th century, showing an approximate increase of 8% between "1976-1980" and "1988-1994" surveys, and "1988-1994" and "1999-2000" surveys respectively (Flegal et al., 2012; Ogden et al., 2012). Flegal et al., (2012), observed that the rate of increase in the population prevalence of obesity is slowing down with no significant increase between estimates for "2003-2008" and "2009-2010". But, they found a significant linear trend from 1999 to 2010 for men and disparities within race/ethnicity groups for women, with no indication of a decline in the prevalence in any group for both men and women.

Cossrow and Falkner (2004) observed racial/ethnic differences in the prevalence of obesity and obesity related comorbidities in the U.S. Minority races; African-Americans, Mexican Americans and American Indians (AI) showed a higher vulnerability to these diseases compared with their white counterparts. The underlying causes for this disparity are very complex to understand. Genetic factors, culture, environment and socioeconomic status are likely to be

contributing to this difference (Caprio et al., 2008; Cossrow and Falkner, 2004; Pena et al., 2012).

Health Disparities among American Indians

The 2010 Census reported 2.9 million respondents representing "American Indian and Alaska Native alone" category and another 2.3 million in combination with another race, accounting for a population of 5.2 million with American Indian and Alaska Native origin (AI/AN) in the U.S. (Humes et al., 2011). There are over 560 federally recognized AI/AN tribes distributed throughout the country (Ogunwole, 2006).

As NHANES survey and many other nutritional surveys do not specifically consider AI reservations in their sample design, data on prevalence of obesity in AI/AN reservations at the national level is rare compared to data available on the U.S. general population (Broussard et al., 1991). But there are various individualized studies conducted with rather smaller sample sizes and mostly confined to a few tribes. The health data reported by the Indian Health Service (IHS) based on its' service population of 1.9 million AI primarily residing on reservations, is the most complete health related data for AI (Story et al., 2003). IHS, within the Department of Health and Human Services (HHS) is the responsible agency in the country for providing federal health services to AI/AN.

Compared to all other races, AI/AN population experiences substantial health disparities (Warne, 2006). This disparity is evident for many health indicators; higher infant mortality, higher age-adjusted death rate for alcoholism, tuberculosis, diabetes, cancer, sexually transmitted diseases and accidents (Forquera, 2001). Barnes et al. (2010) supports this fact by pointing out that AI/AN populations life expectancy at birth is 2.4 years lesser than that of the U.S. general population as an ultimate result of this disparity. Infant death rate for AI/AN is almost double the

rate for whites and the rate for diabetes is found to be more than twice that for whites (United States Department of Health and Human Services [HHS], 2010). Jones (2006) claims that this disparity has persisted for about 500 years since Europeans arrived in the Americas, and to date continue to experience worse health conditions in the country.

Prevalence of overweight and obesity among AI is found to be higher than the corresponding level for the general population of the U.S. (Story et al., 1999; Zephier et al, 2006). Zephier et al. (1999) found that overweight condition among AI youth is twice the corresponding national rate, and adult obesity prevalence is three times higher. Obesity is found be an important risk factor for many diseases such as type 2 diabetes, hypertension, cardiovascular disease (CVD), hypertriglyceridemia, low HDL cholesterol and endometrial cancer in women, and colorectal cancer in men (Story et al., 1999). Heart diseases, malignant neoplasm, unintentional injuries and diabetes mellitus are found to be the leading causes of deaths among AI/AN (IHS, 2013).

It is hard to define a single explanation to this inequality in health status. Explanations are derived relating to various factors such as religion, diet, living conditions, climate, cultural practices, racial differences and socioeconomic status (Jones, 2006). Warne (2006) focuses on genetic predisposition, socioeconomic factors, access to and use of services, and cultural factors as potential causes. IHS (2013) points out inadequate education, poverty, discrimination in health service distribution, and cultural differences as root causes for lower life expectancy and disparity in health condition existing among AI/AN populations. As reported in *Healthy People, 2010* (HHS, 2010), the framework for the nation's health priorities; health disparities observed among different race and ethnic groups is the result of complex interactions among genetic variations, environmental factors, and specific health behaviors.

Factors Associated with High Prevalence of Obesity among American Indians

High prevalence of obesity among AI compared to the general U.S. public may be due to various reasons. Both genetics and the environment are clear determinants of obesity (Story et al., 1999). Genetic predisposition as a contributing factor in developing obesity was emphasized in many research interventions during the past few years. Many studies have revealed that genetic factors possess strong potential to influence obesity, but the association is not clearly understood and requires more research (Perusse and Bouehard, 2000; Story et al, 2003). Warne (2006) argues that genetics is only one component of a much larger and complex set of factors associated with the health of AI such as socioeconomics, poverty related lifestyles, access to healthcare facilities, and cultural factors.

Contribution of genetics in developing obesity is explained by Story et al., (2003) as responsible genes increases the susceptibility of an individual once exposed to an adverse environment characterized by abundance of food that are high in energy density, inexpensive and good tasting. Hence, the contribution of environment in developing obesity is substantial.

The above explanation is more reliable when considering conclusions made by Welty (1991) where he found that obesity was developed among the AI populations only in the last 1-2 generations, when high-fat foods became available and when their lifestyles were changed from active to sedentary mainly due to relocation. Losing their traditional lands, plants, animal herds, water resources, and fish nearly destroyed the traditional AI food systems, food sovereignty, and health and livelihood security (Conti, 2006).

Based on the rapid increase of obesity prevalence observed as a country, environmental change, physical and social factors are more likely to be the major cause rather than a change in a biological factor (Jeffery et al, 2006).

The nutrition transition

Nutritional studies conducted in the first half of the 20th century persistently reports evidence of food insecurity, poor diet quality and quantity resulting in malnutrition among AI communities (Broussard et al., 1991; Compher, 2006; Story et al., 1998). They have had higher childhood malnutrition rates compared to corresponding national rates, as reported at a 1969 conference on nutrition, growth and development of North American Indian Children (Story et al., 1998). By 1991, a significant improvement in nutritional status was achieved through increased food availability, improved health care delivery, housing and sanitation. This progress is signified by a decrease in infant mortality from 62.7 infant deaths per 1000 births in 1955, to 7-9 deaths per 1000 births in 1991 (Story et al., 1998).

In contrast, some other studies conducted in the last two decades of the 20th century elaborates the growing concern over high rates of obesity in AI populations, especially in some reservations in Arizona, Oklahoma and the Dakotas (Broussard et al., 1991; Story et al, 2003; Story et al., 1999; Zephier, 2006).

Compher (2006) clarifies this transition from severe malnutrition to excess obesity experienced by AI/AN populations using 'nutrition transition' paradigm forwarded by Popkin and Larsen, (2004). They propose that this shift in nutritional concerns is a result of changed diet structure and physical activity experienced by modern societies during the last two decades of the 20th century, driven by various social and economic factors. This argument is confirmed by *Dietary Guidelines for Americans, 2010* (USDA & HHS, 2010) demarcating that the epidemic of overweight and obesity prevalent in the U.S. is mainly due to poor diet and physical inactivity.

Several studies conducted over the years have observed that changes occurred in food environments; production and transportation, supply and access, prices, socioeconomic status

(SES) of consumers and their food consumption behavior has simultaneously contributed to a much larger shift in nutritional behavior of the society as a whole (Cutler et al., 2004; Jeffery et. al., 2006; Lakdawalla et al., 2004; Morland and Evenson, 2009; Ogden et al., 2010; Philipson et al., 2004; Rosenheck, 2008; USDA & HHS, 2010).

Popkin and Larsen (2004) observed that during this period people increasingly consumed more energy rich, tasty, affordable foods that are high in saturated fats and sugars, but low in fiber, which are generally known as the "Western diet". Finkelstein and Strombotne (2010) recognized that simple economic forces of price and demand have driven this change in food consumption. They reveal that since early 1980s' the price of fats and oils, sugars and sweets, and carbonated beverages increased at lower rates (30% - 70%) compared to much higher increases observed in more healthful alternatives such as fresh fruits and vegetables (190%), all fruits and vegetables (144%), fish (100%) and dairy products (82%). Cutler et al. (2004) attributes this change in prices to advancements achieved in food processing technologies, and improvement in transportation, reducing the cost of mass production.

Reduced cost of production lead to a dramatic expansion in food supply and availability, increasing the average daily calories available per person in the marketplace by approximately 600 calories during the 40 years between 1970 to 2008 (USDA & HHS, 2010). In addition, an increasing trend is observed in food consumption behavior towards "eating away from home" particularly at fast food outlets, increasing the proportion of calories consumed from food outside of the home (Jeffery et al., 2006; USDA & HHS, 2010). This trend can be correlated with the huge boom in the fast food industry in the U.S., where the number of outlets escalated from about 30,000 in 1970 to more than 233,000 in 2004 making it the most rapidly expanding sector of the food distribution system in the U.S. (Jeffery et al., 2006; Rosenheck, 2008).

Conti (2006) comprehensively explains how relocation and loss of their natural resources cause an erosion in AI health; as subsistence living no longer provided a good life with their traditional occupations such as hunting, gathering and farming steadily shifted to a cash economy, and became more dependent on purchased foods and government food programs. Four main characteristics of this new food eating behavior introduced into AI culture caused a gradual erosion of AI health (Conti, 2006).

1. Drinks contain added sugar and/ or alcohol
2. Meats are processed with added fat and less protein
3. Access to and consumption of fruits and vegetables is low
4. Grains are highly processed and often fried

Sedentary behavior

As explained in *Dietary guidelines for Americans,* 2010 (USDA & HHS, 2010) physical inactivity is the other major contributing factor of the obesity epidemic in the U.S. In contrast to higher energy consumption, a reduction in energy expenditure is evident mainly due to technological advancements, urbanization, economic growth and culture (Popkin and Larsen, 2004).

Technological sophistication has changed the way people get physically active both at home and workplace, shifting from a strenuous lifestyle to a more sedentary one (Philipson et al., 2004). Prolonged exposure to this asymmetry in energy balance leads to overweight and obesity conditions in a society, depending on their genetic predisposition (Compher, 2006). AI/AN people possess a higher genetic risk compared to their white counterparts (Compher, 2006; Warne, 2006), making them more vulnerable to obesity.

Substantial contribution of the environment in developing obesity among AI/AN populations is further proved by a study conducted by Ravussin et al. (1994); they studied the impact of the changed lifestyles of Pima Indians on prevalence of obesity and type-2 diabetes with the use of Pima ancestry as a control group, who are living a more traditional AI lifestyle in rural Northwestern Mexico. They found that, even though both groups share the same genetic predispositions to the conditions, the traditional lifestyle of the Pima ancestry group characterized by low fat and high carbohydrate diet, coupled with greater energy expenditure through physical activity protects them against developing obesity and type-2 diabetes. The traditional Pima Indian diet of 100 years ago had been composed of 70-80% carbohydrates, 8-12% fat and 12-18% proteins; but the composition of the current Pima Indian diet consists of 47% carbohydrates, 35% fat, 15% protein and 3% alcohol (Boyce and Swinburn, 1993; Smith et al., 1996). Though there aren't studies conducted on each of the AI tribes, most tribes that were relocated from their native lands undergo a similar change in diet and physical activity.

Socioeconomic status and local food environment

According to Drewnowski and Darmon (2005) the obesity epidemic in the U.S. is a socioeconomic issue which can be considered as a determinant of local food environments. The importance of socioeconomic status (SES) as a predictor of health has been a topic of interest in health research for more than two decades. SES is an indication of an individual's accessibility to social and economic resources, and the command they have over those resources (Duncan et al., 2002). Winkleby et al. (1992) states SES as one of the strongest and consistent factors of a person's morbidity and mortality.

Education, income and occupation are the most commonly used indicators in measuring SES in health research (Winkebly et al., 1992). Often these factors affect an individual's health

differently at different stages of life, with a possible interaction with other social characteristics such as sex and racial/ethnic group (Braveman et al., 2005). Duncan et al. (2002) suggested that a variety of SES indicators should be used systematically to capture different aspects of overall health. According to Beckles and Truman (2011), income has a direct effect on living standards providing better access to food, housing and health-care services, whereas education is an indemnity for future employment and income; therefore, those two are the most commonly used indicators to assess the influence of SES on health. Inequalities in income and education is associated with variances observed in the prevalence of certain health conditions including obesity, heart disease, high blood pressure, diabetes and low birth weight (HHS, 2010).

As revealed by the 2005-2008 NHANES survey, obesity prevalence among men varied by race and ethnicity while no association being observed between education and obesity. But, women with a college degree were less vulnerable to obesity with respect to less educated women. Overall, obesity prevalence had increased in adults at all income and education categories (Ogden et al, 2010). Based on a comprehensive literature review, Drewnowski and Darmon (2005) states that high rates of obesity is prevalent in lower-income states, lower-income congressional districts and highly deprived areas in the U.S., and increasingly observed among low income and low education individuals, signifying the association between poverty and incidence of obesity and type 2-diabetes. *Healthy People, 2010* (HHS, 2010) reports that population groups that experience the worst health status in the U.S. are the groups that have the highest poverty rates and the lowest education.

Neighborhood characteristics such as SES and race/ ethnic composition have an influence on the local food environment, creating a disparity in food accessibility (Morland & Evenson, 2009). Compared to small grocery stores and convenience stores, supermarkets offer a wide variety of

"heart-healthy" foods at a lower price (Morland et al., 2002; O'Connell et al., 2011). Examining the neighborhood characteristics influencing the location of food stores, Morland et al. (2002) found that supermarkets are predominately found in nonminority and wealthy neighborhoods compared to poor and minority neighborhoods. They further revealed that lack of private transportation available to these communities severely curtails their accessibility to healthy foods, and thereby makes healthy eating habits difficult to achieve.

Compared to the national rate of 14.3%, 27% of AI/AN people nationwide are in poverty (Macartney et al., 2013). They also have a lower median household income ($35,062) compared to the national estimate of $50,046 (U.S. Census Bureau, 2011). Therefore, based on the above facts SES of most AI favors poor local food environments to exist in their reservations and thereby increase the risk of obesity and related comorbidities. Jernigan et al. (2011) supports this argument stating that coupled with structural barriers to physical activity, food insecurity experienced by many AI reservations due to geographic isolation, extremely limited access to fresh produce, and poverty is the central cause for many health disparities AI communities experience. Based on O'Connell et al. (2011) study conducted in Washington state; out of the 29 federally recognized AI reservations, 17 did not have a supermarket on their reservation and the distance for the closest off-reservation supermarket was about 10 miles away, which seriously affects their healthy food accessibility.

Morland et al. (2002) recognizes cost as the most important predictor of dietary choices. Therefore, financial limitations may drive poor people to choose inexpensive, energy-dense foods in order to maximize their spending power (O'Connell et al., 2011).

Prevention of Overweight and Obesity among American Indians

Given the high prevalence of obesity among AI/AN populations, immediate and long-term efforts should be initiated for both prevention and treatment (Story et al., 2003). *Dietary Guidelines for Americans* (USDA & HHS, 2010), a document prepared with the long term goal to facilitate and promote healthy eating and physical activity among all Americans, and reduce health disparities among different social segments, provides the recommendations for developing nutrition-related programs. As explained in this document; maintaining a calorie balance over time between total calorie intake through foods and beverages and total calorie expenditure through metabolic processes and physical activity, is the central focus in the prevention of overweight and obesity conditions.

Healthy People, 2010 (HHS, 2010) recommends to choose a healthy diet that includes vegetables, fruits, whole grains, fat-free or low fat milk products and fish, lean meat, poultry or beans, and engage in regular physical activities to reach and maintain a healthy weight. Simultaneously to selecting healthy foods, it is important to cut back on foods that are high in saturated fats, added sugars, and sodium (USDA & HHS, 2011).

Access, availability and consumption of fruit and vegetables

Consumption of fruits and vegetables (F&V) has many health benefits. A diet high in F&V lowers the risk of many chronic diseases including heart disease, stroke, high blood pressure, diabetes and some cancers, and is also important in weight management (CDC, 2013b; CDC, 2011; CDC, 2010). As outlined in *"Dietary Guidelines for Americans 2012"*, three reasons support the recommendation for increased F&V consumption:

1. Most vegetables and fruits are major sources of many nutrients that are under consumed in the US - folate, magnesium, potassium, dietary fiber and Vitamins A,C, and K.

2. Consumption of F&V is associated with reduced risk of many chronic diseases – at least 2 ½ cups of vegetables and fruits per day is associated with reduced risk of cardiovascular diseases (CVD).
3. Most vegetables and fruits, when prepared without added sugar, are relatively low in calories – helping to achieve and maintain a healthy weight.

It is clearly evident that consumption of F&V, which contains many bioactive compounds including dietary fiber, potassium, antioxidants, vitamin C, and several phytochemicals such as carotenoids, isoflavanoids, glucosinolates and folic acid, would reduce the risk of developing CVD (Hu, 2008; Veer, 2000). Phytochemicals are unique plant-derived compounds that promote good health and protection from many diseases through the consumption of fruits, vegetables, beans, cereals and beverages of plant origin such as tea and wine (Heneman & Zidenberg, 2008). According to Shahidi and Naczk (1995), more than 5,000 phytochemicals are estimated to have been identified and still, there are many that remain unknown. There are a variety of phytochemicals found in F&V that function as antioxidants, phytoestrogens and anti-inflammatory agents (Slavin and Lloyd, 2012).

Flavonoids are the most diverse group of phytochemicals. They are polyphenolic compounds naturally present in many fruits, vegetables and beverages such as tea and vine. Studies have revealed significant associations between flavonoids and reduced risk of mortality from CVD (Hertog et al., 1993).

The non-digestible form of carbohydrates and lignin, naturally occurring in plants are known as dietary fiber (United States Department of Agriculture [USDA], 2012). Soluble and insoluble fibers are the two main types of fiber. Although these forms cannot be digested or absorbed into the blood stream, they play a vital role in maintaining good health by giving a feeling of fullness

on fewer calories, and is also found to be good for the digestive tract and more importantly helps in reducing the risk of obesity and CVD (HHS, 2010b; Slavin and Lloyd, 2012).

As reported in the *State Indicator Report on Fruits and Vegetables, 2013 (CDC, 2013b),* on average, U.S. adults consume fruits about 1.1 times and vegetables about 1.6 times per day, which is below the recommendations forwarded in *The Dietary Guidelines for Americans, 2010.* Only 70% of all census tracts in the U.S. have at least one food retailer offering a wide variety of healthy and affordable F&V within ½ mile, hence, there is much more to achieve with regard to F&V access and consumption in the U.S. (CDC, 2013; CDC, 2013b). As supermarkets are often characterized with a better availability of produce, offering a greater selection at a lower price, living closer to a chain supermarket is associated with increased F&V consumption (Abusabha et al., 2011).

As a measure of increasing F&V consumption, *Healthy people, 2010* (HHS, 2010) designed its' framework with the objectives of increasing the proportion of Americans aged 2 years and above that consume $\geq$ 2 servings of fruit daily to 75%, and $\geq$ 3 servings of vegetables to 50%. However, according to the Behavioral Risk Factor Surveillance System (BRFSS) 2007 survey, the proportion of people meeting these requirements were far below these goals. The survey found only 32.8% of adults and 32.2% adolescents consume daily $\geq$ 2 servings of fruit, 27.4% of adults and 13.2% of adolescents consume $\geq$ 3 servings of vegetables, and 14% of adults and 9.5% adolescents meeting both levels together (CDC, 2009).

Drewnowski and Rolls (2005) stated that accessibility and affordability of foods are crucial factors influencing healthy food choices of individuals. *State Indicator Report on Fruits and Vegetables, 2009* (CDC, 2009) also identifies increased F&V access, availability and affordability as the key strategies to increase F&V consumption in the nation.

Maintaining the health promoting qualities of F&V is vital in developing strategies to increase access and availability; they can either be fresh, frozen, canned or dried but should maintain a certain level of healthfulness (CDC, 2011). As no one food category provides all the required nutrients, consumption of a variety of F&V is necessary to acquire the proteins, vitamins and minerals at required levels for optimum growth and development (Slavin and Lloyd, 2012). Along with other healthy food categories, it is recommended to make half of the plate F&V with essentially red, orange and dark-green vegetables in main and side dishes (USDA & HHS, 2011).

Physical activity

Regular physical activity plays a pivotal role in maintaining a healthy weight and is found to have significant association with reduced risk of developing many chronic diseases including obesity and CVD (Lichtenstein et al., 2006). Physical inactivity has an effect on weight gain and obesity, and thereby increases the risk of developing diabetes (Fretts et, al., 2009). Regular physical activity also has an effect on psychological wellbeing, by reducing symptoms of depression and anxiety (HHS, 2010).

According to *Physical Activity Guidelines for Americans, 2008* (HHS, 2008) adults need at least 150 minutes of moderate-intensity aerobic activity such as brisk walking every week, or 75 minutes of vigorous-intensity aerobic activity such as jogging or running per week.

The Strong Heart Study (SHS) conducted by Fretts et al. (2009) found a significant relationship between physical activity and incidence of diabetes among American Indians, using 1,651 participants from 13 AI communities in Arizona, North Dakota, South Dakota and Oklahoma, with a 10-year follow-up period. SHS study further revealed that men were more active than females, and gardening, walking and hunting were the most common leisure-time activity for

men whereas gardening, walking and dancing were the most common leisure activity for females.

American Indians in Kansas

According to the 2010 census data 5.2 million people were recorded with AI/AN origin, and 15 states had more than 100,000 AI/AN residents (CDC, 2012b). The majority of the AI/AN population were distributed in ten states; California, Oklahoma, Arizona, Texas, New York, New Mexico, Washington, North Carolina, Florida and Michigan (Norris et al., 2012). The largest population of AI/AN was in California (723,225), followed by Oklahoma (482,760) and Arizona (353,386) (CDC, 2012b). Therefore, a large majority of the scientific literature on AI/AN health, nutrition and food environment are focused on tribal communities living in these states (Boyce and Swinburn et al, 1993; Caballero et al., 2003; Edgerly et al., 2009; Fretts et al., 2009; Fleischhacker et al., 2012; Gittelsohn and Rowan, 2011; Gittelsohn et al., 2006; Going et al., 2003; O'Connell et al., 2011, Jernigan et al., 2011; Teufel-Shone, 2006; Zephier et al., 2006; Zephier, et al., 1999).

Comparatively, much less attention has been given to the AI populations living in Kansas in scientific studies. This may be due to the fairly small population of AI/AN living in Kansas, which is reported to be 59,130 alone or in combination with another race (Norris et al., 2012). Historically many AI tribes were native to Kansas, but relocation of many immigrant tribes and the movement of settlers after the Civil War has changed the AI composition in Kansas, where currently only four Indian reservations remain: the Iowa Tribe of Kansas & Nebraska, Kickapoo Tribe in Kansas (KTK), Prairie Band Potawatomi Nation (PBPN), and Sac & Fox Nation of Missouri in Kansas & Nebraska (KSHS, 2013).

Prairie Band Potawatomi Nation (PBPN) tribe in Kansas

PBPN tribe in Kansas is a tribal unit which originated in the Great Lakes area, where they mainly depended on fishing in the lakes, hunting in the forests and trading with other tribes and later with European settlers for nourishment (PBPN, 2009). Currently, the PBPN tribe resides on 77,000 acres of land in Jackson County, Kansas (PBPN, 1998).

Garry E. Mitchell, a PBPN tribal historian reports the process of relocation as follows: after the first contacts with non-Indians in1641, the issue of land resources arose as non-Indians were interested in lands for mines, timber and establishment of towns, cities and ports to cater to the growing needs of the society. The 1830 Removal Act of the U.S. government convinced eastern Indians to move to lands west of the Mississippi river in exchange for their lands. After two temporary stops in Missouri's Platte region in the mid-1830's and the Council Bluffs area of Iowa in the 1840's, in 1846 the PBPN tribe finally settled at present day Kansas in a thirty square mile tract of land. Beginning with 568,223 acres in 1846, negotiations with railroad interests, religious and political involvement and even internal divisions within the tribe caused a 87% loss of lands, ending up with only 77,357 acres in 1847 (PBPN, 2009). The tribe faced another division in 1861, based on a treaty which required the signers to adopt U.S. citizenship by conceding their tribal membership which created the Citizen Potawatomi Nation tribe currently residing in Oklahoma (CPN, 2013).

Currently there are around 5,000 enrolled members of the PBPN (PBPN, 2009). Out of the total population of the tribe a majority do not live on the reservation, where the residential population of the reservation was recorded as 691 (U.S. Census Bureau, 2010).

As discussed earlier, scientific literature available on AI/AN health and nutrition are confined to a few states and sometimes few tribal reservations with larger populations. Therefore, small AI

reservations residing in states with comparatively low AI populations are seriously understudied. Being a reservation with only about 700 residential tribal members, there has not been any systematic studies conducted to measure the health and nutritional status of the PBPN tribal members alone. Even though deficiency of data on small tribes does not affect national level estimations from a statistical point of view, it is important for the tribal governments and interested agencies to have tribe-specific health and nutrition data for decision making with respect to designing health and nutrition-related interventions.

As data on prevalence of obesity and nutritional status is not available specifically for either PBPN tribe or AI residing in Kansas, available data for the State of Kansas can be considered as the best baseline for planning and implementing obesity prevention and treatment activities for PBPN. But, when using this data it is important to consider the health and nutritional disparities existing among AI/AN with respect to the U.S. general population.

Obesity, Physical Activity and Nutrition in Kansas, 2013 (KDHE, 2013) reports evidence of obesity prevalence in the state reaching epidemic proportions, with 64.4% adults being either overweight or obese. A significant increase in obesity prevalence among adults has been observed during the last decade which increased from 20.8% in 2000 to 34.8% in 2011. The strong association of obesity with developing chronic diseases is stressed in this report, where prevalence of diabetes, kidney diseases, depression, arthritis, asthma, CVD, high cholesterol and high blood pressure had found to be significantly higher among obese people compared to those who were not obese.

With respect to guidelines forwarded in *Physical Activity Guidelines for Americans, 2008;* physical activity of 83.5% Kansas adults were found to be insufficient or no physical activity at

all. *Considering the Dietary Guidelines for Americans, 2010;* 44.4% adults consumed fruit less than 1 time per day and 22.3% consumed vegetables less than 1 time per day (KDHE, 2013).

According to county population density subgroups defined in KDHE (2013) Jackson county, in which the PBPN reservation is located, belongs to "densely-settled rural" category (20 to 39.9 persons per square mile). In Kansas, obesity prevalence was significantly higher in "densely-settled rural" counties compared to urban counties (KDHE, 2013).

These data suggest that prevalence of obesity and related comorbidities in PBPN tribe should be considerably high and on the rise, similar to the state and national situations. Therefore, designing obesity prevention and treatment interventions for the PBPN tribe is vital to reverse this epidemic.

In 2009, Centers for Disease Control and Prevention (CDC) released a report; *"Recommended Community Strategies and Measurements to Prevent Obesity in the US*" to be used by communities and local governments to design and implement environmental and policy-level changes for obesity prevention (CDC, 2009b). The 24 recommended strategies in this report were divided mainly into 6 categories:

1. Strategies to promote the availability of affordable healthy food and beverages
2. Strategies to support healthy food and beverage choices
3. A strategy to increase breastfeeding of infants
4. Strategies to encourage physical activity or limit sedentary activity among children and youth
5. Strategies to create safe communities that support physical activity
6. A strategy to encourage communities to organize for change

Project Rationale

Prevalence of obesity in the U.S. is found to be reaching epidemic proportions in recent years, affecting all social segments of the society. In 2010, prevalence of obesity among Kansas adults was significantly higher compared to the U.S. median prevalence of 27.5% (KDHE, 2013).

Prairie Band Potawatomi Nations (PBPN) is an AI tribe residing in Jackson County, Kansas. Being a small tribe, PBPN is understudied with respect to health and nutritional behavior, therefore, lacks research data on the prevalence of obesity in the reservation.

Due to health and nutritional disparities, prevalence of obesity and related comorbidities among AI/AN is found to be significantly higher than the U.S. general population (Story et al., 1999; Zephier et al, 2006). Therefore, knowing the obesity rates for the general population of Kansas, it can be assumed that the incidence of obesity in PBPN to be higher. As obesity is associated with increased risk of developing many chronic diseases, it is vital to reverse the trend of declining health status of the tribe.

As outlined in *Healthy People, 2010* (HHS, 2010); eating a healthy diet high in fruits and vegetables, and engaging in regular physical activities is essential in maintaining a healthy weight. F & V consumption in the U.S. and in Kansas is far below the recommended levels in *Dietary Guidelines for Americans, 2010* (USDA & HHS, 2011).

Healthy food choices are associated with F&V access and affordability. Therefore, increasing availability and affordability are the key strategies to increase F&V consumption (CDC, 2009). Out of the 24 recommended strategies listed in *"Recommended Community Strategies and Measurements to Prevent Obesity in the U.S.*", the first strategy is to promote availability and affordability of healthy food (CDC, 2009b). Using a "veggie mobile" that brought fresh F&V to a low-income neighborhood and selling them at a comparatively lower price, Abusabha et al.

(2011) showed that increasing F&V consumption among low-income seniors is achievable with increased produce availability and affordability.

Not being a farming community, individual vegetable gardens are not common in PBPN tribe. Therefore, the tribal members have to mainly purchase F&V to meet their healthy diet requirement. Supermarkets offer a wide variety of healthy choices at a lower price. But, as SES and neighborhood characteristics such as race/ethnicity are determinants of the local food environment, locating supermarkets in a low-income, non-white neighborhood is erratic (Morland & Evenson, 2008). Therefore, being a population group that has high poverty rates and less education, accessibility to healthy food options is usually curtailed for AI.

Alternatively, if these communities are encouraged to grow F&V on their reservations either in community gardens or individual home gardens, they can increase the availability and thereby affordability of fresh produce within their reservation.

Objectives

To promote a healthy lifestyle, the long term goal of this project is to increase fresh fruit and vegetable availability through gardening for the PBPN tribe in Kansas through determining the best vegetable cultivars for soils and climate of their reservation, mentoring and culturally relevant gardening education.

In achieving the ultimate goal of the project, this thesis is designed as a part of the project with two main objectives:

1. To better understand the health and nutritional status on the reservation, evaluate the nutritional and behavioral health indicators for the residential population of the tribe and identify key constraints of gardening activity in the reservation.
2. Conduct vegetable varietal trials to evaluate the suitability of different open-pollinated and hybrid varieties of tomatoes, peppers and eggplants to Kansas soils and climate.

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Chapter 2 - Evaluation of Nutritional and Behavioral Health Indicators of the Prairie Band Potawatomi Nation Tribe in Kansas

Abstract

Due to health and nutritional disparities, prevalence of obesity and related diseases among American Indians is found to be higher than the U.S. general population. To promote a healthy lifestyle, a gardening project was designed with the long term goal of increasing fresh fruit and vegetable availability through gardening for the Prairie Band Potawatomi Nation tribe in Kansas. The objective of this study was to evaluate the nutritional and behavioral health indicators for the residential population of the tribe and identify key constraints of gardening activity in the reservation. Three surveys were conducted to assess the residential population with respect to gardening activity, fruit and vegetable consumption, health status, physical activity and socioeconomic status, using convenience samples. The respondent group exhibited significant health disparities compared to the U.S. and Kansas populations. Fifty percent of the respondents met the recommendation for fruit consumption, but only 22% consumed vegetables at recommended levels. A substantial portion of the group (30%) was below the poverty threshold which had strong correlations with level of education, land ownership, gardening experience and attendance to gardening workshops. “No knowledge’ and “no space” were identified as major gardening constraints. By increasing participation at the community garden and attendance for gardening workshops these limitations could be mitigated. Complex interactions between behavioral, nutritional and social factors manifest in a negative health outcome among the tribal members. High rates of poverty could be imposing a significant community effect on the health outcome and is also associated with gardening activity. Therefore, strategic approaches should be implemented to attract these people in poverty to engage in gardening, and thereby increase gardening activity in the reservation for nutritional, health and economic benefits.

Introduction

Compared to other races in the United States, American Indian and Alaska Native (AI/AN) populations experience substantial health disparities which are reflected through many health indicators (Forquera, 2001; Warne, 2006). This is supported by the fact that prevalence of obesity and related comorbidities among AI/AN is being significantly higher than the U.S. general population (Story et al., 1999; Zephier et al, 2006). Obesity is found to be an important risk factor for many diseases such as type 2 diabetes, hypertension, cardiovascular disease (CVD), hypertriglyceridemia, endometrial cancer in women, and colorectal cancer in men (Story et al., 1999).

In contrast to the current situation of high prevalence of obesity, nutritional studies conducted in the first half of the 20th century persistently reported evidence of food insecurity, poor diet quality and quantity resulting in malnutrition among AI communities (Broussard et al., 1991; Compher, 2006; Story et al., 1998).

Compher (2006) clarifies this transition from severe malnutrition to obesity experienced by AI/AN populations as a 'nutrition transition' paradigm forwarded by Popkin and Larsen, (2004). They propose that this shift in nutritional concerns is a result of changed diet structure and physical activity experienced by modern societies during the last two decades of the 20th century, driven by various social and economic factors. This argument is confirmed by *Dietary Guidelines for Americans, 2010* (United States Department of Agriculture and United States Department of Health and Human Services [USDA & HHS], 2010) demarcating that the epidemic of overweight and obesity prevalent in the U.S. is mainly due to poor diet and physical inactivity. Given the high prevalence of obesity among AI/AN populations, immediate and long-term efforts should be initiated for both prevention and treatment (Story et al., 2003).

According to the 2010 census data 5.2 million people were recorded with AI/AN origin in the U.S. with only 15 states recording more than 100,000 AI/AN residents (Centers for Diseases Control and Prevention [CDC], 2012b). The majority of scientific literature on AI/AN health and nutrition are confined to tribal communities with large populations. Comparatively, much less attention has been given to the AI populations living in Kansas. This may be due to the fairly small population of AI living in Kansas, which is reported to be 59,130 alone or in combination with another race (Norris et al., 2012). The Prairie Band Potawatomi Nation (PBPN) in Jackson County, Kansas is one of the four federally recognized AI tribes residing in Kansas (KSHS, 2013). According to the official website of the PBPN tribe (2009) there are around 5,000 enrolled members of the tribe but, the majority do not live on the reservation. According to the U.S. Census Bureau (2010) the residential population of the tribe is 691. Being a small tribal unit, there is a lack of research data available on the health and nutritional behavior of the PBPN tribal members residing on the reservation.

As outlined in *Healthy People, 2010* (United States Department of Health and Human Services [HHS], 2010), eating a healthy diet high in fruits and vegetables (F & V), and engaging in regular physical activities (PA) is essential in maintaining a healthy weight. But, F & V consumption in the U.S. and in Kansas is far below the recommended levels in *Dietary Guidelines for Americans, 2010* (USDA & HHS, 2011).

Availability of F & V in the home food environment provides easily accessible healthy food choices for individuals, which is a crucial factor influencing F & V consumption (Drewnowski and Rolls, 2005; Story et al., 2008). Gardening-based nutrition-education has proved to be an effective tool to increase F & V intake and PA, especially among the youth (Robinson O'Brien,

2009; Hermann et al., 2006). Park et al., (2008) stated that gardening provides a low to moderate intensity PA for older adults.

Therefore, to promote a healthy lifestyle, a gardening project was initiated in Spring 2012 by Kansas State University Research and Extension in cooperation with Haskell Indian Nations University (HINU) and PBPN Health Center. The long term goal of this project was to increase fresh F & V availability through gardening for the PBPN tribe in Kansas.

The objective of this study was to evaluate the nutritional and behavioral health indicators: gardening activity, fruit and vegetable consumption, health status, physical activity, and socioeconomic status for the residential population of the tribe and identify key constraints of gardening activity in the reservation.

Materials and Methods

This study was reviewed by the Institutional Review Board (IRB) of Kansas State University and was exempted from further review (Appendix A.1).

For the purpose of this study the residential population of the tribe (N = 691) was divided into two groups: workshop participants (WP) and non-workshop participants (NWP). Three surveys were conducted to gather information using convenience samples of these two groups. This information were used to make inferences about the population of interest, and understand delineating characteristics of the WP group driving them to engage in project activities. In all the surveys the respondents were PBPN tribal members aged 18 years and older.

Pre-season gardening survey 2012

Initiating the project in spring 2012, the pre-season gardening workshop was held on the reservation with 35 participants. All the tribal members were invited to attend the workshop through advertising in a tribal newsletter and through fliers. A questionnaire was developed to survey the general gardening practices and identify specific gardening related problems to be addressed through the project (Appendix A.2). Table 2.1 summarizes the structure of the survey. There were 21 respondents for the pre-season gardening survey.

Table 2.1 Structure of the 2012 pre-season gardening survey

	Section	No. of questions
A	General gardening	4
B	Seed saving	9
C	Tribal gardening	5

Harvest feast survey 2012

In fall 2012, the gardening project team was invited to attend the annual harvest feast; a large dinner featuring wild game meats and traditional food. This ceremony was organized by the tribal health center as an initiative to promote consumption of traditional food, called "Return to a Healthy Past".

A written questionnaire was developed to survey the gardening activity, consumption of fruits and vegetables, health status, physical activity, and the socio-economic status of the residential population of the tribe, and the WP and NWP groups separately (Table 2.2) (Appendix A.3).

As the tribal members arrived for the ceremony they were given the questionnaire and asked to complete the survey.

Table 2.2 Structure of the 2012 harvest feast survey

	Section	No. of questions
A	Vegetable gardening	5
B	Fruit and vegetable purchase	3
C	Fruit and vegetable consumption	3
D	Traditional foods	3
E	Physical activity	5
F	Health status	4
G	Socio-economic status	8

Raffle tickets for a drawing for a variety of gardening gifts as well as a choice of several thank-you gifts, such as t-shirts and re-usable grocery bags were provided to all that returned the survey. One hundred surveys were distributed, 95 were returned completed for a 95% completion rate. The 95 respondents were composed of 15 WP and 80 NWP.

The Centers for Disease Control and Prevention (CDC) has developed "Chronic Disease Indicators" (CDI) representing a wide range of cross cutting conditions, risk factors, and social contexts which are important to public health practice (CDC, 2012a). The Behavioral Risk Factor Surveillance System (BRFSS) survey of CDC has several questions to measure these CDIs' (CDC, 2013). Exactly the same questions used in BRFSS to measure certain indicators were included in this survey, which made it possible to make comparisons between the U.S. general population, the Kansas population and PBPN tribal members with respect to nutritional and health behavior.

As a measure of increasing F&V consumption, *Healthy people, 2010* (HHS, 2010) designed its framework with the objectives of increasing the proportion of Americans aged 2 years and above that consume $\geq$ 2 servings of fruit per day to 75%, and $\geq$ 3 servings of vegetables per day to 50%. Hence, two questions were included in the survey with a clear clarification of what "a serving" means, to measure the proportion of the population meeting these recommendations.

The health status of the population was determined using a series of questions used in the BRFSS surveys (CDIs): "self-rated health status", "recent activity limitation", "daily activity limitation", and "major impairment or health problem" were estimated for the tribe and compared with corresponding estimates for the U.S. and Kansas.

According to *Physical Activity Guidelines for Americans, 2008* (HHS, 2008) adults need at least 150 minutes of moderate-intensity aerobic activity such as brisk walking every week, or 75 minutes of vigorous-intensity aerobic activity such as jogging or running per week. Four questions were used to estimate the level of physical activity of the respondents.

A series of demographic and socio-economic status (SES) questions were asked including age, employment, household income and education level.

Pre-season gardening survey 2013

The second pre-season workshop was held in spring 2013 with 89 participants (Appendix A.4). There were 44 respondents to the survey. Except for the questions on age and household information, all the other questions were multiple choice type questions (Table 2.3).

Table 2.3 Structure of the 2013 pre-season gardening survey

	Section	No. of questions
A	Vegetable gardening	9
B	Fruit and vegetable consumption	2
C	Socio-economics	5

Data analysis

All data analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp. Armonk, NY, USA). General patterns were observed using descriptive statistics. The population proportion estimates for the questions adopted from BRFSS surveys were compared with corresponding proportions for the U.S. and Kansas using non-parametric chi-square analysis. Relationship between two variables was tested using Pearson correlation analysis. The statistical significance for these tests was established at ($p \leq 0.05$) level.

Determining the poverty status of each respondent was done by comparing the annual household income to a set of dollar values (Table A.5) called "poverty thresholds" that vary by family size, number of children, and age of family members.

When analyzing nutritional and behavioral health data, related federal guidelines and recommendations such as 2010 *Dietary guidelines for Americans* (USDA & HHS, 2010), *Healthy people 2010* (HHS, 2010), and *2008 Physical activity guidelines* (HHS, 2008) were taken into consideration.

Results

General description of the study sample

During the first year 2012, 35 tribal members attended the gardening workshop. This WP group represented 5% of the residential population of the tribe. The WP group in the second year was 89 tribal members which is 13% of the residential population (Table 2.4).

Table 2.4 Description of the study sample – All three survey studies

Event	Total no. of attendees to the event	Representation of the total residential population (%)[a]	No. of respondents to the survey	Representation of the target population (%)	
				WP	NWP
Pre-season workshop (2012)	35	5.06%	21	62%[c]	-
Harvest feast (2012)	200	28.9%	95[b]	-	-
- WP	-	-	15	42%[c]	-
- NWP	-	-	80	-	12.1%[d]
Pre-season workshop (2013)	89	12.9%	44	49%[e]	-

[a] Total residential population (N) = 691

[b] Total respondents composed of 15 WP and 80 NWP

[c] Target population is the WP group, at this stage WP (n = 35)

[d] Target population is the NWP group, at this stage NWP (n = 656)

[e] Target population is the WP group, at this stage WP (n = 89)

Inferences on the WP group can be made using the data from the two gardening workshop surveys, and the responses of the 15 WP of the survey conducted at the harvest feast. In each of these instances there was more than 40% representation of the target group. The total 95 respondents to the harvest feast survey were used to make inferences on the residential population, which had a 29% representation.

Characteristics of PBPN residential tribal members

The following sections makes inferences on the residential population of the tribe using the combined data of the 95 respondents to the survey conducted at the harvest feast, 2012.

Gardening activity

The majority of the respondents (74%) reported less than 5 years of gardening experience. The percentage with no previous gardening experience was 41%. For those with no gardening experience 50% indicated "no land" and 11% "no knowledge" as their major reason for not gardening.

Tomato and pepper were the two most commonly grown vegetables on the reservation while corn, which has a cultural significance in AI communities, was third (Figure 2.1).

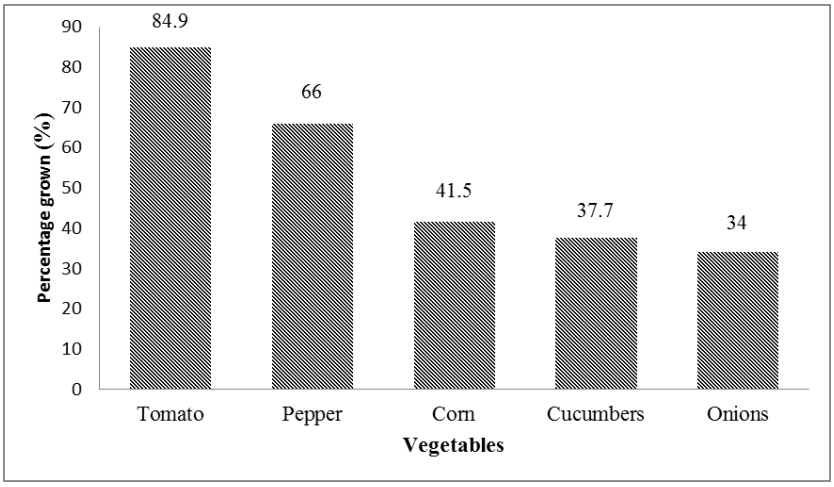

Figure 2.1 Most commonly grown vegetables in the reservation

Fruit and vegetable consumption

Mean number of servings of F & V consumed per day were 1.7 (95% CI; 1.5, 1.9) servings of fruits, and 1.9 (95% CI; 1.7, 2.1) servings of vegetables.

Fifty percent of the respondents reported consuming two or more fruit servings per day which was significantly higher than for the Kansas χ^2 (1, N= 95) = 36.28, $p < .001$, and the U.S. χ^2 (1,

N= 95) = 13.27, $p < .001$ populations. The proportion of respondents consuming three or more vegetable servings per day was similar to the Kansas and U.S. populations.

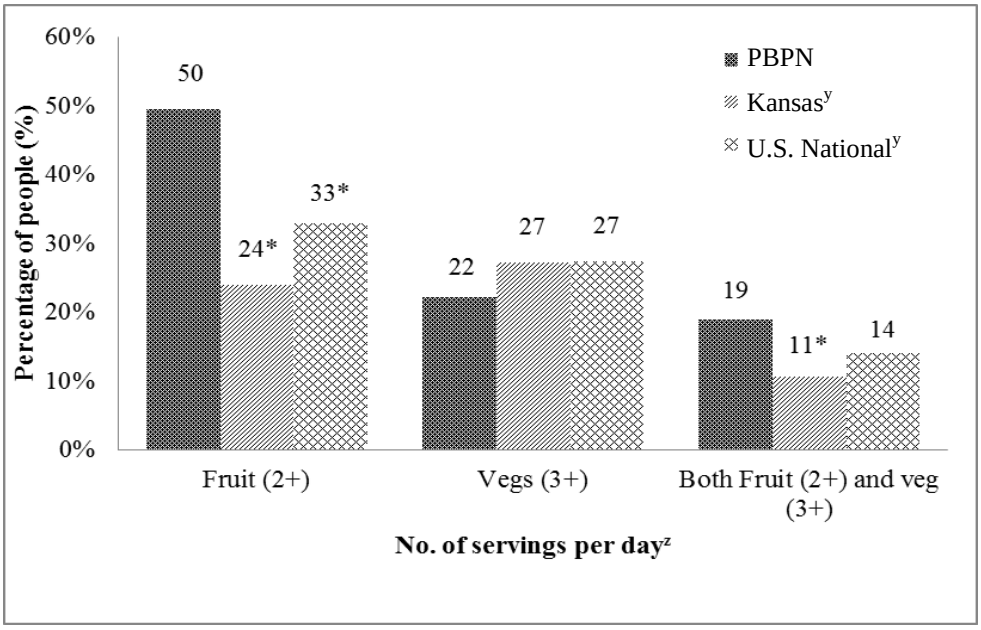

Figure 2.2 Fruit & vegetable consumption in PBPN compared with state and national level

[z] * Indicates corresponding proportion for PBPN is significantly different from this proportion ($p \leq 0.05$) by Chi square (χ^2) test.

[y] Data on F & V consumption for the U.S. and Kansas populations: CDC (2009)

Health status

Used as a CDI, *BRFSS 2010* CDC (2010b) measured the proportion of the population self-rating themselves either as "fair or poor" in general health. Results of this survey had revealed that 16.9% of the U.S. population rated themselves as "fair or poor", and the Kansas population was 16%. Using the same question it was found that the corresponding proportion for the PBPN tribe was 33.7%. This was significantly different compared with both the U.S. χ^2 (1, N= 95) = 22.30, $p < .001$, and Kansas χ^2 (1, N= 95) = 25.60, $p < .001$ proportions.

BRFSS 2010 used activity limitation among adults as a health indicator where each respondent reported the number of days during the past 30 days in which usual activities such as self-care,

work, gardening or recreation was limited due to poor physical health (CDC, 2010b). This measure is also used as a CDI. This is reported as the mean for the population group. Respective mean number of days for the U.S. population: 2.3 days (95% CI: 2.2, 2.4), Kansas: 1.7 days (95% CI: 1.5, 1.9) and PBPN: 3.54 days (95% CI: 2.1, 5.0).

Even though not considered as a CDI, *BRFSS 2011* (CDC, 2011a) estimated that 24.3% of the U.S. population, and 23% of the Kansas population are limited in daily activities due to either physical, mental, or emotional problems. In the harvest feast survey a similar question was included, with 34.7% of the respondents reported being limited in daily activities because of an impairment or health problem. Even without considering mental or emotional conditions, this proportion for the PBPN was significantly higher compared with the U.S. χ^2 (1, N= 95) = 9.26, p = 0.002, and Kansas χ^2 (1, N= 95) = 11.48, p = 0.001 proportions.

Prevalence of arthritis was the health problem indicated by a majority as the major reason for their limited physical activity. Out of the total respondents 12.6% indicated that they are limited in activity due to arthritis. This is comparable with the proportion for the U.S. (11.2%) and Kansas (10.6%) populations (CDC, 2009).

Comparing their health to the health of the rest of the community in general: 35.8% (n=34) rated themselves as having "excellent or better", 42.1% (n=40) "about the same", and 12.6% (n=12) "worse or significantly worse" health statuses. In combination, 77.9% of the respondents indicated their health status is "about the same or better" compared to the health of the rest of the community. Out of this 77.9% of respondents, 25.7% self-rated their general health status as "fair or poor", responding to a previous question.

Physical activity

There were no significant differences observed between the proportions of the various populations meeting the physical activity (PA) recommendation of at least 150 minutes a week of moderate intensity PA or 75 minutes a week of vigorous intensity PA (HHS, 2008). About 50% met the recommendation (PBPN: 50.5%, U.S: 51.0%, and Kansas: 48.5%).

Self-reporting "good or better" health and meeting the PA recommendation was found to be correlated, r (84) = 0.26, $p < .05$.

Socio-economic status (SES)

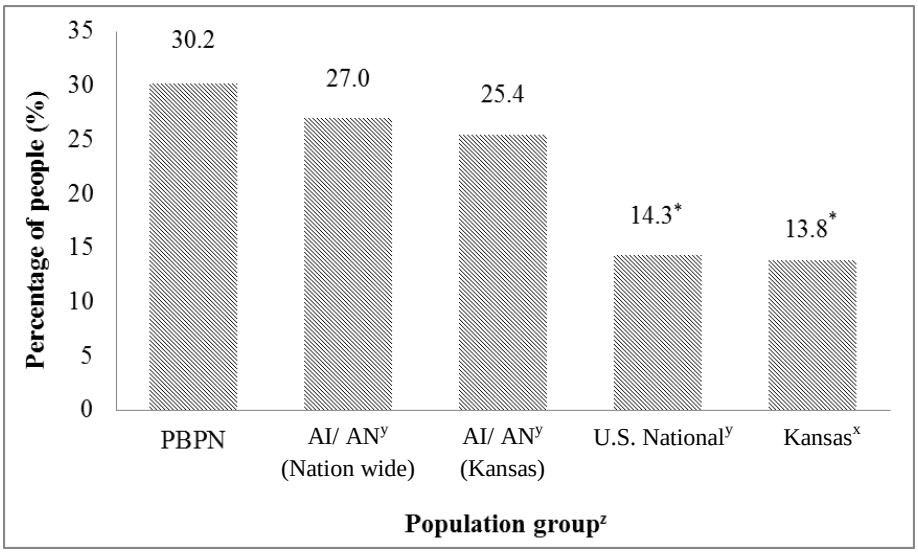

Figure 2.3 Percentage of people below poverty level, in different population groups

[z] * Indicates corresponding proportion for PBPN is significantly different from this proportion ($p \leq 0.05$) by Chi square (χ^2) test.

[y] Data on poverty rates for the U.S. and American Indian/Alaska Native population groups: Macartney et al. (2013)

[x] Data on poverty rates for the Kansas population: Bishaw (2012)

The percent of PBPN below the federal poverty threshold was similar to the nationwide and Kansas AI/AN populations but was significantly higher compared with the estimates for the U.S.

χ^2 (1, N= 95) = 15.80, $p < .001$, and Kansas χ^2 (1, N= 95) = 12.39, $p < .001$ populations (Figure 2.3).

The mean and median age of the PBPN respondent group was estimated to be 48.2 and 47 respectively. As illustrated in figure 2.4, the respondent group showed a bimodal age distribution with an aggregation into two age groups; "above 65" and "between 18 to 30".

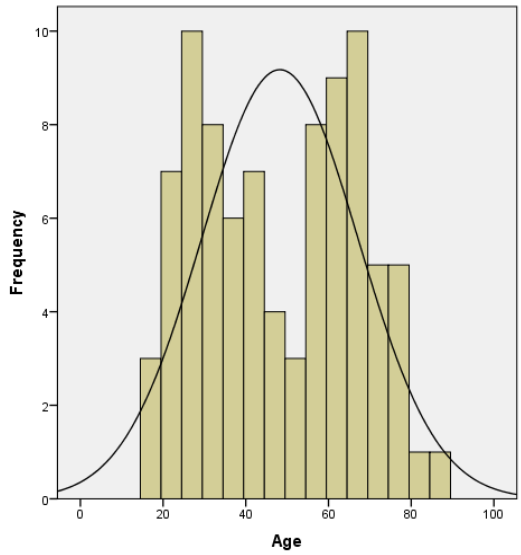

Figure 2.4 Age distribution of the respondent group

A total of 27% mentioned their current status as "retired and unemployed". But, this might include people who served in the military and retired at an earlier age than 65. Hence, after re-categorizing the respondents into two groups, "18 to 64" and "65 and older", it was found that 25.3% of the respondents were above 65 years of age. In comparison the U.S. and Kansas populations were both composed of 13.3% of people above 65 years of age. A significant difference was observed between these two proportions χ^2 (1, N= 95) = 10.84, $p < .001$.

A majority (56.2%) had an education level of higher than high school level, and this is comparable to the U.S. (54.8%) and Kansas (60.7%) levels. Respondents "general health" (self-rated) was found to be significantly associated with "level of education". Self-rating themselves with "good or fair" health was positively correlated with having a minimum of high school level

education r (87) = 0.22, $p < .05$. In addition, the two variables "being in poverty" and "educational level" were correlated r (74) = 0.50, $p < .05$.

To measure the influence of having their own land on gardening activity, the respondents were asked whether they own or rent the place where they live. The majority (52.6%) of the total group owned, 38% rented while 9.5% skipped answering this question. A correlation between "poverty" and "land ownership" was observed, where "falling below the poverty threshold" being positively correlated with "not owning the land", r (70) = 0.47, $p < .05$. Land ownership was also found to be positively correlated with gardening experience, "land ownership" positively correlated with having more than 5 years of gardening experience r (82) = 0.30, $p < .05$. Different land ownership categories exist in AI reservations as there are privately owned and tribally owned lands, which were not documented in this study. This fact will be further addressed in the discussion section.

Workshop participant (WP) and non-workshop participant (NWP) groups

Gardening activity

A major portion of the WP group (60%) were experienced gardeners with at least 5 years of gardening experience compared to only 19% in the NWP group (Figure 2.5). Similar results were obtained for the WP group from the 2013 pre-season gardening survey where 53.3% had more than 5 years of gardening experience. The portion with no previous experience in gardening in the NWP group was 46%. Out of this 46%, 55% mentioned "no land" and 12% "no knowledge" as the major reason for not gardening. Therefore, if we consider the total number of respondents (N = 95), the portion that did not engage in gardening due to "not having land" and "no knowledge" was 27%.

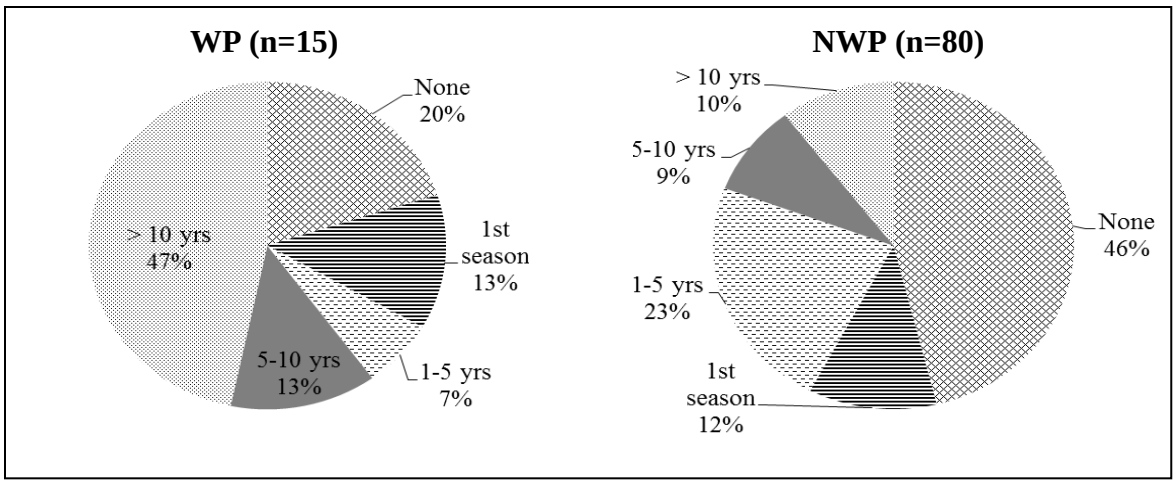

Figure 2.5 Comparison between workshop participants (WP) and non-workshop participants (NWP) groups based on gardening experience

Through the 2013 gardening survey it was found that 86.4% of the respondents (WP) grew vegetables at their home garden, and another 9.1% in "patio or container".

Tomato and pepper were the two most commonly grown vegetables by both the WP and NWP groups (Figure 2.6). But, the order of popularity of various vegetables changed between the two groups thereafter. The same order of preference for WP group was observed in the 2012 Pre-season survey as well (Figure 2.1).

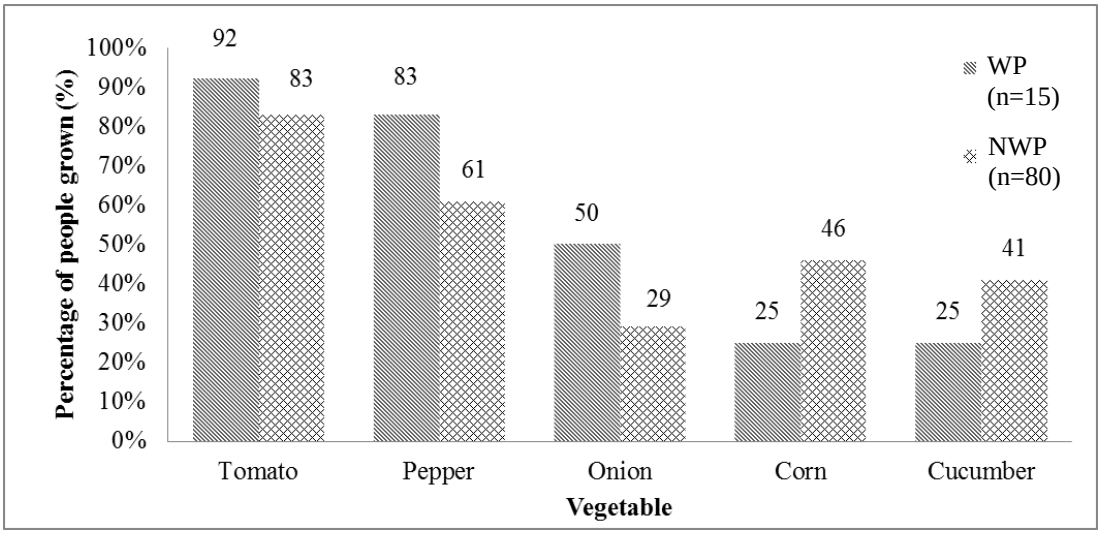

Figure 2.6 Most commonly grown vegetables by workshop participants (WP) and non-workshop participants (NWP) groups

Health status and nutrition

Considering the general health status of the NWP group, 36.3% of the respondents self-rated their health status as "fair or poor". Similar to the response of the whole group of respondents, this estimate was significantly higher compared with the U.S. (16.9%) χ^2 (1, N= 80) = 24.45, $p <$ .001, and Kansas (16%) χ2 (1, N= 80) = 27.76, $p <$ .001 estimates. But, the corresponding proportion for the WP group was considerably lower at 20%, which was not significantly different from the proportions for the U.S and Kansas. The mean number of days during the past 30 days respondents reported activity limitation was 4.1 days (95% CI: 2.5, 5.9) for the NWP, where as it was less than 1 day (0.4) (95% CI: -.1, 1.0) for the WP group.

No significant differences were observed between WP and NWP groups with respect to fruit and vegetable consumption

Socio-economic status (SES)

The proportion of the NWP group falling below the poverty threshold was 33.8%, and this was higher than the estimate for the whole group (30.8%). The above value for the NWP group was significantly higher compared with the U.S. (14.3%) χ^2 (1, N= 68) = 21.15, $p <$ .001, and Kansas (13.8%) χ^2 (1, N= 68) = 22.91, $p <$ .001 estimates. In contrast the WP group did not have any respondents falling below the poverty threshold. Participation in the workshop was found to be correlated with poverty; where "falling below the poverty threshold" and "not participating in the workshop" being positively correlated r (74) = 0.23, $p <$ .05.

All the above results were based on the 2012 harvest feast survey. The 2013 pre-season gardening survey assessed the SES of the WP group as well. But, compared to 2012 the WP group increased in number (n = 89). At this survey 15.9% of the respondents were reported to be falling below the poverty threshold, which was comparable to the corresponding record for the

U.S. and Kansas. But, it was significantly different than the proportion observed for PBPN at the harvest feast survey (30.2) χ^2 (1, N= 43) = 3.95, p = 0.047.

As recorded at the harvest feast survey, the median age of the NWP group was 44.5 years, while 58 years being the median age of the WP group. At the 2013 pre-season survey the new median age of the WP group was 61.5 years. Meanwhile, 38.6% of the respondents to the 2013 pre-season survey were “65 or above” in age.

Discussion

Health disparities experienced by AI communities compared to the general U.S. population are revealed through many nutritional and health research literature. Jones (2006) claims that this disparity has persisted since Europeans arrived in the Americas, and to date AI communities continue to experience the worst health conditions in the country.

This disparity in health status is expressed in the PBPN respondent group when comparisons are made with the U.S. and Kansas populations. The first indicator used to measure the health status was "fair or poor self-rated health status among adults aged $\geq$ 18 years" as defined by CDC in BRFSS survey resources (CDC, 2010b). The proportion rating them in this category for PBPN was twice the proportions for U.S. and Kansas, and was significantly different. This indicator is found to be a strong measure of overall health status, and it does correlate with subsequent health service use, functional status and mortality (CDC, 2012c). Therefore, this suggests that the health condition of this group is comparatively poor. A considerable proportion of the respondents who indicated their health status is "about the same or better" compared to the health of the rest of the community, self-rated their general health as "fair or poor". This might be an indication of severe health problems prevailing in this community.

"Recent activity limitation among adults aged $\geq$ 18" was another indicator adopted from the BRFSS 2010 survey which was reported as the mean number of days for a particular population (CDC, 2010b). This estimate was higher for the PBPN respondent group compared with the U.S. and Kansas populations. The significance of this measure is explained by CDC (2012c) as; activity limitation interferes with social functioning, health behavior and is an indicator of population productivity.

A major portion of the PBPN respondent group (34.7%) was limited in daily activities either due to impairment or a health problem. This proportion was significantly higher than the U.S. and Kansas levels even without considering mental or emotional problems, which was included in the question included in the BRFSS 2011 questionnaire (CDC 2011b). Arthritis was the major health problem in the community, which is comparable to the prevalence at state and national levels. When conducting the survey it was visually observed that many of the respondents were either overweight or obese. But, surprisingly this was not expressed in the data, where only one respondent admitted being obese. This is a common feature in a self-reported health survey. Many studies testing the validity of self-reported overweight and obesity condition, or mentioning their height and weight has revealed that these data should be used with caution as they are low in accuracy (Flood et al., 2000; Elgar et al., 2005).

Considering all the above factors it is conclusively evident that this respondent groups' health status is significantly poorer compared to the general population of the U.S. and Kansas, and similar to many AI communities in the U.S.

As reported in *Healthy People, 2010* health disparities observed among different race and ethnic groups is the result of complex interactions among genetic characteristics, environmental factors, and specific health behaviors (HHS, 2010). Consuming a diet high in fruits and vegetables is one such behavior which is associated with lowering many chronic diseases including heart disease, stroke, high blood pressure, diabetes and some cancers, and also important in weight management (CDC, 2013b; CDC, 2011b; CDC, 2010). Taking this into consideration, *Healthy People, 2010* designed its framework with the objective of increasing the proportion of Americans aged 2 years and above that consume $\geq$ 2 servings of fruit per day to 75%, and $\geq$ 3 servings of vegetables per day to 50% (HHS, 2010).

Considering the nutritional behavior of the community, a higher proportion (50%) met the recommendation for fruit consumption compared to the U.S. and Kansas populations (Figure 2.2). But, still it was far below the targeted level defined in *Healthy People 2010* objectives. Comparatively a lower percentage (22%) met the recommendation for vegetable consumption. A proportion of 27% consumed more than 5 servings of F & V in any combination. But, only 19% met both recommendations for fruits ($\geq$ 2 servings per day) and vegetables ($\geq$ 3 servings per day) together. This suggests that many people meet the requirement of 5 servings per day through fruits, but do not consume vegetables as required. The type of fruits mainly consumed was not identified through the survey, which would have been interesting to look at. As no one food category provides all the required nutrients, consumption of a variety of F&V is necessary to acquire the proteins, vitamins and minerals at required levels for optimum nutrition (Slavin and Lloyd, 2012). Along with other healthy food categories, it is recommended to make half of the plate F&V with essentially red, orange and dark-green vegetables in main and side dishes (USDA & HHS, 2011). Therefore, this can be identified as a potential area of improvement for the tribe. If it is possible to increase the vegetable consumption, a larger portion would consume a balanced diet as fruit consumption is already high in the community. Meanwhile high PA was observed among the respondent group as 50% were engaging in PA at recommended levels which is comparable to U.S. and Kansas levels.

The importance of socioeconomic status (SES) as a predictor of health has been a topic of interest in health research for more than two decades. SES is an indication of an individual's accessibility to social and economic resources, and the command they have over those resources (Duncan et al., 2002).

By race the highest national poverty rates exist within AI/AN communities, and this was similarly expressed in the PBPN respondent group as 30% of them were below the poverty threshold. This was twice the proportion estimated for both Kansas and U.S. populations. *Healthy People, 2010* (HHS, 2010) reports that population groups that experience the worst health status in the U.S. are the groups that have the highest poverty rates and the lowest education. But, the level of education as a group was comparable to U.S. and Kansas populations, and it was found to be positively correlated with general health of an individual.

Looking back at the above findings contradictory results were obtained concerning physical and nutritional health behavior affecting general health of this group. Compared to U.S. and Kansas populations the PBPN tribe had higher fruit consumption with comparable levels of vegetable consumption, PA and educational level, yet we see a negative health outcome as a group. On the other hand, a high rate of poverty was observed among this group, which might impose a significant community effect on the health outcome. Therefore, this suggests the existence of a complex interaction between behavioral, nutritional and social factors affecting the health behavior of this population.

Therefore, it is possible to consider that high poverty rates observed within the community is an important predictor of deprived health. Poverty was also negatively correlated with education level. Morland & Evenson (2009) reported that SES of a community has an influence on their local food environment. Being a population group that has high poverty rates, AI/AN communities experience problems with healthy food accessibility. Several studies conducted on gardening and healthy eating has shown that gardening based nutrition education to be associated with increased F & V consumption and PA (Robinson O'Brien, 2009; Hermann et al., 2006; Park

et al., 2008). These findings highlight the importance of reaching people in poverty through this gardening project and assist them to adopt a healthier lifestyle.

The long term goal of the project is to increase the availability of fresh F & V on the reservation through gardening. But, at the initial stage only a small portion of the residential population got involved in project activities and participated in workshops. In order to achieve the overall goal of the project it is vital to reach more tribal members and motivate them to engage in gardening activities. Therefore, it is necessary to identify delineating characteristics of the WP group compared to the NWP, so that strategic approaches could be followed to attract more tribal members to engage in gardening activities.

Comparing the health indicators with the U.S. and Kansas levels, significant differences were observed for the NWP group similar to the aggregated values obtained for the whole tribe. But, for the WP group these estimates were comparable with the U.S. and Kansas estimates, suggesting that the WP group comparably have a better health status on average.

The WP group is composed of more experienced gardeners compared to the NWP group, where a major portion of the NWP group (46%) did not have any previous gardening experience (Figure 2.5). Twenty-seven percent of the total respondents did not engage in gardening due to either “no land” or “no knowledge”. Land ownership was found to be correlated with gardening experience, which explains the previous fact that people who do not own land did not engage in gardening. The strong correlation observed between land ownership and poverty suggests that, indirectly, poverty or the SES of the individual plays a deterministic role in gardening activity. Meanwhile, participation in the workshop was found to be correlated with poverty. Considering the above explained influence poverty has on gardening activity, it is explicable why people who are in poverty show a low tendency to participate in the workshops.

It is important to consider the fact that the mode of land ownership was not clearly demonstrated through this study. To improve standard of living, the PBPN housing department offers three housing options for all tribal members: "rental housing", "senior housing", and "rent to own housing leading to total home ownership in future" (PBPN, 2009). In addition, there might be other rental agreements and land ownership categories existing in this reservation. According to Gilbert et al. (2002) for AI, land ownership is a significantly important factor both culturally and socially, as it is one of the few forms of wealth they have. Therefore, it is vital to understand land ownership in detail in future studies.

The above discussed findings highlights both the importance of addressing major issues of "no land" and "no knowledge", and the potential they have on increasing gardening activity in the reservation. If it is possible to establish a community garden in the reservation which is accessible to everyone, people who do not own land can be attracted to grow their own vegetables. Encouraging participation at gardening workshops and delivering relevant gardening advice can help reduce the existing knowledge gap. These strategies would increase gardening activity in the reservation.

Limitations of the study

The respondent group (n=95) of the harvest feast survey is a convenience sample of the residential population of the PBPN tribe (N=691) which represents 14% of the target population. These 95 respondents were gathered from a group of 200 (29% of the population) tribal members who attended a tribal gathering. Therefore, we can consider it a good sample of the residential population with a higher representation. As it is not possible to reach tribal members who are not involved in gardening at gardening workshops this was the most feasible and representative sample we could get to make inferences about the population for the purpose of this project. But,

when generalizing these findings to the PBPN residential population a lack of a representative sample should be taken into consideration.

Conclusions

Fruit and vegetable consumption for the tribe was far below the targeted levels outlined in Healthy people 2010 objectives, and increasing vegetable consumption would increase the overall proportion of the population having a balanced diet. Twenty-seven percent of the population did not garden because of “no knowledge” and “no space”. By increasing the participation at the community garden and attendance at gardening workshops these limitations could be mitigated.

A higher portion of the total residential population of PBPN fell below the poverty threshold, which has strong correlations with land ownership, gardening experience, and participation in the gardening workshops.

As a tribe, the PBPN residential population experiences significant health disparities compared to the general U.S. and Kansas populations. Complex interactions between behavioral, nutritional, and social factors manifest in negative health outcomes. High rate of poverty is an important predictor of deprived health in the community. Therefore, strategic approaches should be implemented to attract these people in poverty to engage in gardening.

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Chapter 3 - Comparing Hybrid and Open-pollinated Vegetables as Part of an American Indian Gardening Project

Abstract

To promote a healthy lifestyle, a gardening project was designed to increase the fresh fruit and vegetable availability through gardening for the Prairie Band Potawatomi Nation tribe in Kansas. As part of the project, cultivar trials comparing different hybrid and open-pollinated (OP) pepper (*Capsicum annum*), eggplant (*Solanum melongena var. esculentum*), and tomato (*Lycopersicon lycopersicum*) cultivars were conducted in 2012 and 2013 growing seasons, to identify the best yielding cultivars. Six cultivars of pepper, three cultivars of eggplant and five cultivars of tomato were included in the trials. Hybrid *Jetstar* was the best tomato cultivar identified among the cultivars tested, while *Cherokee purple* was the best yielding OP cultivar. "Yield per plant" and "fruit per plant" estimates were higher for all the tomato cultivars in 2013 compared to the 2012 trial. No difference in performance was observed among the three eggplant cultivars tested, where OP cultivars *Black Beauty* and *White Beauty* performed comparably to hybrid *Galine* throughout the season. Sweet pepper hybrids *Flamingo* and *Alliance* outperformed OP *California Wonder* which had only a moderate production. OP chili pepper cultivar *Anaheim 118* and hybrid *Chili G76* outperformed hybrid *Charger* both by "fruit per plant" and "yield per plant" estimates for the season. Identified best yielding cultivars could be distributed among tribal members in the next growing season to support in-place gardening initiatives.

Introduction

Due to health and nutritional disparities, prevalence of obesity and related comorbidities among American Indian and Alaska Natives (AI/AN) is found to be significantly higher than the general population of U.S. (Story et al., 1999; Zephier et al., 2006). Many studies conducted on this aspect identified a "nutritional transition" taking place in these communities mainly due to relocation, which ultimately made high fat foods become more abundant on Indian reservations and changed their lifestyles from active to be more sedentary (Conti, 2006; Popkin and Larsen, 2004; Welty, 1991). Eating a healthy diet high in fruits and vegetables along with increased physical activity is essential in achieving and maintaining a healthy weight (United States Department of Health and Human Services [HHS], 2010).

To promote a healthy lifestyle a gardening project was designed with the long term goal of increasing fresh fruit and vegetable availability through gardening for the Prairie Band Potawatomi Nation (PBPN) tribe in Kansas. This was accomplished through 1) organize gardening workshops to deliver gardening advice, mentoring and study the population characteristics through surveys, and 2) distribute recommended vegetable cultivars identified through cultivar trials to tribal members to support their in-place gardening initiatives.

A gardening survey conducted at a tribal gathering revealed that tomato and pepper were the most commonly grown vegetables in the reservation. Therefore, tomato and pepper were selected to be the main vegetables to be tested in the cultivar trials.

AI practice seed saving by carefully selecting the best seeds and preserving them for the next growing season as they believe that the quality of a garden is determined by the quality of the seeds (Buchanan, 1997). Vegetable seed saving is simply collecting healthy, mature seeds from one season's harvest to produce the crops for the next season. Seed saving cannot be successfully

practiced with hybrid seeds as they won't be "true to type" generations after the initial cross (SSE, 2012). Therefore, open-pollinated (OP) cultivars should be selected to save seeds.

Considering these facts, along with hybrid cultivars, OP cultivars were included in the trials to identify the best yielding OP cultivars which then can be provided to tribal members who are interested in seed saving.

Therefore, in achieving the ultimate goal of the project, the objective of this study was to conduct vegetable cultivar trials comparing different OP and hybrid cultivars of tomato *(Lycopersicon lycopersicum)*, pepper *(Capsicum annum)* and eggplant (*Solanum melongena* var. *esculentum)* to identify the best yielding cultivars and distribute them among the tribal members in the next growing season.

Open-pollinated cultivars (OP)

A cultivar that has the ability to produce "true to type" offspring from seeds that were saved from previous season's produce is known as an OP cultivar. The offspring will have the same characteristics as its parent (SSE, 2012).

Heirlooms

According to the Seed Savers Exchange (SSE) definition, heirloom cultivars are *open-pollinated* (OP) cultivars with a long history of being cultivated and saved within a family or group which has evolved by natural or human selection over time (SSE, 2012). As explained by Ashworth (2002) certain heirloom vegetables have a long history (more than 150 years) of careful selection and preservation, where the best seeds were passed along many generations resulting in developing vigorous seeds that are best suitable for that local environment; resistant to local insects and diseases, and well adapted to local climates and soils.

Hybrids

A hybrid plant is a result of a cross between two inbred pure lines, which were produced by a series of self-pollinations; a very closely and carefully monitored process (Gough & Moore-Gough, 2011). The resulting first generation of such a controlled cross, known as the "first filial generation" is designated as F1 hybrids.

Choosing between a hybrid and OP cultivar depends on the requirement of an individual grower. For some growers higher yield and uniformity may be superior characteristics but for some, taste and diversity among the produce might be much important than the yield and uniformity.

An explicit comparison between hybrid and open-pollinated cultivars are given in Appendix B.1.

Materials and Methods

All the evaluations were conducted at "Willow Lake" student farm managed by the Department of Horticulture, Forestry and Recreation Resources (HFRR), Kansas State University, Manhattan KS. The farm has similar weather conditions to the PBPN reservation. This land is managed following non-certified organic methods such as; crop rotation, cover crops, use of compost amendments and organic fertilizers, and botanical and biological pesticides. According to the Natural Resources Conservation Service (NRCS) web soil survey categorization the major soil type of this land is Eudora silt loam, rarely flooded (NRCS, 2013).

Commercially available sweet bell pepper cultivars (n=3): *Flamingo, Alliance* and *California Wonder*, chili pepper cultivars (n=3): *Anaheim 118, Charger* and *Chili G76,* eggplant cultivars (n=3): *Galine, Black Beauty* and *White Beauty*, and tomato cultivars (n=5): *Jet Star, Abraham Lincoln, Cherokee Purple, German Giant* and *Striped German* were evaluated for their performance during 2012 and 2013 growing seasons. Three tomato cultivars: *Jet Star, Abraham Lincoln* and *Cherokee Purple* were grown in both years. Information for the selection of varieties

was obtained from commercial seed catalogs and horticulture extension publications. The OP eggplant cultivar *White Beauty* and OP tomato cultivar *Striped German* were included in the study based on recommendations of two local growers (Appendix B).

All the plants were started from seeds in plastic cell trays and were raised in a greenhouse until they were ready to be transplanted. Seeding was done on 29 March 2012 and 28 March 2013. Metro-mix 350 professional growing mix (SunGro Horticulture, Canada), formulated with 45-55% horticulture grade vermiculite, Canadian sphagnum peat moss, bark ash, and dolomitic limestone was used. Watering was done daily to prevent the growing mix from drying out, and the greenhouse temperature was maintained between 21 to 26 °C, to ensure optimum germination. During seedling growth, after a thorough watering they were left to dry slightly before the next watering to avoid over-watering. Seedlings were thinned out when the plants developed their first true leaves to provide them more growing room. Plants were hardened off by reducing water supply and allowing them to wilt slightly for one week before transplanting.

Field preparation was done with a tractor mounted rototiller to a depth of six inches and compost mixed into the soil. Plants were transplanted to the field on 14 May 2012 and 16 May 2013. Plants were arranged in a randomized complete block design (RCBD) with four blocks. In 2012 trials, there were three plants per plot of each cultivar randomly arranged in each block, whereas five plants per plot was used in the 2013 trials. Alfalfa pellets (Standlee Hay Company Inc. Certified premium alfalfa pellets) were applied to each plant as an organic fertilizer.

In the tomato plots, t-posts were driven between every other plant and two lines of twine were strung on either side of the stem. Plants were supported by weaving them every 10-15 days throughout the season. Support for the eggplant and pepper plants were provided by tying each plant to a bamboo stake using plastic garden tape. An optimum supply of water to the plants was

maintained using a drip irrigation system. Hay mulch was added with an underlying layer of newspapers to conserve moisture and control weeds. The mulch was effective in reducing Bermuda grass (*Cynodon dactylon* (L.) Pers.) invasion and was supported by hand-weeding to keep the plots clean. No chemical fertilizers or pesticides were applied to any of the trials. The plants didn't encounter any serious pest damage other than spontaneous occurrences of tomato hornworm *(Manduca quinquemaculata)* which was controlled by hand-picking when noticed.

The first harvest was done when mature fruits were first observed on the plants. Successive harvests were done every 7-10 days, depending on weather, availability and schedule of the research group. Marketable fruits were selected according to United States Department of Agriculture (USDA) fresh market vegetable grade standards using visual observations (USDA, 1991; USDA, 2005; USDA, 2007; USDA 2013). Selected fruits were counted and weighed separately for each plant. In each cultivar trial, a combination of hybrid and OP cultivars were compared based on their yields throughout the season. Statistical analysis was performed using the PROC MIXED procedure of SAS version 9.3 for Windows (SAS Institute Inc. Cary, NC, USA). Mean separation tests were conducted using Tukey's Honest Significant Difference (HSD) test with establishing statistical significance at $p \leq 0.05$ significance level. Means of the following were tested: "cumulative number of fruits per plant", "cumulative yield per plant", "fruits per plant by harvest period", "yield per plant by harvest period" and "mean weight of a fruit" throughout the season.

Tomato trial - 2012

Three OP cultivars: *Cherokee Purple*, *Abraham Lincoln*, *German Giant* and one F1 hybrid cultivar: *Jet Star* were tested. Appendix B.2 provides specific details about the cultivars and their characteristics.

Seeding was done on 29 March 2012 and was raised in the greenhouse. Seedlings were thinned on 19 April 2012. Transplanting to the field was done on 14 May 2012. As recommended by Marr et al. (2010), healthy looking dark green plants were chosen as transplants and planted slightly deeper in beds prepared by shallow tilling in two rows 3 ft apart, with a plant spacing of 4 ft. Plants were arranged in a RCBD with 4 blocks. Individual plots contained 3 plants. A total of forty-eight plants were included in the study. The first harvest was done on 6 August 2012, and subsequent harvests were done every 7-10 days, as they reached maturity.

Tomato trial - 2013

Based on yield data of 2012 evaluations the poorest performing cultivar *German Giant* was dropped from the trial for 2013, and was replaced with a new entry *Striped German*, another OP cultivar. *Cherokee Purple*, *Abraham Lincoln* and *Jet Star* were retained to be tested for another year.

Seeds were sowed in plastic cell trays in the greenhouse on 28 March 2013. Same procedure was followed in the greenhouse for moisture control as in 2012 except for the use of heat pads to improve germination. Compared to previous year, the seedlings were less in vigor and phosphorous (P) deficiency symptoms were observed: purple color in the lower surface of leaves and stunted growth. Therefore, a NPK fertilizer, Mira-Acid with a grade of 30-10-10 was added to correct the deficiency.

Field transplanting was done on 16 May 2013. Plants were arranged in RCBD with 4 blocks. Plants were spaced 5 ft apart (five plants per plot). A total of eighty plants were included in the study. Alfalfa pellet fertilization, drip tape installment, mulching and supporting the plants were done as same as the previous year. On 19 July 2013, the first harvesting was done.

Eggplant trial - 2012

Two OP cultivars: *Black beauty* and *White beauty*, and one F1 hybrid: *Galine* were evaluated. Appendix B.3 provides specific details about the cultivars and their growth characteristics. Seeds were sowed on 16 March 2012 and were raised in the greenhouse until they were transplanted to the field on 14 May 2012. Similar to tomato trials, RCBD experimental design with four blocks was used to arrange the plants in the field. But, all four blocks were arranged in a single row with three plants per plot of each cultivar being replicated in each block. A total of thirty-six plants were included in the study. First harvest was done on 26 July 2012. The final harvest was done on 3 October 2012.

Sweet bell pepper trial - 2012

One OP cultivar: *California Wonder* and two F1 hybrids: *Flamingo* and *Alliance* were included in this trial. Appendix B.4 provides specific details about the cultivars and their growth characteristics. Seeding and transplanting were done on the same dates along with eggplant. All other field operations including harvesting were done similar to eggplant.

Both eggplant and sweet bell pepper rows were placed on the same bed. The two rows were kept 3 ft apart with a plant spacing of 3 ft within a row.

Chili pepper trial - 2013

Three chili pepper cultivars; *Anaheim 118, Chili G76* and *Charger* were included in the study. *Anaheim 118* was the only OP cultivar used in the evaluation. Appendix B.5 provides specific details about the cultivars and their growth characteristics. Greenhouse seeding was done on 28 March 2013 and germination was encouraged by using heat pads. Field planting was done on 16 May 2013 in two rows. Plants were arranged in a RCBD; four blocks with five plants per plot of each cultivar replicated in each block.

Results and Discussion

Tomato

Both in 2012 and 2013 significant differences were observed for **"**yield per plant", "fruits per plant" and "weight of a fruit" between the cultivars tested (Table 3.1).

Table 3.1 Summary of results - 2012 Tomato trial

Cultivar	Mean marketable fruits (no. / plant)		Mean marketable yield (lb / plant)		Mean weight of a fruit (lb)	
	2012	**2013**	**2012**	**2013**	**2012**	**2013**
Jet Star	59.5 a[z]	106.4 a	12.9 a	32.5 a	0.21 c	0.30 c
Cherokee Purple	30.3 b	50.1 c	8.8 ab	23.3 b	0.32 b	0.47 b
Abraham Lincoln	29.0 b	67.1 b	6.7 bc	17.6 c	0.23 c	0.27 c
German Giant[x]	8.2 c	-	3.5 c	-	0.43 a	-
Striped German[y]	-	29.1d	-	19.4 c	-	0.66 a

[z] Within a column, means with the same letter are not significantly different ($p \leq 0.05$) by Tukey's Honest Significant Difference (HSD)

[x] Cultivar was tested only in 2012

[y] Cultivar was tested only in 2013

Compared to the 2012 trial, all the cultivars tested in both years: *Jet Star, Abraham Lincoln,* and *Cherokee Purple,* produced much higher yields in 2013 (Table 3.1). These cultivars nearly doubled the number of fruits produced per plant. In both years, "fruits per plant" estimate of hybrid *Jet Star* was significantly higher than the OP cultivars tested. As illustrated in Figure 3.1, the gap between *Jet Star* and other cultivars follow an increasing trend. Cumulative yields although different each year, the order of cultivar performance was similar.

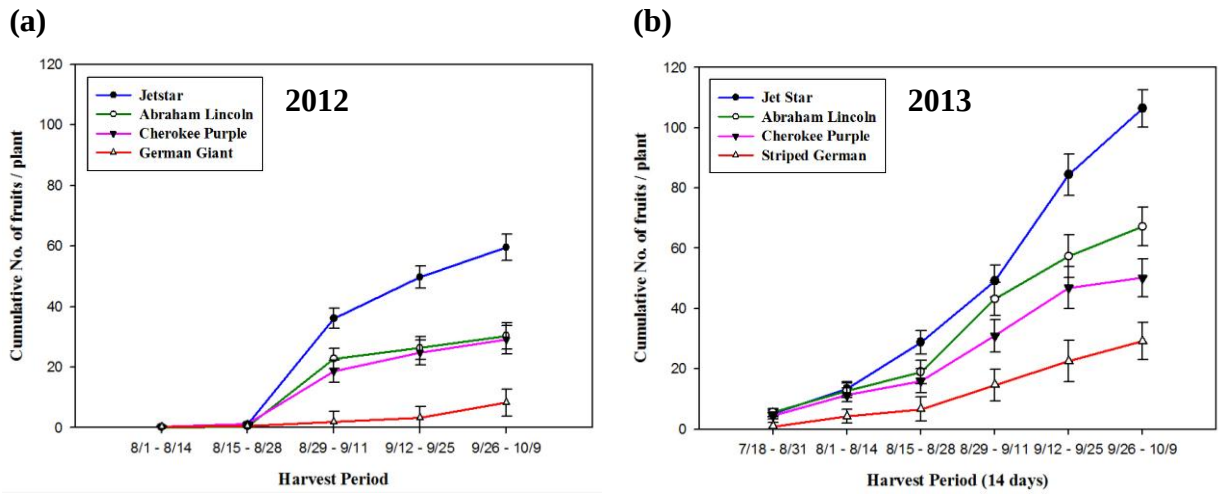

Figure 3.1 Cumulative number of fruits per plant for 2012 and 2013 - Tomato

When considering "yield per plant" in 2012; even though *Jet Star* had a higher yield by weight it was not significantly different from *Cherokee Purple.* Similarly, *Cherokee Purple* and *Abraham Lincoln* weren't significantly different as well. But, it is important to notice that the final harvest for the season was done in the first week of October, a few days before the first predicted frost. As the gap between *Jet Star* and *Cherokee Purple*, and *Abraham Lincoln* and *Cherokee Purple* is increasing (Figure 3.2a), a significant difference between these cultivars might have been observed if harvesting was continued for another one or two weeks. In contrast, significant differences for "yield per plant" were observed among these cultivars in 2013 (Figure 3.2b).

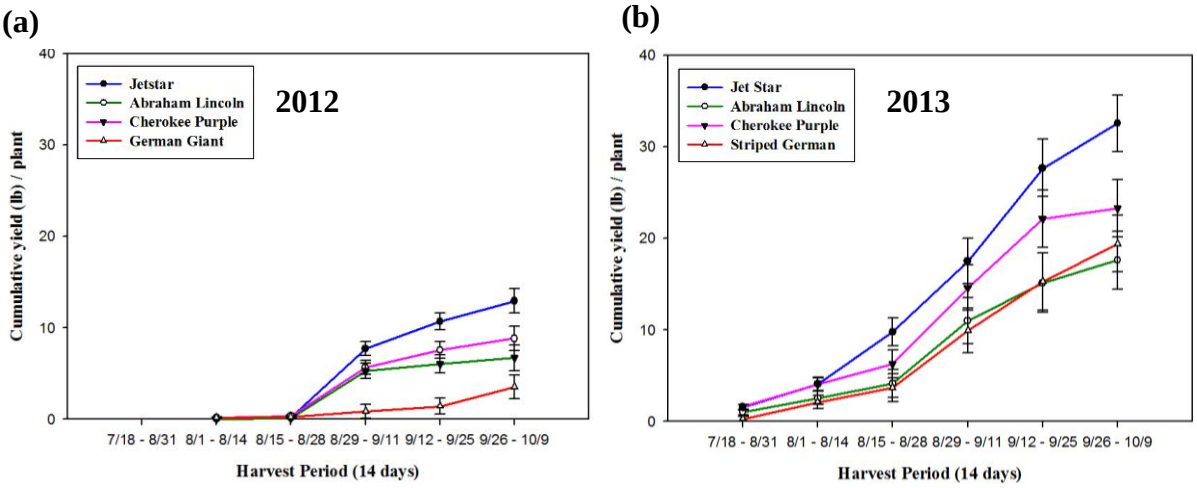

Figure 3.2 Cumulative yield (lb) per plant for 2012 and 2013 - Tomato

Even though *Cherokee Purple* and *Abraham Lincoln* were not statistically different in 2012, they revealed a significant difference in the 2013 evaluation with regard to all three parameters. In 2013, *Abraham Lincoln* produced more fruits than both *Cherokee Purple* and *Striped German* (Figure 3.1b) but, the average fruit weight was much less for *Abraham Lincoln*. Therefore, "yield per plant" estimate recorded for *Cherokee Purple* and *Striped German* was greater than *Abraham Lincoln* (Figure 3.2b). The new entry *Striped German* performed far better than *German Giant* which was dropped from the study due to poor performance. *German Giant* clearly was the poorest performing cultivar during the growing season of 2012. *Striped German* produced the largest fruits among all the cultivars, and its yield was comparable to *Abraham Lincoln.*

In 2012; *Jet Star, Cherokee Purple and Abraham Lincoln* reached their peak production during the 3rd harvest period from 29 August 2012 to 11 September 2012, and a decrease in production was observed thereafter (Figure 3.3a). In contrast, *German Giant* didn't reach its peak production until late into the season.

(a) **(b)**

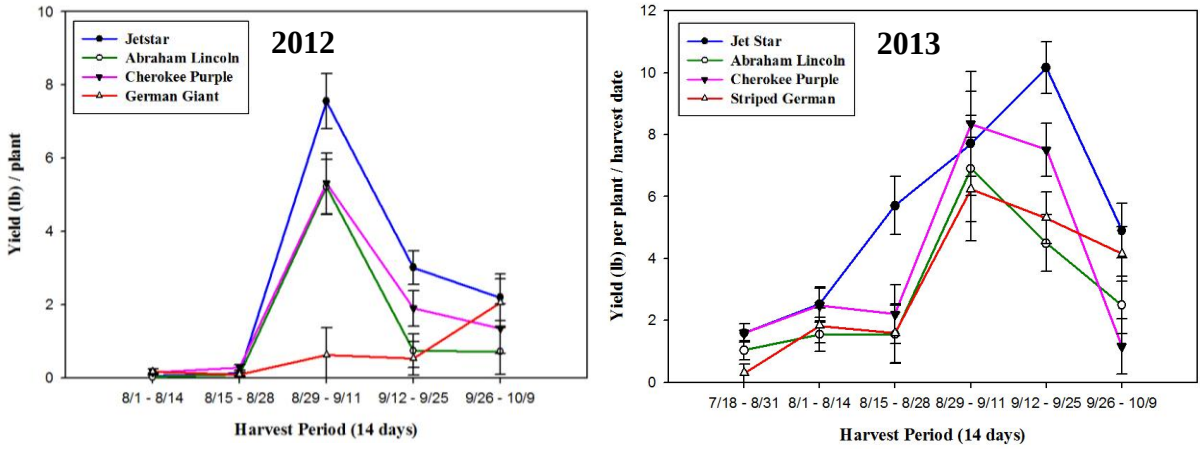

Figure 3.3 Yield (lb) per plant by harvest date for 2012 and 2013 - Tomato

Similar to 2012, *Abraham Lincoln* and *Cherokee Purple* reached their peak production in early September, while *Jet Star* continued its increasing trend for another two weeks before reaching maximum production (Figure 3.3b).

Comparing the performance of the cultivars tested in both growing seasons; the yield in weight per plant was more than doubled in 2013, and the mean weight of a fruit during the 2013 season was greater than the weight recorded in 2012 for all three cultivars. In addition, plants started to produce much earlier than the previous year. In 2012 the first harvest was done on 6 August whereas in 2013 first harvest was done two weeks earlier, on 18 July (Figure 3.3). All the above facts provide evidence that the same cultivars performed better in 2013 compared to 2012. This may have occurred due to many reasons. Table 3.2 compares the growing season climate from May to the end of September for 2012 and 2013. This data suggest that seasonal difference might have had an influence on the performance of the plants.

Table 3.2 Whether parameters comparing the growing seasons of 2012 and 2013

Parameter	2012[z]	2013[z]
Total rainfall (inches)	13.33	21.02
Days with $\geq$ 0.5 inches rain	8	12
Average temperature (°F)	75 °F	73 °F
Days with $\geq$ 100 °F	26	5
Days with $\geq$ 90 °F	74	52

[z] Weather station: Manhattan Regional Airport (NOAA, 2013)

According to Peet et al. (1997) high temperatures affects ovule development and post-pollen production processes in tomato, and thereby limits fruit set due to inadequate pollen supply. They further revealed that number of fruits per plant, fruit weight per plant and seed content per fruit were detrimentally affected by extreme temperatures. Marr (2003) relates this phenomenon to tomatoes grown in Kansas stating that temperatures above 90 °F with low humidity affects pollination causing blossom drop and poor fruit set. In 2012, there were twenty-six days of high

temperatures exceeding 100 °F, compared to just 5 days in 2013, during the months of May to September, which might have severely affected the reproductive capability of the plants. Further compounding the problem, rainfall was low in 2012 creating a hot, dry growing condition for the plants which was reflected in decreased yields. Sato et al. (2000) observed a difference in pollen release and germination among different cultivars of tomatoes under heat stress, and stated that physiological factors of plants are associated with fruit set under heat stress. Therefore, it is clearly evident that the seasonal differences likely influenced the performance of the plants in the two growing seasons.

Apart from the growing season the plant spacing was different between the two years. In 2012, tomatoes were grown in two rows, 3 ft apart with a 4 ft distance between two plants. Width of the planting bed was 5 ft. Therefore on average a plant had 10 ft^2 of growing space. The plant spacing was increased in 2013, to be 5 ft between two plants, and instead of having two blocks in a single bed (5 ft wide), only one row of plants was raised in a single bed. Hence, the plants had 25 ft^2 of growing space for growth in 2013 trial.

In addition to the above two factors, soil fertility might have played an influential role. The plant beds that were used in 2013 trial grew a cover crop of Sunn hemp (*Crotalaria juncea* L.) in 2012. This plant has the ability to increase organic matter, provide nitrogen and improve soil properties (USDA, 1999). This might have increased the fertility of the soil directly affecting the performance of the plants. A combination of these factors: planting density, weather and soil fertility suggests that plants had better growing conditions in 2013 compared to 2012. When recommendations are made, it is important to choose cultivars that have the ability to perform consistently both under favorable and unfavorable conditions. *Jet Star* had the highest potential

to perform both under favorable and unfavorable conditions compared to other cultivars. *Cherokee Purple* was the best among all the OP cultivars.

Eggplant

No significant differences were observed between the three cultivars tested in terms of "fruits per plant" and "yield per plant" (Table 3.3).

Table 3.3 Summary of results – 2012 Eggplant trial

Cultivar	Mean marketable fruit (no. / plant)	Mean marketable yield (lb / plant)	Mean weight of a fruit (lb)
Galine	14.8 a[z]	6.4 a	0.439 ab
Black Beauty	12.3 a	6.9 a	0.55 a
White Beauty	14.3 a	6.2 a	0.438 b

[z] Within a column, means with the same letter are not significantly different ($p \leq 0.05$) by Tukey's Honest Significant Difference (HSD).

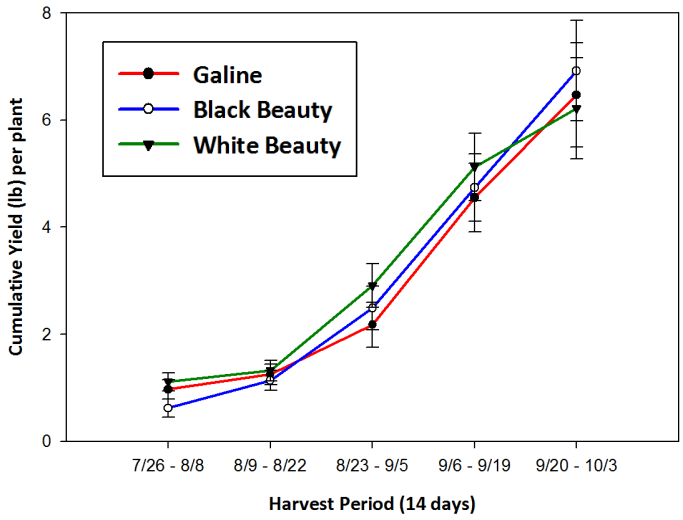

Figure 3.4 Cumulative yield (lb) per plant – 2012 Eggplant trial

The OP cultivars *Black Beauty* and *White Beauty* performed comparably to the hybrid cultivar (Figure 3.4) therefore, all three cultivars can be recommended.

On average *Black Beauty* produced the largest fruits. Though "mean weight of a fruit" for *Galine* and *White Beauty* were similar, due to high variability observed within this data for *White Beauty,* "mean weight of a fruit" they were estimated to be significantly different through the mean separation test.

Sweet pepper

Significant differences were reported for yields between the three cultivars tested in 2012 (Table 3.4).

Table 3.4 Summary of results – 2012 Sweet pepper trial

Cultivar	Mean marketable fruit (no. / plant)	Mean marketable yield (lb / plant)	Mean weight of a fruit (lb)
Alliance	15.1 b[z]	4.3 a	0.29 a
Flamingo[y]	25.8 a	4.0 a	0.15 c
California wonder	10.4 b	2.2 b	0.22 b

[z] Within a column, means with the same letter are not significantly different ($p \leq 0.05$) by Tukey's Honest Significant Difference (HSD).

[y] Data for *Flamingo* is obtained only from 2 Blocks.

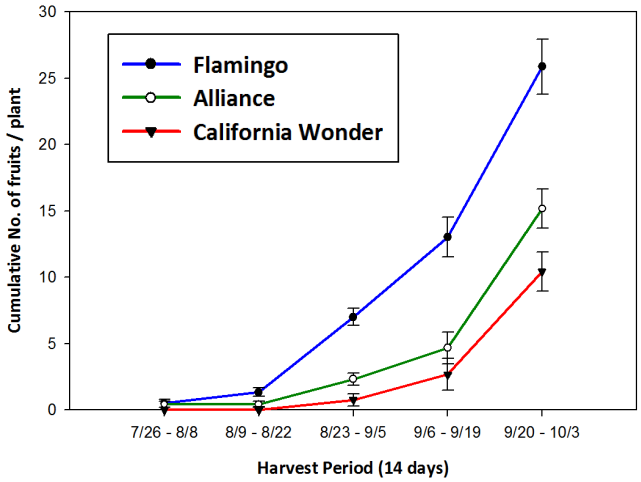

Figure 3.5 Cumulative number of fruits per plant – 2012 Sweet pepper trial

As illustrated in Figure 3.5, hybrid cultivar *Flamingo* outperformed the hybrid *Alliance* in terms of "fruits per plant". The difference between the two estimates was about 10 fruits per plant (Table 3.4).

However higher production of fruit by *Flamingo* was not reflected in its "yield per plant" estimate, and it was not statistically different between the two cultivars (Figure 3.6). This is due to the fact that *Alliance* had greater yield later in the season with much larger fruits, allowing it to slightly surpass the yield of *Flamingo* by the end of the season.

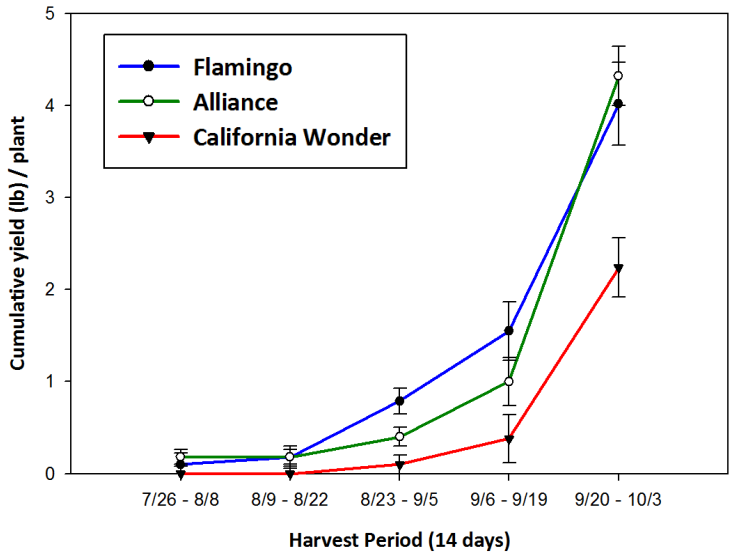

Figure 3.6 Cumulative yield (lb) per plant – 2012 Sweet pepper trial

Throughout the season the performance of the OP cultivar *California Wonder* was low compared to the two hybrids (Figure 3.5 and Figure 3.6). But its "fruit per plant" estimate was comparable with *Alliance* and "mean weight of a fruit" was significantly higher than *Flamingo.* These data suggest that *California Wonder* performed moderately compared to hybrids *Flamingo* and *Alliance.*

Due to an experimental error, data from the 6 plants labeled as *Flamingo* plants in the first two blocks were not used in the analysis. To ensure these incomplete two blocks did not affect the

final results, data were re-analyzed using only the data from third and fourth blocks (for all three cultivars). But, similar results as above were obtained.

Chili pepper

The OP cultivar *Anaheim 118* and hybrid *Chili G76* outperformed the new hybrid *Charger* (Table 3.5).

Table 3.5 Summary of results – 2013 Chili pepper trial

Cultivar	Mean marketable fruit (no. / plant)	Mean marketable yield (lb / plant)	Mean weight of a fruit (lb)
Anaheim 118	45.7 a[z]	4.0 a	0.09 a
Chili G76	47.4 a	4.1 a	0.09 a
Charger	35.8 b	3.1 b	0.09 a

[z] Within a column, means with the same letter are not significantly different ($p \leq 0.05$) by Tukey's Honest Significant Difference (HSD).

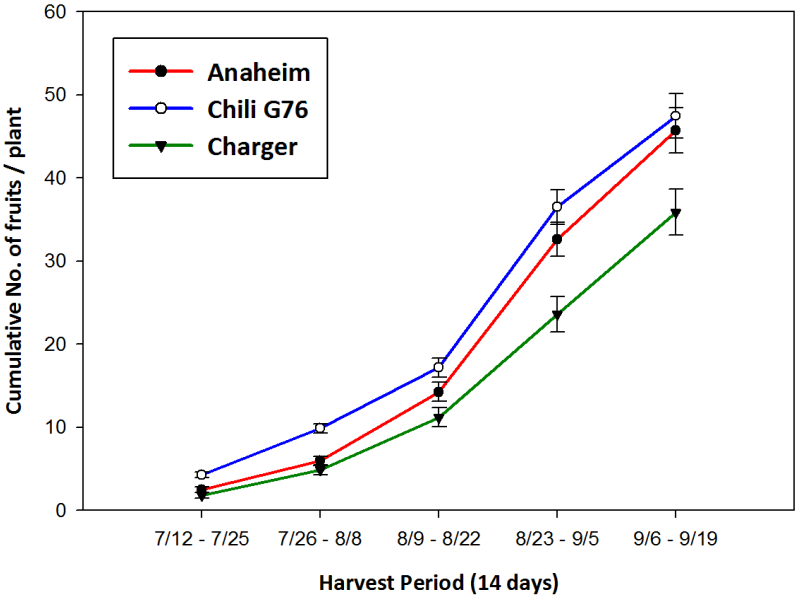

Figure 3.7 Cumulative number of fruits per plant – 2013 Chili pepper trial

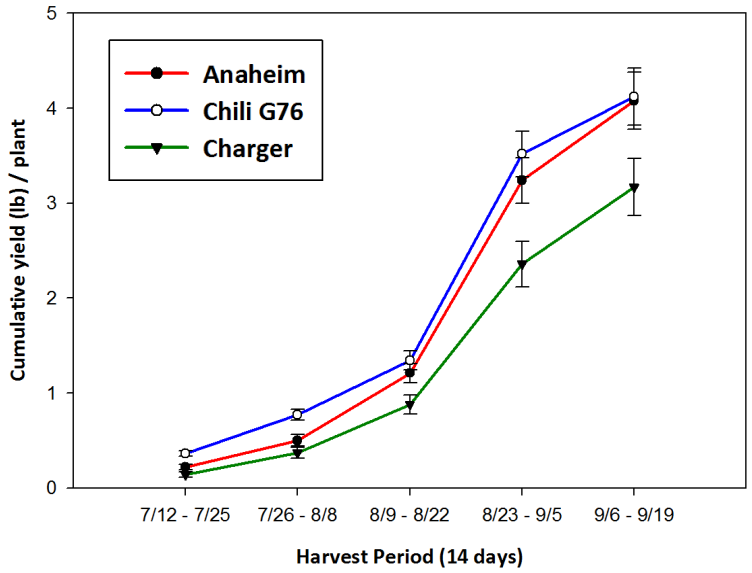

Figure 3.8 Cumulative yield (lb) per plant – 2013 Chili pepper trial

Both "fruits per plant" and "yield per plant" illustrated a similar trend throughout the season where *Charger* having comparably low yields (Figure 3.7 and Figure 3.8).

According to Seedway (2013) a commercial seed catalog, *Charger* is a new hybrid cultivar which produces fruits that are slightly larger and heavier than the fruits of OP cultivar *Anaheim 118.* But, the cultivar trial yielded contradictory results where the OP cultivar *Anaheim 118* had significantly higher "fruits per plant" and "yield per plant" estimates than *Charger.* Out of all the cultivar trials conducted, this was the only instance where an OP cultivar outperformed a hybrid.

Conclusions

Tomato

1. Hybrid *Jet Star* is the best cultivar among the five tomato cultivars tested.
    - Outperformed all other OP cultivars tested
    - Therefore, can be recommended to be distributed among the PBPN tribal members in the next growing season

2. *Cherokee Purple* is the best OP cultivar tested in the trials
    - This cultivar can be recommended if interested in seed saving
3. *Abraham Lincoln* is not consistent in performance compared with *Cherokee purple*
    - More mortality reported
    - Should be tested for another year along with *Striped German*
4. *German Giant* is not suitable for this environment

Eggplant

1. All three cultivars tested; *Galine (hybrid), White beauty (OP)* and *Black beauty (OP)* can be recommended to be distributed among PBPN tribal members
2. *White beauty* and *Black beauty* is recommended if interested in seed saving

Sweet pepper

1. Both hybrids; *Flamingo* and *Alliance* outperformed OP cultivar *California wonder*
    - Both the hybrids are recommended to be distributed among PBPN tribal members
2. *California wonder* had a moderate production
    - Recommended if interested in seed saving

Chili pepper

1. OP cultivar *Anaheim 118* and hybrid *Chili G76* outperformed hybrid *Charger*
    - Both *Anaheim 118* and *Chili G76* are recommended to be distributed among PBPN tribal members
    - *Anaheim 118* can also be used for seed saving

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Appendix A - Support Material for Chapter 2

A.1 - IRB exemption

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Charles Barden
HFRR
3036 Throckmorton

Proposal Number: 6228

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: April 19, 2012

RE: Proposal Entitled, "Gardneing behaviour survey of the Kickapoo Trible in Kansas (KTK) and Prairie Band Potawatomi Nation (PBPN)"

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §46.101, paragraph b, category: 2, subsection: ii.**

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

203 Fairchild Hall, Manhattan, Lower Mezzanine, KS 66506-1003 | (785) 532-3224 | fax: (785) 532-3278 | www.k-state.edu/research/comply

Informed Consent

Gardening behavior survey of the Prairie Band Potawatomi Nation (PBPN).

Project Information: This study aims to gather information on vegetable gardening, practiced by the tribal members of the KTK and PBPN. This information will be used in designing vegetable gardening promoting interventions which ultimately will increase the fresh vegetable availability in the reservations.

Investigators: Charles Barden, Ph.D., Kansas State University, Candice Shoemaker, Ph.D., Kansas State University, Pabodha Galgamuwa, Kansas State University.

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

What is involved? : If you agree to participate in this study, you will be completing a questionnaire on "Vegetable gardening & Seed saving" which would take about 15-20 minutes.

Participants: You should be a tribal member of Prairie Band Potawatomi Nation (PBPN) and at least 18 years old to participate in this study.

Information is confidential: All the information will be completely confidential. This sheet of information will be removed from your questionnaire. Therefore, no one will be able to connect your personal information in this document with the information you provide in the questionnaire. The "age" mentioned at the end of the questionnaire will be used only for analysis.

Risks: There are no foreseeable risks at this time from participating in this study.

Potential benefits: As stated above, the information you provide will be used to support your vegetable gardening activities in the future. This will ultimately increase the fresh vegetable availability within your community.

Participant Rights: Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide not to participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled.

Questions or Problems: You are encouraged to ask questions at any time during this study.

- For further information about the study contact Pabodha Galgamuwa, 2601 Throckmorton, Kansas State University, Manhattan, KS 66506 (785-532-1223) pabodha@ksu.edu

Print Name _____

SIGNATURE: _____ Date: _____

Witness to Signature (Project Staff): _____ Date _____

A.2 – Pre-season gardening survey 2012

Q. No…… Date: ……/……/……

1. General Gardening

In this section we would like to know about your experiences with growing vegetables.

1.1. How many years have you grown vegetables? *Please select one answer*

a. Never before ☐ - ***If select this, skip to 3.2***
b. This is my 1st year ☐
c. 1-5 years ☐
d. 5-10 years ☐
e. More than 10 years ☐

1.2. What vegetables did you grow last year? *Select all that apply*

a. Beans ☐
b. Beets ☐
c. Corn ☐
d. Cucumbers ☐
e. Cabbage ☐
f. Cauliflower/ Broccoli ☐
g. Cantaloupe ☐
h. Carrots ☐
i. Eggplant ☐
j. Onions ☐
k. Peas ☐
l. Peppers ☐
m. Potatoes ☐
n. Squash – winter (including pumpkins) ☐
o. Squash – summer (including Zucchini) ☐
p. Salad greens ☐
q. Tomatoes ☐
r. Watermelons ☐

1.3 *An heirloom plant or variety is what was commonly grown during earlier periods in human history, but not used in modern large scale agriculture.*

Heirloom plants are also considered as those that are handed down from one family member to another for many generations.

Do you grow any heirloom / traditional vegetables, that fall into either of the above two definitions.

Yes ☐ No ☐

If yes, what are those vegetables and the varieties (if known)?

Vegetable (eg:- Tomatoes)	**Varieties** *Cherokee purple*
…….	…….....
…….	…….
…….	…….

1.3. What information sources do you rely on for gardening advice? *Select all that apply*

a. Websites & online resources ☐
b. Local extension office ☐
c. Tribal Environmental or Health office ☐
d. Seed catalogs / Magazines / Publications / Books etc. ☐
e. Neighbors (fellow gardeners) ☐
f. Other …….

2. Seed Saving

In this section we need to gather some information regarding "seed saving" and purchase of seeds and transplants from stores.

2.1. Do you currently do seed saving?

Yes ☐ No ☐ ***If No, Skip to 2.6 (next page)***

2.2. **What vegetable seeds do you save?**

……

……..

2.3. How did you learn about seed saving? *Select all that apply*

a. Learned from relatives, neighbors or other tribal members ☐
b. Websites & online resources ☐
c. Local extension office ☐
d. Tribal Environmental or Health office ☐
e. Seed catalogs / Magazines / Publications / Books etc.. ☐

If other, specify; ……

……

2.4. Why do you do seed saving? *Select all that apply*

a. Save money ☐
b. Preserve & perpetuate varieties that could die out ☐
c. Be independent, have control over what I grow in my field, rather than what is available in the market ☐
d. Carry on the cultural values attached / Memory of ancestors ☐
e. Maintain the diversity among varieties ☐
f. Other ☐

If other, specify; ……

……

2.5. Have you experienced any difficulties / disadvantages in saving seeds? *Select all that apply*

a. I have not experienced any difficulties/ disadvantages ☐
b. Hard to get the desired outcome *(hardiness, vigor, Pest and disease resistance, production etc.)* ☐
c. Hard to get the number of plants required for next planting ☐
d. Time consuming ☐
e. Difficult to control unwanted cross pollination ☐
f. Difficult to raise healthy seed because of certain diseases that carry over on or in the seed ☐
g. Requires specific skills and knowledge ☐
h. Other ☐

If other, specify; ……

……..

2.6. Why do you purchase seeds and transplants from the store? *Select all that apply*

a. High crop yield ☐
i. Get desired traits in new plants (*hardiness, vigor, pest and disease resistance, yield etc..)* ☐
b. Doesn't require specific skills and knowledge as with seed saving ☐
c. More marketable products ☐
d. Easy to grow ☐
e. Inexpensive ☐
f. Other ☐

If other, specify; ……..
……..

2.7. Please check the appropriate box, whether you agree or disagree with the following statements

	Agree	Disagree	No opinion
a. New vegetable varieties require more fertilizers and pesticides than heirloom and other traditional varieties.	☐	☐	☐
b. Saving and exchanging seed is not only about seeds; it involves exchange of ideas and knowledge, of culture and heritage.	☐	☐	☐
c. Saving seed is a waste of time.	☐	☐	☐
d. Seed saving brings some control over what we cultivate	☐	☐	☐
e. New vegetable seeds are produced by large companies, and dependency on those seeds will make our community less independent	☐	☐	☐
f. Promoting and supporting "seed saving" is important for my community	☐	☐	☐

2.8. Was "seed saving" practiced traditionally in your tribe

Yes ☐ No ☐ Don't know ☐

2.9. The practice of "seed saving" is not done in our culture today as frequently as in our parent's generation?

Yes ☐ No ☐ Don't know ☐

3. <u>Tribal Gardening</u>

In this section, we need to know the challenges you face in vegetable gardening and how we should support you to overcome those challenges.

3.1. What is the major challenge you face when growing vegetables?

……
……
……

3.2. What support could increase vegetable gardening success among the tribal members

a. Educational workshops ☐
b. Informational materials (books, leaflets. etc.) ☐
c. A gardening club ☐
d. Demonstration garden ☐
e. Other ☐

If other, specify; ……
…….

3.3. What is the most important vegetable gardening advice / technique / practice you learned from the pre-season vegetable gardening workshop held in March?

……
……
……

3.4. Did you receive a floating row cover at the pre-season workshop?

Yes ☐ No ☐

3.5. What is the main advantage of using a floating row cover in your vegetable garden?

……..
……..
……

4. For the purpose of analysis, we need to know your age. As the informed consent form with your name will be removed from the questionnaire all the information you provided in the questionnaire, including your age wouldn't be able to link with your name for anyone.

Your age: ……

A.3 – Harvest feast survey 2012

A. Information on Gardening

1. Did you participate in the pre-season vegetable gardening workshop held last March *(at the Rock Building)? (Mark one)*

- ○ Yes
- ○ No

2. How many years have you grown vegetables? *(Please select one answer)*

- ○ None - ***skip to Question 5.***
- ○ This was my 1st year
- ○ 1-5 years
- ○ 5-10 years
- ○ More than 10 years

3. What vegetables did you grow this year? *(Select all that apply)*

- ○ Beans
- ○ Beets
- ○ Corn
- ○ Cucumbers
- ○ Cabbage
- ○ Cauliflower/ Broccoli
- ○ Cantaloupe
- ○ Carrots
- ○ Eggplant
- ○ Onions
- ○ Peas
- ○ Peppers
- ○ Potatoes
- ○ Squash – winter (including pumpkins)
- ○ Squash – summer (including Zucchini)
- ○ Salad greens
- ○ Tomatoes
- ○ Watermelons

4. What was the major challenge you faced when growing vegetables this season?

……

From Question 4, go to Question 6.

5. If you answered 'none' for question 2, what is the major reason you do not grow vegetables?

……

B. Information on fruits & vegetables

6. When you go shopping what type of fruits do you ***usually*** purchase? *(Mark one)*

- ○ Fresh
- ○ Frozen
- ○ Canned, in natural juice
- ○ Canned, in syrup
- ○ I do not buy fruits

7. When you go shopping what type of vegetables do you ***usually*** purchase? *(Mark one)*

- ○ Fresh
- ○ Frozen
- ○ Canned
- ○ I do not buy vegetables

8. Where do you ***usually*** get fruits & vegetables from? *(Mark one)*

- ○ Grocery store
- ○ Convenience store
- ○ Farmers market
- ○ Community garden
- ○ Home garden
- ○ Neighbor or family
- ○ Other

C. Information about the foods you eat

9. For each food listed, put a check showing how often on average you ate that item during the past year.

	Never	Once a week	2-4 per week	5-6 per week	Daily	Once a month	Once in 3 months	Once a year
Fresh Tomatoes								
Onions								
Raw Cucumbers (not including pickles)								
Melons								
Sweet or Hot Peppers (green, red, or yellow)								
Summer Squash/Zucchini								
Winter Squash								
Okra								
Cooked Greens (such as spinach, turnip, collard, or kale)								
Raw Greens (such as spinach, turnip, collard, or kale)								
French fries, home fries, hash browned potatoes, or tater tots								
Baked, boiled, or mashed potatoes								
Baked goods (such as cookies, cakes, or brownies)								

Please make sure you have placed a check mark in each row.

A serving of <u>fruit</u> is equal to:	**A serving of <u>vegetables</u> is equal to:**
1 medium piece of fresh fruit	1 medium carrot or other fresh vegetable
½ cup (4 oz.) of fruit salad	1 small bowl of green salad
¼ cup of raisins, apricots or other dried fruit	½ cup (4 oz.) of fresh or cooked vegetables
6 oz. of 100% orange, apple or grape juice	¾ cup (6 oz.) of vegetable soup
<u>Do not count</u> fruit punch, lemonade, Gatorade, Sunny Delight or fruit drink	<u>Do not count</u> French fries, onion rings, potato chips or fried okra

Instructions: Please answer the following questions about what **you** eat.

	0 None	**1 serving**	**2 servings**	**3 servings**	**4 servings or more**
10. On a <u>typical day</u>, how many servings of fruit do you eat?	○	○	○	○	○
11. On a <u>typical day</u>, how many servings of vegetables do you eat?	○	○	○	○	○

D. <u>Information about traditional foods</u>

12. Over the <u>past year</u> did you eat any of the following **traditional foods?**

	Yes	**No**
Corn		
Fish		
Gooseberries		
Indian beans		
Milkweed		
Pawpaws		
Squash		
Wild potatoes		
Wild game		
Wild onions		
Wild rice		
Wild strawberries		

Please make sure you have placed a check in each row.

13. Over the <u>past year</u> how often did you eat **traditional foods?** *(<u>Mark one</u>)*

- ○ Occasionally (Once a season)
- ○ Regularly (2-3 times per week during the season)
- ○ Often (2-3 times per week all year)
- ○ Primarily during ceremonies/powwows

14. Over the past year how often did you drink **traditional Indian/wild teas?** *(Mark one)*

- ○ Occasionally (Once a season)
- ○ Regularly (2-3 times per week during the season)
- ○ Often (2-3 times per week all year)
- ○ Primarily during ceremonies/powwows

E. Information about your activities

Instructions: We are interested in two types of physical activity – vigorous and moderate. Vigorous activities cause large increases in breathing or heart rate, while moderate activities cause small increases in breathing or heart rate. In the following section, please think about the physical activities **you** do in a typical week.

15. How many days per week do you do **moderate activities**, such as brisk walking, bicycling, vacuuming, gardening or anything else that causes some increase in breathing or heart rate for at least 10 minutes? **Do not include physical activity done for work.**

☐ Days per week

- ○ Mark if 0 days per week *and skip to Question 17*

16. On days when you do **moderate activities** for at least 10 minutes at a time, how much total time per day do you spend doing these activities?

☐ Hours ☐ Minutes

17. How many days per week do you do **vigorous activities** such as running, aerobics, heavy yard work or anything else that causes large increases in breathing or heart rate for at least 10 minutes? **Do not include physical activity done for work.**

☐ Days per week

- ○ Mark if 0 days per week and *skip to Question 19*

18. On days when you do **vigorous activities** for at least 10 minutes at a time, how much total time per day do you spend doing these activities?

☐ Hours ☐ Minutes

19. In a typical week, how many days do you participate in **community-sponsored physical activity** *(zumba, walks, chair exercises)*?

☐ Days per week

F. Information about your health

20. Would you say that in general your health is *(Mark one)*

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

21. During the ***past 30 days,*** how many days did poor physical health keep you from doing your usual activities, such as self-care, work, gardening or recreation?

☐ Days

22. Are you limited in any way in daily activities because of any impairment or health problem? *(Mark one)*

- ○ Yes, if yes, what is the major impairment or health problem that limits your activities?

  _____

- ○ No

23. How would you compare your health to the health of the rest of the community in general? *(Mark one)*

- ○ My health is excellent compared to the rest of the community
- ○ My health is better compared to the rest of the community
- ○ My health is about the same as the rest of the community
- ○ My health is worse than the rest of the community
- ○ My health is significantly worse than the rest of the community

G. Information about you and your household

24. What is your gender? *(Mark one)*

- ○ Male
- ○ Female

25. What is your age? ☐

26. How many adults ***(over the age of 18)*** are currently living in your home? ☐

27. How many children ***(under the age of 18)*** are currently living in your home? ☐

28. What is the highest grade of school or year of college you have completed? *Mark the highest category you have completed.*

- ○ Elementary (K – 6th Grade)
- ○ Middle School (6th – 8th Grade)
- ○ High School (9th – 12th Grade)
- ○ Associates Degree or Two Years of College
- ○ Bachelor's Degree or Higher

29. Do you or your family own the place where you are living now, or do you rent? *(Mark one)*

- ○ Own
- ○ Rent

30. Are you currently working?

- ○ Yes
- ○ No, if No, what is your situation? *(Mark one)*
  - ○ Temporarily laid off
  - ○ Unemployed
  - ○ Retired
  - ○ Permanently disabled
  - ○ Homemaker
  - ○ Student
  - ○ Other

31. If you added together the yearly incomes, before taxes, of all the members of your household for last year, what would the total be? *(Mark one)*

- ○ $ 0 - $ 9,999
- ○ $ 10,000 - $ 19,999
- ○ $ 20,000 - $ 29,999
- ○ $ 30,000 - $ 39,999
- ○ $ 40,000 - $ 49,999
- ○ Over $ 50,000

32. Is there anything else you would like to comment on regarding gardening, eating fruits and vegetables, or your health?

Thank you for your participation!

A.4 - Pre-season gardening survey 2013

A. Information on Gardening

1. Did you participate in the pre-season vegetable gardening workshop held last year *(at the Rock Building)? (Mark one)*
   - ○ Yes
   - ○ No - ***skip to Question 4.***

2. Did you receive any plants (pepper or tomato) from this project last year? *(Mark one)*
   a. Yes
   b. No - ***skip to Question 4.***

3. How did these plants perform during last season? *(Mark one)*
   a. They performed well
   b. Moderate
   c. Didn't perform well / low yield
   d. They died prematurely
   e. Didn't use them

4. Did you have a vegetable garden last year? *(Mark one)*
   a. Yes
   b. No

5. Do you plan to have a vegetable garden this year? *(Mark one)*
   a. Yes
   b. No

6. How many years have you grown vegetables? *(Mark one)*
   - ○ This is my 1st year
   - ○ 1-5 years
   - ○ 5-10 years
   - ○ More than 10 years
   - ○ None

   If none, what is the major reason you do not grow vegetables …….

7. Where do you grow your vegetables? *Eg:- Home garden / Community garden*
   ……

8. Last year, did you receive vegetables from the community garden established behind the Tribal Health Center? *(Mark one)*
   a. Yes b. No

9. Information about the foods you eat

A serving of fruit is equal to:	**A serving of vegetables is equal to:**
1 medium piece of fresh fruit	1 medium carrot or other fresh vegetable
½ cup (4 oz.) of fruit salad	1 small bowl of green salad
¼ cup of raisins, apricots or other dried fruit	½ cup (4 oz.) of fresh or cooked vegetables
6 oz. of 100% orange, apple or grape juice	¾ cup (6 oz.) of vegetable soup
Do not count fruit punch, lemonade, Gatorade, Sunny Delight or fruit drink	Do not count French fries, onion rings, potato chips or fried okra

Instructions: Please answer the following questions about what **you** eat.

	0 None	**1 serving**	**2 servings**	**3 servings**	**4 servings or more**
10. On a typical day, how many servings of fruits do you eat?	◯	◯	◯	◯	◯
11. On a typical day, how many servings of vegetables do you eat?	◯	◯	◯	◯	◯

12. **Information about you and your household**

13. What is your gender? *(Mark one)*
    - ○ Male
    - ○ Female

14. What is your age? ☐

15. How many adults ***(over the age of 18)*** are currently living in your home? ☐

16. How many children ***(under the age of 18)*** are currently living in your home? ☐

17. If you added together the yearly incomes, before taxes, of all the members of your household for last year, what would the total be? *(Mark one)*
    - ○ $ 0 - $ 9,999
    - ○ $ 10,000 - $ 19,999
    - ○ $ 20,000 - $ 29,999
    - ○ $ 30,000 - $ 39,999
    - ○ $ 40,000 - $ 49,999
    - ○ Over $ 50,000

A.5 – Poverty thresholds

Table A.1 Poverty threshold for 2012

Size of family unit	Related children under 18 years								
	None	One	Two	Three	Four	Five	Six	Seven	Eight or more
One person (unrelated individual).....									
Under 65 years.....	11,945								
65 years and over.....	11,011								
Two people.....									
Householder under 65 years.....	15,374	15,825							
Householder 65 years and over.....	13,878	15,765							
Three people.....	17,959	18,480	18,498						
Four people.....	23,681	24,069	23,283	23,364					
Five people.....	28,558	28,974	28,087	27,400	26,981				
Six people.....	32,847	32,978	32,298	31,647	30,678	30,104			
Seven people.....	37,795	38,031	37,217	36,651	35,594	34,362	33,009		
Eight people.....	42,271	42,644	41,876	41,204	40,249	39,038	37,777	37,457	
Nine people or more.....	50,849	51,095	50,416	49,845	48,908	47,620	46,454	46,165	44,387

Source: U.S. Census Bureau.

Appendix B - Support Material for Chapter 3

B.1 – Comparison between hybrids and open-pollinated cultivars

Table B.1 A comparison between hybrid and open-pollinated cultivars

Quality	Hybrid	Open-pollinated
Vigor	- Hybrid vigor is one of the main advantage over OP cultivars - Valuable for gardeners in extreme conditions - Seeds emerge vigorously and uniformly - Advantage of hybrid vigor is highly evident in some vegetables; Eg:- Corn, Broccoli	- Comparably less vigor, especially under extreme conditions - In unseasonable weather, many OP s' go into a "holding pattern" - For some vegetables difference between hybrid and OP is less evident Eg:- squash, melons, cucumbers and tomatoes
Yield	- Hybrid vigor and other traits could double the yield over OP cultivars - Higher yield per plant is important for commercial scale growers - Hybrids show a concentrated fruit set which is favorable for commercial scale growers	- Yield is comparably low - For small scale gardeners extended fruit set is more important than concentrated fruit set, which is often showed by open-pollinated cultivars
Resistance to diseases	- Disease resistance is much easier to breed into hybrids cultivars. - But, still the microorganisms get evolved to attack them	- More often, susceptible to diseases compared to hybrids. - Yet, there are many OP cultivars that are resistant to diseases
Cost	- Cost of maintaining breeding lines and producing hybrids is high. - Therefore, the costs of seeds are high. - Seeds cannot be saved, hence have to purchase seeds in every season	- Cost is low comparably - As the seeds can be saved for the next season, do not have to purchase every season
Taste	- Depends on the gardener. - Hybrids show a uniform taste/flavor and it depends on the market demand.	- It is not uniform often, especially among the heirlooms there is a high diversity. - Gardeners can chose cultivars according to their preference

Quality	Hybrid	Open-pollinated
Improved qualities	- Hybrids show improved qualities such as extended post-harvest life	- Extended Post-harvest life and some characters of hybrids suits for commercial scale growers. For home gardeners these are not a concern

B.2 – Tomato cultivars

Table B.2 Tomato cultivar information

Cultivar	Duration	Growth type	General Remarks
Jetstar - *F1 hybrid*	72 days Mid-season	Indeterminate Fairly compact.	Big yields of 7 - 8 oz. attractive, red, globe shaped bright fruits generally free of cracks. Pleasant flavor but low in acid; not recommended for canning. Vines grow vigorously with offering good foliage cover Resistant to; *Verticillium wilt* & *Fusarium wilt.*
Abraham Lincoln - *Heirloom* - *Open-pollinated*	77 days Mid-season	Indeterminate	Producing 6 – 10 oz. round red fruits in abundance. Tender, fine texture and fair amount of acid that is nicely tempered with sweetness. A popular cultivar since 1920's.
Cherokee Purple - *Heirloom* - *Open-pollinated* *(Ddescendent of a variety used by Cherokee Indians)*	72 days Mid-season	Indeterminate Compact plant	Very productive bearing loads of 10 – 12 oz. fruits. Fruits are dusky rose/ purple with deep brick red interiors. Medium large, deep oblate fruits are delicious with pleasantly sweet rich flavor. Thin skin, soft flesh and meaty texture.
German Giant - *Heirloom* - *Open-pollinated*	77 days Late season	Indeterminate	The family heirloom cultivar produces in abundance of deep pink tomatoes, 2 lbs. or more. Smooth in shape, huge and brimming with luscious flavor.
Striped German	78 days Late season	Indeterminate Medium-tall vines	Bicolor red and yellow fruit weighs about 12 oz and over. The marbled interior looks beautiful sliced. Complex, fruity flavor and smooth texture.

B.3 – Eggplant cultivars

Table B.3 Eggplant cultivar information

Cultivar	Duration	General Remarks
Galine - *F1 hybrid*	65 days	High yielding, strong plants Black bell type, very glossy uniform fruits.
Black Beauty - *Heirloom 1902* - *Open-pollinated*	83days	Produce large, broad, thick, attractive fruits on sturdy, tall upright plants. Fruits are purple in color
White Beauty - *Heirloom* - *Open-pollinated*	70 days	Green-white striped round fruits. Produce in abundance. Does well in hot humid areas. Hardy and productive in southern areas

B.4 – Sweet pepper cultivars

Table B.4 Sweet pepper cultivar information

Cultivar	Duration	General Remarks
Flamingo - *F1 hybrid*	66 days	Produce smooth, slightly tapered, waxy fruits. Fruits are ivory-yellow colored and changes to orange-red at maturity. High in vigor as resistant to TMV[a].
Alliance - *F1 hybrid*	70days	Offers the best disease package out of the most hybrid cultivars. Resistant to BLS[b], PVY[c], PYMV[d], TMV and PMV[e], and intermediate resistance to CMV[f]. Produce blocky, large to extra-large fruits with thick walls and unattractive green color that ripens to red.
California Wonder - *Open-pollinated*	75 days	High yields and extra-large fruits have made this cultivar the most popular OP bell pepper. About 4.5 inches long and 4 inches wide. Have crispy, thick walls and that are sweet taste. Tall plants are resistant to TMV. Best suited to areas with warm nights and a long growing season. But doesn't yield with the hybrids.

[a] TMV – Tobacco mosaic virus
[b] BLS – Bacteria leaf spot
[c] PVY – Potato virus Y
[d] PYMV – Potato yellow mosaic virus
[e] PMV – Pepper mottle virus
[f] CMV – Cucumber mosaic virus

B.5 – Chili pepper cultivars

Table B.5 Chili pepper cultivar information

Cultivar	Duration	General Remarks
Anaheim 118 - *Open pollinated*	75 days	Produces a pungent pepper with medium thick flesh suitable for canning, freezing or market. Fruits are dark green in color and turn red at maturity.
Charger - *F1 hybrid*	75 days	A new hybrid recommended over Anaheim 118. A flavorful pepper providing mild heat. The plant grows vigorously with excellent foliage cover to protect the fruits. On average a fruit weigh 150-170 g. Fruits mature from green to deep red. Resistant to TSMV[a]. Slightly larger, heavier and dark green than Anaheim 118 plus has TSMV resistance. Roasts and peels very well.
Chili G76 - *F1 hybrid*	72 days	Produce uniform, medium-thick fleshed fruits that have delicious mild heat and rich chili flavor. Fruits ripen from bright green to red at full maturity. This type has been a Southwest favorite for making chile rellenos, grilling and roasting. Intermediate resistance to TMV[b].

[a] TSMV – Tomato spotted wilt virus

[b] TMV – Tobacco mosaic virus