Effectiveness of Home Gardening in Reducing Food Insecurity and Improving Health in Chacraseca, Nicaragua: A Pilot Study

by

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ABSTRACT

Nicaragua has a high rate of food insecurity determined by factors such as, poverty, employment, education, social capital and climate change. Home gardening and nutrition education can decrease food insecurity and improve community health. There is a need to evaluate garden-based nutrition education to determine its effectiveness in improving food security and health in Nicaragua. It is also important to engage stakeholders at all stages of community research studies as it may lead to improved outcomes. The objective for this study was to evaluate the effectiveness of home gardening and nutrition education in improving food security, health, nutrition knowledge and nutrient intake among residents in Chacraseca, a small farming community in Nicaragua. A community needs assessment was conducted using focus group discussions and key-informant interviews to determine home gardening and nutrition education as priority interventions to improve food security and health in Chacraseca. Participants from Chacraseca were randomly recruited into the intervention and control groups. The intervention participants were recruited from residents previously involved in activities with JustHope, Inc., whereas the control group included participants not engaged in JustHope, Inc. activities. A longitudinal study design was used to promote and evaluate the effectiveness of home gardening and nutrition education in improving food security, health, nutrition knowledge and nutrient intake.

Research tools including food security questionnaires, anthropometry and blood pressure measures were used to collect baseline data on food security and health. After a year of promoting home gardening to the intervention participants, the same survey tools used at baseline were used to determine changes in food security and health at post-study. Concurrent

with home gardening, a longitudinal study of nutrition education was conducted to determine the effect of garden-based nutrition education in improving nutritional knowledge and nutrient intake. Nutrition education questionnaires and 24-hr recalls were used to collect baseline data on food intake and nutrition knowledge. After collection of baseline data, the intervention participants also involved in home gardening received six nutrition education lessons using the community nutrition education model. A year later, nutrition knowledge questionnaires and 24-hr surveys were used to determine changes in nutrition knowledge and nutrient intake. Qualitative data was analyzed using ATLAS.ti version 8.2.4 for iOS, whereas quantitative data was analyzed using SAS version 9.4.

Fifty participants were recruited into the intervention and control groups. At post-study, there were no significant changes in body mass index ($p = 0.99$), systolic blood pressure ($p = 0.13$), and diastolic blood pressure ($p = 0.92$) between the intervention and control groups. The average BMI for the intervention and control participants at baseline and post-study was within the overweight range (BMI between 25 and 29.9). The control group showed a greater percentage increase in participants with normal blood pressure (40%, n =18 at baseline to 60%, n = 27 at post-study) compared to the intervention group (48%, n = 23 at baseline to 54%, n = 26 at post-study). In households with children, at baseline and post-study, there was a decline in percentage of participants categorized as having low food security from 52% (n = 26) to 44% (n = 22) in the intervention group. Both the intervention and control groups showed improvements in participants categorized as having high food security from 2% (n = 1) to 6% (n = 3) in the intervention group and from 0% to 8.3% (n = 4) in the control group.

At post-study, participants in the intervention group had significant improvement in nutrition knowledge scores. There were non-significant changes in nutrient intake between the intervention and control groups except for vitamin A ($p = 0.04$) and sodium ($p = 0.03$).

However, there were observed non-significant increase in nutrient intake that were not specific to either the intervention or the control group. Although there was not enough evidence to demonstrate that home gardening improves health status, non-significant evidence pointed to an increase in number of participants with normal blood pressure. This, together with the slight improvement in food security and the significant improvement in nutrition knowledge demonstrated the potential of home gardening to improve health, food security and nutrient intake. Future researchers should focus on using several food security indicators in the evaluation, recruit larger sample sizes and should evaluate older home gardening projects. In addition, future research studies should last longer and include more intensive nutrition education and gardening training.

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ABBREVIATIONS AND ACRONYMS

WHO	World Health Organization
WFP	World Food Programme
FAO	Food and Agriculture Organization
GAIN	Global Alliance for Improved Nutrition
UNICEF	United Nations Children's Fund
INEC	Instituto Nacional de Estadlsticas y Censos
MINSA	Ministerio de Salud de Nicaragua
UN	United Nations
UNGA	United Nations General Assembly
IACHR	The Inter-American Commission on Human Rights
ELCSA	Latin America and Caribbean Food Security Scale
USDA	United States Department of Agriculture
IFAD	International Fund for Agriculture Development
UNDP	United Nations Development Program
IDA	International Development Agency
PAHO	Pan American Health Organization
CIA	Central Intelligence Agency

CHAPTER I: INTRODUCTION

The present study was conducted in Nicaragua, a country in Central America that has experienced a reduction in poverty levels over years but with persistently high levels of undernourishment above 17% (The World Bank, 2015a; FAO, 2013). Five kilometers (3.1 miles) South East of Nicaragua's second largest city Leon, Chacraseca is a farming community where this research was conducted. According to the Global Agriculture Information Network (GAIN), most families in Chacraseca have less than an acre of land for growing food and few families store food for off-season consumption (GAIN, 2013). There is currently inadequate food processing and most foods consumed in Chacraseca are imported from other Central American countries and from the United States (GAIN, 2013). These practices, coupled with insufficient intake of products of animal origin and other food sources of iron and vitamin A, predispose families to protein, energy and micronutrient deficiencies. Crop production and environmental sustainability issues combined with low income levels result in high levels of food insecurity.

The Food and Agriculture Organization of the United Nations (FAO) stated that food insecurity exists when people lack physical and economic access to sufficient, safe and nutritious food for an active and healthy life (FAO, 1996). Food insecurity often presents as over nutrition or undernutrition. Over nutrition is expressed as obesity, a major risk factor for chronic conditions including diabetes, cancer, and cardiovascular disease which are more predominant in developed countries. On the other hand, chronic undernutrition is predominant in developing countries, and in children, it usually presents as stunting defined as being short for one's age. Overnourished adults present with obesity, loss of appetite and sometimes

mortality (UNICEF, 2018; Collins & Myatt, 1998). According to the Nicaragua's Ministry of Health, chronic malnutrition is more evident in school-aged-children, with those in rural areas having twice the rate compared to children in urban areas (INEC and MINSA, 2013).

Several strategies are employed to reduce food insecurity in Nicaragua. These strategies include; conditional cash transfers defined as programs that transfer cash to poor households with the aim of facilitating investment in human capital of their children (Gitter & Caldes, 2010), international food aid defined as a program where free food is given to a country to assist in meeting its food needs (WFP, 2018), investing in agriculture (IFAD, 2018), improving infrastructure like roads, financial institutions and market systems (The World Bank, 2018), extending microcredit programs that aim to boost livelihoods through extending loans to communities (JustHope, Inc., n.d) and community agricultural interventions, for example home gardening (WFP, 2018). Home gardening is a practice that involves crop and animal husbandry within walking distance from human dwellings (Mitchell & Hanstad, 2004). Home gardening has been practiced for decades in developing countries to produce food for supplementing diets, foods for emergencies and or food for sale (Niñez, 1987). Some individuals establish home gardens for leisure or for rehabilitation programs (Niñez, 1987).

There is need to evaluate the effectiveness of home gardens to determine whether they help improve food security and health. This is of utmost importance in developing countries where some households depend on food produced in home gardens for survival. Most home gardens have been developed to increase the intake of certain nutrients or to increase overall food security (Carney et al., 2012; Niñez, 1987). The purpose of the present study was to evaluate the effectiveness of home gardening in reducing food insecurity and improving health in Chacraseca. It was hypothesized that by training participants in adaptive farming technologies, individuals would transfer the knowledge into their home gardens. This study

used a longitudinal design between the years 2015 and 2017 to determine, (i) the effectiveness of home gardening in improving food security and health, (ii) the impact of garden-based nutrition education on nutrition knowledge and nutrient intake of participants. In a long-term, home gardening may increase food availability and access to healthy, safe and nutritious foods.

The present study is structured as follows:

- Chapter 2 presents a literature review on food security and home gardening.
- Chapter 3 examines a needs assessment done using a community-based participatory approach to identify interventions for improved food security and health in Chacraseca.
- Chapter 4 presents the evaluation of home gardening in improving food security and health in Chacraseca.
- Chapter 5 presents the effects of garden-based nutrition education on nutrition knowledge and nutrient intake.
- Chapter 6 draws together general conclusions and sets the way forward.

CHAPTER II: LITERATURE REVIEW

Food Security Defined

According to the FAO's Food Price Index, agricultural commodity prices have, on average, remained relatively high in the past decades hence affecting food security (FAO, 2013). The Food Price Index is a measure of the monthly change in international prices of a basket of food commodities including diary, sugar, cereals, vegetable oil and meat (FAO, 2013). The global rise in food prices has led to an increased attention by policy makers and the media towards food security (Pinstrup-Andersen, 2009). Over the years, the definition of food security has undergone several modifications to reflect changes in official policy (FAO, 2003). Food security was originally defined in 1974 as *"the availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices"* (UN, 1975). This definition focused more on price stability of basic foodstuff at both national and international levels without accounting for the need for all citizens to have access to enough food for an active and healthy life (FAO, 2006). A food insecure country would then be defined as one that is unable to produce the food it needs or where citizens are unable to buy the food and one without currency to import food (Pinstrup-Andersen, 2009). Thus, at the World Food Summit of 1996, FAO revised the definition of food security to read, "*a situation that exists when all people at all times have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preference for a healthy and active life*" (FAO, 1996).

Importance of Measuring Food Security

Food security is an essential universal dimension of household and personal well-being. The 186 member states of the UN signed the Declaration of Rome at the 1996 International Food Summit pledging political will to eradicate hunger in all countries and to reduce the number of undernourished people by half between 1990 and 2015 (FAO, 1996). Achieving food security is in line with article 25 of the Universal Declaration of Human Rights, article 11 of the International Covenant on Economic Social and Cultural Rights, articles 24 and 27 of the Convention on the Rights of the Child and article 11 of the American Declaration on the Rights and Duties of Man (UNGA, 1948; UN, 1967; UNICEF, 1989; IACHR, 1948).

The main goal for measuring food security is to determine the degree at which individuals have availability, access, utilization and stability of sufficient safe and nutritious food for an active and healthy life (Lele, Masters, Kinabo, Ramaswami, & Meenakshi, 2016). Measuring food security therefore, may help to identify and understand the aspect of societal well-being as well as to identify population subgroups with unusually severe conditions (Bickel, Nord, Price, Hamilton, & Cook, 2000). Accurate measuring and monitoring of food security can help public officials, policy makers, service providers and the public to assess and design programs as well as evaluate existing programs (Babu, Gajanan, & Sanyal, 2014). Statistics on food security facilitate informed public debate regarding food insecurity, its impacts on the well-being of citizens as well as providing a guideline for public policies and public assistance programs (Babu, Gajanan, & Sanyal, 2014).

Additionally, accurate measurement of food security is vital to prevent global shocks in the food system. For example, in addition to the several causes of the 2008 global food-commodity price crisis including; public policy failure, linkages between biofuel, food and economic markets (Tadasse, Algieri, Kalkuhl, & Von Braun, 2016; Hochman, Rajagopal,

Timilsina, & Zilberman, 2014; Baltzer, 2014; Berazneva & Lee, 2013; Kumar & Quisumbing, 2013), part of the problem was blamed on the inability of international agencies and national governments to monitor food security in a sufficiently accurate and timely manner (Headey & Ecker, 2013). Therefore, researchers and organizations need to continuously measure the food security status of populations to determine whether residents are having optimal food intake and to inform the public about risks and possible interventions to food insecurity.

How Household Food Security is Determined

Several researchers have discussed various methods for measuring household food security. Maxwell (1996), developed a method for measuring food security by estimating the total/gross food stocks produced or purchased for household consumption over a period of time, followed by estimating the growth or reduction in food stocks over that same period of time. This method holds an assumption that the food that has disappeared from the household has been consumed. One limitation to this method is that it ignores food loss and food waste. Food loss is defined as the decrease in quality or quantity of food whereas food waste refers to discarding or alternative use of food that is safe and nutritious for human consumption" (FAO, 2018a). Food loss is an important aspect of food security in developing countries where 40% of the food is lost due to poor post-harvest handling (FAO, 2018b). Failure to account for food loss may yield misleading results as food lost due to poor storage facilities may be counted as food consumed within the household. Another limitation discussed by Maxwell (1996) is that the method does not account for differences in individual food consumption but measures total household food consumption. Even in the same household, individual food consumption may differ; For example, when men eat first and women eat last. Failure to account for differences in individual food consumption undermines the definition of household food security that stresses access to sufficient food by all people at all times (FAO, 1996).

Maxwell (1996) developed a second method based on 24-hour recalls of food consumption for individual members within the household. After collecting the 24-hour recalls, each food is then analyzed for complete nutrient composition. The advantage of this method over the food stock method described above is that it captures food consumption for individual household members (Maxwell, 1996). Limitations to the 24-hour recall method is that it relies on individuals' memory, and only accounts for 24 hours which in this case is a brief period of time to accurately estimate food security (Maxwell, 1996). To get an accurate estimate, a researcher may have to do multiple 24-hour recalls, which makes the process expensive to use. Neither the food stock nor the 24-hour recall methods measure vulnerability or sustainability, and as such may not a yield a full assessment for food security (Maxwell, 1996).

Geographical Information Systems (GIS) is gaining popularity for revealing insights, patterns, relationships, and situations in food systems. GIS tools analyze spatial location and organizes layers of information into visualizations using Maps and 3D scenes (ESRI, 2018). In terms of food security of an area, GIS can show information in a single picture organized in several levels. For example, at the bottom level, a GIS may show information related to slope, vegetation, water sources and international boundaries (Abbott, 2003). This could be followed by visualizations relating to land use, rainfall, soil type, cultivation, settlements/population patterns and transport routes (Abbott, 2003). On the top layer, a sample GIS may show information that is more precise such as conflict areas or minefields (Abbott, 2003). These levels of visualizations may be used by policy makers to make informed decisions.

GIS has been used to define and manage food security conditions in Tanzania (Hagai, 2014), Iran (Feizizadadeh, Pourmoradian, & Samereh, 2015), and in Mexico (Galeana-Pizana, Couturier, & Monsivais-Huertero, 2018). In the aftermath of the Haiti earthquake, GIS was used to identify areas of extreme damage to critical infrastructure as well as central areas for

water and food distribution (Theodore, 2010). Online and mobile GIS platforms allowed distribution networks to visually display areas that had received versus those that had not received food rations and humanitarian assistance (Cruse, 2013). The use of GIS by the UN organizations is becoming widespread. FAO produces GIS datasets for monitoring, assessing and analyzing environmental and socio-economic factors that cause poverty and food insecurity (FAO, 2018). FAO's GIS information is made available through the *FAO-GeoNetwork* powered by *GeoNetwork opensource* and collectively produced by FAO, WFP, United Nations Environment Programme, and the Office for the Coordination of Humanitarian Affairs (FAO, 2018).

Hoddinott and Yohannes (2002) developed a method that relied on linear regression to show an association between dietary diversity and food security. This method was developed by using food consumption data from 10 poor and middle-income countries that were also representative of urban and rural areas (Hoddinott & Yohannes, 2002). Low levels of dietary diversity were associated with low levels of food consumption per person and with low caloric availability. Hoddinot and Yohannes (2002) further displayed that an increase in dietary diversity was associated with increased caloric availability from food staples and from nonfood staples. As such, monitoring dietary diversity of households was determined to shed light on household food security and that this method was much easier and cheaper than traditional food security measures which rely on quantitative information (Hoddinott & Yohannes, 2002). However, this method is unvalidated and has several limitations. Ruel (2002) explained that for dietary diversity to accurately reflect household food security, the method developed by Hoddinot and Yohannes (2002) should be modified to reflect nutrients other than energy and that it should account for portion sizes and frequency of food intake. Additionally, this method

needs to have a scoring system, reference periods and cutoff points to classify food security levels (Ruel, 2002).

Lorenzana and Mercado (2002) developed and validated a simple method for determining food insecurity in poor urban households. This method comprises of both qualitative and quantitative components enabling the capture of different dimensions of household food security (Lorenzana & Mercado, 2002). The quantitative measure captures main sources of energy and specific nutrients in a home whereas the qualitative measure is used to gather information on food intake due to constrained resources and experiences of hunger in the home (Lorenzana & Mercado, 2002). The authors advise that this method can be simplified for use by non-experts in local communities by measuring food diversity instead of measuring predictors of available energy (Lorenzana & Mercado, 2002). Since its development, the method has been used in several poor urban communities in Venezuela, Caracas (Lorenzana & Mercado, 2002) and Colombia (Álvarez, Estrada, Montoya, & Melgar-Quiñónez, 2006). Additionally, after Lorenzana and Mercado's method was adapted by Alvarez et al in 2006, it was later in 2012 modified to form part of the Latin America and Caribbean Food Security Scale (ELCSA).

The Latin America and Caribbean Food Security Scale (ELCSA) was developed (de la ELCSA, Comité Científico, 2012) as a modification of food security scales that were being used in Brazil (Pérez-Escamilla et al., 2004), Colombia (Álvarez, Estrada, Montoya, & Melgar-Quiñónez, 2006), and in the United States (Bickel, Nord, Price, Hamilton, & Cook, 2000). The ELCSA consists of 15 questions that track whether any household member experienced food insecurity in the previous three months (de la ELCSA, Comité Científico, 2012). Affirmative responses are coded as "1" and the total raw score ranges from 0 to 15 for households with children and from 0 to 8 for households without children (de la ELCSA, Comité Científico,

2012). Using the scale in latter sentence, food security can be determined for (Shamah-Levy, Méndez-Gómez-Humarán, Gaona-Pineda, Cuevas-Nasu, & Villalpando, 2016):

- *"Households with minors as* 'household food secure' (score=0), 'mild household food insecurity' (score=1-5), 'moderate household food insecurity' (score=6-10), 'severe household food insecurity' (score=11-15)."
- *"For households with members above the age of 18 as* 'household food secure' (score=0), 'mild household food insecurity' (score=1-3), 'moderate household food insecurity' (score=4-6), 'severe household food insecurity' (score=7-8)" (Shamah-Levy, Méndez-Gómez-Humarán, Gaona-Pineda, Cuevas-Nasu, & Villalpando, 2016).

The ECLSA has been validated for use in various Latin American and Caribbean countries (Perez-Escamilla, Dessalines, Finnigan, Hromi-Fiedler, & Pachón, 2008; Munoz-Astudillo, Martinez, & Quintero, 2010). Ballard et al. (2013) reported the ELSCA to uniquely detect sufficient changes in access to the quality and quantity of food, as well as psychosocial expressions of anxiety and uncertainty around food access. The ELSCA is used to collect data on individual perception of food security and may not be representative of household food security (Jones, Ngure, Pelto, & Young, 2013). Additionally, the ELSCA does not capture diet quality and should therefore be accompanied with other quantitative measures such as food frequency questionnaire or 24-hour dietary recall (Jones, Ngure, Pelto, & Young, 2013).

Bickel et al. (2000) developed a food security survey module commonly used to determine household food security in the United States. The United States Department of Agriculture (USDA) household food security survey module has been used unmodified or modified in several studies to determine household food security using a series of 18 questions (Coleman-Jensen, Gregory, & Singh, 2014; Sahyoun et al., 2014). The scale for measuring

food security based on the USDA household survey module captures four kinds of events or situations that represent general food security as defined by FAO (FAO, 1996). These events include the qualitative and quantitative aspects of household food security together with responses to psychological and behavioral situations (FAO, 1996). Situations represented by the questionnaire include anxiety or perception of inadequate food budget, perception of inadequate quality of food, reported instances of reduced food intake for adults and a child section that captures instances of reduced food intake for children (Bickel, Nord, Price, Hamilton, & Cook, 2000).

Similar to the ECLSA described earlier, the USDA household food security survey module does not capture dimensions such as the nutritional status of children and adults (Babu, Gajanan, & Sanyal, 2014). It should therefore, be modified or used along with other survey tools if the effects of food security on health are of importance to the researcher (Silva, Caro, & Magaña-Lemus, 2016). One such tool that can be combined with the USDA food security survey module to capture effects of food security on health is the measure of anthropometry. Anthropometry involves the determination of an individual's body measurements (for example; weight, height, arm and neck circumference, waist to hip ratio and calf circumference) to determine the distribution of body fat and skeletal muscle resulting from nutrient intake. Combining the USDA household food security survey module with anthropometry measures not only the psychological and behavioral situations related to food security but also capture the effects of food security on health.

Both the ECLSA and the USDA household food security survey module are termed as experience-based measures designed to capture the psychological and behavioral parameters of household food insecurity. The USDA household food security survey module, however, has child referenced questions directed to experiences that occurred during the previous twelve

months versus three months for the ECLSA. Additionally, Bickel et al. (2000) explains that unlike the ECLSA, the USDA food security survey module has a standard 6-item subset that was developed from the 18-item core module. The six-item short version is necessary to quickly scan households for identifiable signs of hunger and food insecurity (Bickel, Nord, Price, Hamilton, & Cook, 2000). As such, this short version may be used in time sensitive research or preliminary analysis for community needs assessment.

Pillars of Food Security

The FAO acknowledges four pillars of food security including food availability, access, utilization, and stability (FAO, 1996). Physical food availability addresses the supply side of food security and is defined as the presence of sufficient quantities of food of appropriate quality, supplied through domestic production, national stock levels and imports including food aid (FAO, 2006). Food access reflects the demand side of food security (Barrett, 2010). Even with an adequate food availability at both national and international level, access to food is only guaranteed with policy focus on incomes, prices and favorable infrastructure (FAO, 2008). Food utilization defines the ability for individuals and households to make good use of food to which they have access (Barrett, 2010). The food stability component of food security encompasses political stability and economic factors that may have an impact on the food security status (FAO, 2008). The resilience with which countries, regions within countries, communities, and households attain food security should be taken into consideration in analysis of food security (Babu, Gajanan, & Sanyal, 2014).

Information on food availability is usually obtained from national, regional, and sub-regional food balance sheets (Babu, Gajanan, & Sanyal, 2014). These balance sheets are obtained from the FAO balance sheet database for individual countries and regions (FAO,

2017). Using the food balance sheets, food availability is determined by adding foodstuffs produced in a country to the total quantity of food imported and then adjusted to any change in stocks that may have occurred since the beginning of the reference period (FAO, 2017). As such, FAO balance sheets do not provide information on consumption patterns and relate only to supply and availability of food at the national level instead of the household level (Babu, Gajanan, & Sanyal, 2014). Used alone, food availability does not accurately estimate household or individual food security.

Food access is measured as a combination of both physical access determined by access to food in the market and economic access to food at the household level (Babu, Gajanan, & Sanyal, 2014). Having economic access to food depends on the purchasing power of the household and the existing level of food prices. Economic access in turn depends on the physical access to food (Thomson & Metz, 1999). For example, WFP reported that during the 2008 global food crisis, food insecurity in Nicaragua was principally due to reduced economic access to food compounded by decreased employment opportunities (WFP, 2009).

Household food access is measured through food or nutrient intake at the household level reported in "adult equivalent" units to facilitate comparison among individuals within a household as well as among households (Babu, Gajanan, & Sanyal, 2014). Barett (2010) highlights that food access denotes problems in responding to shocks such as unemployment spells, price hikes or loss of assets. Given that food access is an inherently multidimensional concept that encompasses food markets, infrastructure and economics, it is a much more difficult pillar to measure than food availability. Surveys that collect information on household composition and household expenditure patterns with a focus on food and non-food items, caloric intake, consumption of major products, and socioeconomic characteristics can be used to evaluate food access over time. Food access can be deduced from these surveys by

estimating amounts of food consumed, composition of the diet, and nutrient availability at the household and individual level (Babu, Gajanan, & Sanyal, 2014). The multidimensional nature of food accessibility measurement makes it an expensive and time consuming tool to estimate household food security. Renzaho and Mellor (2010) explained that access to food does not guarantee household or individual food security unless the food is nutritionally adequate. They further explained that food access and food availability cannot be used to estimate household or individual food security without accounting for food utilization (Renzaho and Mellor, 2010).

Food utilization can be assessed by determining feeding practices, food preparation, diet diversity and intra-household distribution of food. Food utilization defines the nutritional status of individuals (FAO, 2008). It relates to how consumed food is translated into nutritional and health benefits of individuals (Babu, Gajanan, & Sanyal, 2014). Using this relationship, the quality and quantity of consumed food in relation to its ability to meet energy and nutrient requirements is a basic measure of food utilization (Babu, Gajanan, & Sanyal, 2014). To determine the quality and quantity of food, food intake is determined using dietary recalls such as the food record, the 24- hour dietary recall or the food frequency questionnaire. From this, the nutrient composition is determined and compared with recommended intakes of energy and nutrients (Babu, Gajanan, & Sanyal, 2014). Although food intake includes protein and other nutrients, energy intake is the focus and is extremely important in improving food utilization (Babu, Gajanan, & Sanyal, 2014).

Food security depends on the stability of food supply. Weather variability, price fluctuations, political and economic factors can affect the stability of food supply (UNICEF, 2018). Food security is linked to political stability at national, regional and international levels. Conflict causes displacement of families, loss of assets, loss of lives and destruction of markets. According to FAO (2016), conflict can have a profound impact on animal health and

access to milk, meat and livestock ownership hence directly affecting food security. This is important because one of Nicaragua's major exports is beef and other animal products. In 2007, conflicts arising from change of governance caused increased prices for chicken, fish and other food stuffs throughout Nicaragua (Reed, 2010). The conflicts in 2007 coincided with the global food crisis of 2008 and with hurricane Felix of 2007. Additionally, in 2010 FAO noted that prices for rice, beans and corn in Managua were above international prices mainly driven by inclement weather and to a lesser extent by civil conflicts (FAO, 2010). In April 2018, a civil war broke up in Nicaragua. In addition to conflict, climate change is likely to affect food stability and ultimately lead to increased food insecurity. Unlike the access, utilization and availability pillars of food security, there is no known measure of food stability. This may be partly because most conflict and climate events occur spontaneously allowing for no time for predictions of effects.

Even though the four pillars of food security can be measured individually, they cannot sufficiently be used to determine household food security. Information on food availability gives insight about consumption patterns at the national level but not at household level (Babu, Gajanan, & Sanyal, 2014). However, the USDA household food security survey module (Bickel, Nord, Price, Hamilton, & Cook, 2000) accounts for qualitative and quantitative aspects of household food security with responses to psychological and behavioral situations (FAO, 1996). This makes the USDA household food security survey module fit for determining household food security.

Global Food Insecurity Statistics

Each year, the FAO publishes the state of food insecurity and nutrition in the world. The FAO combines data from the extent of hunger (defined as prevalence of

undernourishment) and the prevalence of severe food insecurity to determine global food insecurity (FAO, IFAD, UNICEF , WFP and WHO, 2017). By using the direct interviews using the "food insecurity experience scale" (FIES) survey, the FAO collects food access data from adult individuals worldwide and then estimates the prevalence of severe food insecurity (FAO, IFAD, UNICEF , WFP and WHO, 2017). The FIES relies on direct yes/no responses to eight questions regarding access to adequate food. The FIES is a derivation of the USDA household food security survey module (Bickel, Nord, Price, Hamilton, & Cook, 2000), and the ELCSA (de la ELCSA, Comité Científico, 2012). In 2016, FAO et al. (2017) reported that 9.35% (688 million people) of the world population were severely food insecure whereas 11% (815 million people) were undernourished (FAO, IFAD, UNICEF , WFP and WHO, 2017). FAO et al. (2017) further reported that due to conflicts in several parts of the world including, South Sudan, Syria, Democratic Republic of Congo, Palestine, Venezuela and Myanmar, the number of people categorized as food insecure is likely to rise. The effects of conflicts are likely to be exacerbated by climate-related shocks (FAO, IFAD, UNICEF , WFP and WHO, 2017). In the 2016 food security report, FAO et al. (2017) reported statistics on severe food insecurity and undernourishment but not food insecurity in general. Additionally, FAO et al. (2017) adopted the FIES in 2015. Over 140 countries have not reported values of undernourishment needed to estimate food security. Therefore, 2016 statistics reported by FAO are independent values of severe food security and undernourishment, but not general food security.

Food Insecurity Statistics in Nicaragua

Information on the situation of food security in Nicaragua is limited. Using a cross-sectional study design and the Latin America and Caribbean Food Security Scale, researchers determined the level of food insecurity among households in Leon, Nicaragua (Piperata,

Schmeer, Rodrigues, & Torres, 2016). In this survey, Piperata et al. (2016) determined that in a sample of 434 mothers representing 434 households, 25% of the households were determined to fall in the food secure category, 50% were categorized as mild food insecure, whereas 25% of the households were categorized as severely food insecure (Piperata, Schmeer, Rodrigues, & Torres, 2016). Even though the study by Piperata et al. (2016) was carried out in Leon, which is in close proximity to Chacraseca, results may not apply to rural settings and they may not represent a larger population normally consisting of males and females.

In another cross-sectional study, researchers used a food insecurity access scale to determine food insecurity in rural northwestern Nicaragua from a sample of 1431 households (Conteras, Blandon, Persson, Hjern, & Ekstrom, 2015). Results showed that 33% of the sample participants were categorized as food insecure whereas more than 50% were categorized as moderately food insecure (Conteras, Blandon, Persson, Hjern, & Ekstrom, 2015). The food insecurity access scale used by Contreras et al. (2016) was designed to measure the uncertainty of households to obtain food, or to have limited access to high quality food as well as the reduction in food quantity over a period of one month (Coates, Swindale, & Bilinsky, 2007).

The FAO reports food security in terms of undernourishment. The rate of food insecurity is reported as a country's three-year average level of undernourishment. According to FAO the average prevalence of undernourishment in Nicaragua for the years 2014 to 2016 was 17% (FAO, 2017a). Lastly, the Economic Intelligence Unit reports national food security based on the three indicators of affordability, availability and quality and quantity of food within a country (The Economic Intelligence Unit, 2017). Using the three indicators, each country is assigned a score known as the "global food security index." The global food security index score ranges from "1 to 100" where 100 is most favorable (The Economic Intelligence Unit, 2017). Using the global food security index for the year 2017, Nicaragua has a score of

50 and is ranked number 72 out of 113 countries (The Economic Intelligence Unit, 2017). The rate of food security in Nicaragua is defined by factors of poverty, education, employment, social capital and climate change as discussed below.

Factors of Food Insecurity in Nicaragua

Poverty

According to the International Monetary Fund (IMF) and the World Bank, Nicaragua is the second poorest country in the western hemisphere after Haiti (IMF, 2017; Central Bank of Nicaragua, 2017). Recently, Nicaragua has seen poverty levels drop from 42.5% to 24.9% between 2009 and 2016, and extreme poverty dropped to below 15% in 2016 (Central Bank of Nicaragua, 2017; The World Bank, 2016a). Close to half of Nicaragua's population lives in rural areas (The World Bank, 2017a; FAO, 2017). Rural poverty rates are three times higher than the 14.8% poverty rate average in urban areas; 70% of the poor live in rural areas (Harvey, 2017). In rural areas of Nicaragua, one in six households is extremely poor compared with one in twenty for urban areas (Harvey, 2017).

In response to high levels of poverty, the Government of Nicaragua launched a series of poverty reduction strategies. In 2001, Nicaragua adapted the Strengthened Growth and Poverty Reduction Strategy (SGPRS) focusing on economic growth, investment in human capital of the poor and protection of individuals affected by natural disasters and those with physical problems (The Government of Nicaragua, 2001). The SGPRS drew frustrations as Nicaragua realized slow economic progress and slight reductions in poverty (International Monetary Fund, 2005). Due to poor performance of the SGPRS, the National Development Plan (Plan Nacional de Desarrollo – Operativo) was launched in 2004 to increase economic growth, boost exports and to reduce poverty (Republic of Nicaragua, 2005). Wiggins (2007) reported that a

review of the National Development Plan strategy showed little progress in reducing poverty. In 2012, the National Human Development Plan was launched focusing on economic growth through reducing poverty and macroeconomic stability (Republic of Nicaragua, 2012). Even with several poverty reduction strategies over the years, around 2.4 million Nicaraguans still live below the poverty line, with some 83,000 living in extreme poverty (INEDE, 2009). A search for literature revealed limited published work on poverty reduction strategies in rural communities in Chacraseca, Nicaragua, or surrounding areas.

Education

Formal education is one of the main determinants of an individual's income and a key factor for achieving economic and social opportunities (Cruces, Domench, & Gasparini, 2014; Das & Sahoo, 2012; Berger & Fisher, 2013). Adult specific informal education services such as Agricultural Extension can increase food security through the transfer of skills and behaviors (De Muro & Burchi, 2007). According to 2014 statistics by the Education and Policy Development Center, 37% of 15 to 24 year olds in Nicaragua did not complete primary education. Approximately 21% of boys and 15% of girls of primary school age did not attend school. Additionally, 39% of females and 47% of male of secondary school age are held out of school in Nicaragua (Education Policy and Data Center, 2014).

Schmeer et al. (2015) conducted a cross-sectional study to determine the relationship between maternal resources and household food insecurity. In this study, Schmeer et al. (2015) collected qualitative data on maternal resources and quantitative data on household food security from 434 households in Leon, Nicaragua. Results showed that households where mothers attained secondary education had 48% lower chances of experiencing moderate/ severe household food insecurity as compared to households where mothers had lower

education levels (Schmeer, Piperata, Rodríguez, Torres, & Cárdenas, 2015). Given that Schmeer et al. (2015) did not report the specific communities from which data was collected, it is not clear whether Chacraseca (the proposed study area) was part of their study.

Studies relating education attainment to food security in Nicaragua are limited. A study done in Honduras, a country that neighbors Nicaragua, Ben-Davis et al. (2013). sought to explore factors associated with food insecurity. Ben-Davis et al. (2013) collected food security and socio-demographic data from 298 caregivers of children. Using Chi-Square analysis to determine the relationship, caregivers who were found to have no or mild food insecurity were those with education levels beyond primary school. After controlling for age of the caregiver, Ben-Davis et al. (2013) reported caregivers with an education that did not exceed primary level lived in households associated with severe and moderate food insecurity. Smith et al. (2017) explained that educated individuals often possess more property and have access to better infrastructure thus providing opportunities for non-agricultural employment, a factor necessary for attaining food security.

Employment

According to the International Labor Organization, the unemployment rate in Nicaragua has been declining steadily from 8.2% in 2009 to 4.4 % in 2017 (ILO, 1991-2016). The total unemployment rate for Nicaragua in 2017 was below the world average of 5.5% (ILO, 1991-2016). Agriculture has been the main source of job creation, helping to stabilize Nicaragua's employment rate. Rural households earn 60% of their income from agriculture, 27% from nonfarm activities and 13% from remittances. However, agricultural jobs are mainly informal, low skilled and low income (INEDE, 2009).

Despite improvement in primary education completion rates, attainment of labor skills

remains the major reason for unemployment in Nicaragua (IMF, 2015). Nicaragua presents the lowest minimum wage in Central America. All sectors average an hourly minimum wage below $2 US dollars (FIDEG, 2015). This is one of the reasons that 29.6% of the population that lives in poverty and 8.3% in extreme poverty (FIDEG, 2015). Due to low labor skills, men and women are recruited for low wage jobs in local agro-industries, road and house construction sites, as well as agro-cultural farms (Kay, 2006). Some small-scale farmers have resorted to migrating to neighboring countries like Costa Rica, El Salvador and the U.S.A during harvesting seasons in order to obtain money for investing in farming back in Nicaragua (Christoplos & Pain, 2015). However, new regulations in the U.S.A that are becoming strict on illegal immigrants are impeding this coping strategy (Christoplos & Pain, 2015).

Social Capital

Social capital was first defined as good will, fellowship, mutual sympathy, and social interaction among individuals in a social unit (LJ, 1916). More recently, stronger social networks and higher levels of social capital are consistently associated with better health and community well-being (WHO, 2010; Janicki-Deverts & Sheldon, 2009). Nicaragua was found to have a low social capital in terms of net percent trust and community participation scale compared to other Latin American Countries (Rosero-Bixby, Collado, & Selingson, 2005). Social networks and social capital can help create relationships among households and enhance exchange of food products in times of need (Barrett, 2002). Having higher levels of social capital may be an important aspect for household food security as it may promote community work or the ability to exercise coping strategies (for example; barter trade, borrowing money from neighbors or visiting relatives) during periods of food scarcity.

Even though several studies have reported social capital to promote household food

security (Díaz, Drumm, Ramírez-Johnson, & Oidjarv, 2002; Martin, Rogers, Cook, & Joseph, 2004), a literature search for the association between social capital and food security in Nicaragua yielded no results. However, a study done in a low-income community in Kenya was aimed at determining the relationship between social capital and food security. Gallaher et al. (2013) used focus group discussions and household surveys with a sample of 153 farmers and 153 non-farmers in 2011 (Gallaher, Kerr, Njenga, Karanja, & WinklerPrins, 2013). Topics for qualitative interview questions were focused on social capital and included; participation in formal or informal groups, relationship with neighbors, and exchange of goods between households (Gallaher, Kerr, Njenga, Karanja, & WinklerPrins, 2013).

Having good relationship with neighbors was associated with improved food security among households because it promoted coping strategies and group work in times of food scarcity (Gallaher, Kerr, Njenga, Karanja, & WinklerPrins, 2013). Seguuya et al. (2017) explained that social capital improves food security by enhancing unity of group members, access to information from external institutions and observance of group norms. The low social capital of Nicaragua compared to other countries in Latin America may indicate lesser social interaction a factor that could hinder good coping strategy in situations of food insecurity (Rosero-Bixby, Collado, & Selingson, 2005).

Climate Change

The global climate risk index shows that Honduras, Myanmar and Nicaragua experienced the greatest effects of climate change from 1992 through 2011 (Kreft, Eckstein, & Melchior, 2016). Due to its geographical location in the inter-tropical convergence zone, one sixth of Nicaragua's surface is in zones with high or very high sensitivity to climate events (Solé et al., 2016; UNDP, 2011). Impacts of climate change are of utmost importance to

Nicaragua because its economy largely depends on agriculture, cattle raising and fishing; all of which are highly sensitive to climatic conditions. Nicaragua has taken shocks from major climatic events including Hurricane Mitch in 1998, the 1972 earthquake in the capital Managua, landslides, and volcanic eruptions (Ambraseys, 1972; FAO, 1998).

The WFP reported that in October 1998, Hurricane Mitch created significant flooding and mudslides that were responsible for a 30% loss of the coffee crop in Nicaragua (WFP, 1998). Additionally, there was significant damage to basic infrastructure, agricultural production and industries (WFP, 1998). This was accompanied by loss of cereals and pulses that are staple foods for communities around the pacific coast including Chacraseca (WFP, 1998). Hurricane Felix of 2007 and tropical storm Nate in 2017 triggered deadly flooding that destroyed homes, agriculture and transportation infrastructure (WHO and PAHO, 2007; Reliefweb, 2017). These events further support the notion that Nicaragua is prone to severe climatic shocks.

The dry corridor of Central America, of which 20% is part of Nicaragua, is predicted to experience severe drought conditions (Solé et al., 2016). Projections show that between 2020 and 2050 Nicaragua will have average temperature increase of between 1^{o}C and 2^{o}C and between 3^{o}C and 4^{o}C by the end of this century. This will be accompanied by a reduction in precipitation at the national level and a slight increase in the Pacific region (UNDP, 2011; UNDP, 2010). The United Nations Development Plan reports that the predicted climate events will affect food security, jobs, economy, social structure and overall development (UNDP, 2010). Several development experts in Nicaragua are promoting food security and localization of food systems as an adaptation measure to climate change (Bacon, 2011; Holt-Giménez, 2006).

Home Gardening and Food Security

With declining arable land (The World Bank, 2017c) and a predicted decline in precipitation (Dai, 2013; Vicente-Serrano et al., 2014; Erfanian, Wang, & Fomenko, 2016) the current food security strategies should be rethought. Home gardening, also referred to as backyard gardening, is a food security strategy that has been promoted for decades in urban, rural, developed and developing communities (Alemu, Msaki, Sengendo, & Kigutha, 2000; Galhena, Freed, & Meredia, 2013). Home gardens are usually small portions of cultivated land within walking distance from homes planted with mixed crops and some livestock with an aim of providing supplemental food and income (Mitchell & Hanstad, 2004). Ninez described home gardens as small-scale production systems located near human dwellings and have a primary purpose of supplying both plant and animal items that would not otherwise be obtained, affordable or readily available from local markets, field cultivation, hunting, gathering or fishing (Niñez, 1987).

Researchers have examined the relationship between home gardening and food security in Nicaragua. In 2001, Méndez and Somarriba analyzed the relationship between home gardens and the socio-economic importance in Nicaragua. The study was conducted from January to August 1999 with a sample of 20 families and their home gardens. During garden visits, researchers interviewed the farmers who owned the respective home gardens with the farmer explaining the use for different crops (Méndez & Somarriba, 2001). This was followed by mapping the garden into zones based on main crop uses. Results showed that most of the home garden area (37%) was allocated to fruit trees. Méndez and Somarriba (2001) discovered that cucurbit (plants of the gourd family including: melon, pumpkin, squash and cucumber) used for home consumption and passion fruit that was sold for money were the most important food crops in the home gardens. Forty different plants used for home consumption and for sale were

identified as products from home gardens (Méndez & Somarriba, 2001). Although Méndez and Somarriba (2011) did not specifically measure food security, their study revealed that farmers in Nicaragua grow home gardens to provide food for home consumption and for income generation.

Boone and Taylor (2016) sought to define whether home gardens led to food sovereignty in the northern highlands of Nicaragua. Food sovereignty is defined as the right of nations and people to control their food systems including, markets, production modes and food cultures and environment (Lawrence & McMichael, 2012). Boone and Taylor (2016) studied the extent to which home gardens could effectively lead to food sovereignty and why farmers resist changing their food consumption strategies to embrace biodiverse home gardens (Boone & Taylor, 2016). This study was done through in-depth interviews across four cooperative societies including sixteen men and eight women in Estelli and Somoto municipalities of Northern Nicaragua. In addition, researchers interviewed the project management team members as key informants to supplement responses from participants. Results showed that 90% of farmers perceived home gardens as contributing to diversified and healthy diets while offering an opportunity to save money by not purchasing food from local supermarkets (Boone & Taylor, 2016). Arimond et al. (2011) view food availability and food access through production for household consumption as one of the major pathways by which agricultural interventions influence nutrition.

Despite diversified diets, Boone and Taylor (2016) reported that cost of inputs, the need to construct fences around gardens to prevent damage from farm animals, unreliable rainfall, and the lack of sufficient/ appropriate land discouraged farmers from engaging in home gardening. In-depth interviews revealed that farmers found it cheaper to plant more coffee because it requires less labor. The farmers would sell the coffee to the international market, and

in turn purchase food from the local market (Boone & Taylor, 2016). Similarly, Arimond et al. (2011) reported the cost of agricultural inputs (including; fertilizers, herbicides, pesticides, labor and seeds) as a problem for farmers who choose to engage in agricultural interventions. In-depth interview results reported by Boone and Taylor, (2016) further revealed that respondents explained the sale price for vegetables in the markets to be lower than the production costs, especially with the high transport costs to the markets (Boone & Taylor, 2016). The low sale price for vegetables may further discourage farmers who would otherwise have opted to engage in gardening for its income benefits. Additionally, farmers explained that they lacked experience growing vegetables and that it would require them to re- prioritize their labor and economic investments to accommodate home gardens (Boone & Taylor, 2016).

There is limited research on the importance of home gardens in improving food security and health in Nicaragua. Researchers in other developing countries besides Nicaragua have reported effects of home gardening on food security and health. In Eastonside South Africa, Selepe and Hendriks (2014) researched the impact of home gardens on nutrient intake, access to food and dietary diversity in pre-school children. Food consumption and dietary diversity was determined using a 24-hour recall of children's consumption as reported by the caregivers. Analysis of nutrient intakes before project start showed that average nutrient intakes were below recommendations for optimal nutrition except for protein that was double and vitamin A was above the recommended dietary allowance of nutrients.

Selepe and Hendriks (2014) reported an increased frequency of consumption of fresh fruits and vegetables and a doubled increase in the consumption of nuts and legumes by project end. The number of children consuming dark green vegetables and other vegetables increased by 25%, whereas the number of children consuming fish and eggs increased by almost a quarter. Paired t-tests showed statistically significant changes in the consumption of vitamin A

rich vegetables, seeds, nuts legumes, cereals, meat, organ meats and milk. Additionally, Selepe and Hendriks (2014) reported improved dietary diversity representing a direct positive impact of home gardens on food intake. Researchers report increased consumption of vegetables due to promotion of gardening (Hotz et al., 2012; Low et al., 2007; Hagenimana et al., 2001). Diet diversity increased as a result of promoting home gardening was also reported by researchers in Bangladesh (Cabalda, Rayco-Solon, Solon, & Solon, 2011; Helen Keller International, 2010).

According to Selepe and Hendriks (2014) nutrient intake from consumed foods was established using a computer package: "Dietary Manager." Using before and after 24-hour recalls, the only significant nutrient intake was vitamin A and iron but vitamin A intake was way above the recommended daily allowance (but below toxic levels) at the beginning of the project. No significant changes in fiber intake, and macronutrients through paired t-tests was observed from beginning to project end. Additionally, intakes of energy, fat, fiber and calcium remained inadequate by the end of study. Other researchers who promoted vegetable growing in Bangladesh and South Africa reported lack of significant improvement in nutrient intakes (Kumar & Quisumbing, 2011; Faber, Venter, & Benade, 2002).

Besides the high cost of agricultural inputs and unpredictable climate patterns reported by Boone and Taylor (2016) and Arimond et al. (2011), mixed results for the effectiveness of home gardening in improving food security and health could be due to failure to actively engage the target community at all stages of gardening interventions. None of the studies discussed above mentioned involvement of target communities in their home gardening interventions. Target communities can be involved in home gardening projects by using principles of community-based participatory research. A summary of home gardening interventions involving community-based participatory research follows.

Community-Based Participatory Research

Community-based participatory research (CBPR) is defined as a strategy to research that actively engages all stakeholders affected by a research study including; members of the target community, organizational representatives, funders and researchers at each stage of the research process (Israel, Amy, Edith, & Adam, 2001). CBPR involves a participative process that puts the research process in the control of its stakeholders (Israel et al., 2006). Israel et al. summarizes the principles of CBPR as an approach to research that: *" (i) recognizes the community as a unit of identity, (ii) builds on community strengths and resources, (iii) enhances collaboration of all partners at each stage of research process, (iv) integrates knowledge and action for the mutual benefit of all stakeholders, (v) promotes co-learning and empowerment that focuses on social inequalities, (vi) involves a cyclical and interactive process, (vii) tackles health considering both positive and ecological processes and, (ix) disseminates findings and knowledge gained among all stakeholders involved in the research"* (Israel, Sculz, Parker, & Becker, 1998, p. 178-180).

CBPR in Home Gardening Interventions

Even though home gardening has been used for decades as an intervention strategy to curb food insecurity and improve health, published studies highlighting its integration with CBPR is limited. Studies which successfully employed CBPR at all levels of the research process led to community-level action that was followed by improved health and wellbeing of target communities (Salimi et al., 2012).

Carney et al. (2012) used CBPR to determine the impact of gardening on vegetable intake, food security and family relations. In this study, research roles were divided between the community group, "*Nuestra Communidad Sana,"* and the *Oregon Health and Science*

University (OHSU) teams. The community team was responsible for organizing all study meetings and interactions with families whereas the OHSU team developed educational materials used in the study. Even though the educational materials were designed by the OHSU team, the community group translated and adapted the materials to suit the families. The study reported a fourfold increase in vegetable intake among adults and a threefold increase among children. Families reported that gardening contributed to togetherness. Additionally, food security dropped from 31% at baseline to 3% at post-study. Carney et al. (2012) credit the success of the study to partnership and trust established between the community and investigators.

Even though Carney et al. (2012) reported that the CBPR collaboration benefited both the community and the researchers, there were limitations tied to using CBPR. First, researchers recruited more participants at post-study as they did not want to leave out any community members. This could have affected the quality of the results as the research design was altered to accommodate more participants. Secondly, it was reported that gardening supplies were allocated to 40 out of the 42 recruited households due to limited budget leaving out other participants (Carney et al., 2012). Other researchers have reported that CBPR may require larger budgets and longer timelines than focus group discussions (Daley et al., 2010; Calswell, Reyes, Rowe, Winert, & Israel, 2015). Additionally, Carney et al. (2012) felt that no family had to be left out and therefore selection of study participants was not random. CBPR may mean giving up controlling recruitment procedures, focus group protocols and data analysis (Daley et al., 2010). Carney et al. (2012) felt it would be unethical to assign only some families to receive gardening supplies because the whole community was economically struggling.

In another study, Zoellner et al. (2012) used CBPR to explore community gardens in a population with healthcare inequalities. This study described how several regional stakeholders from the civil, faith-based, healthcare, local government, education, small businesses and social government organizations teamed up with research faculty from Virginia Tech to design a unified community effort to address obesity. Zoellner et al. (2012) reported a willingness of participants to engage in community gardening and to eat foods grown in their gardens. Additionally, results showed that parents involved in the study had above average levels of gardening attitude, belief and self-efficacy scores (Zoellner et al., 2012). Partnerships between the community and academic team highlighted the possibility of launching future community gardens with the potential of improving health outcomes. However, Zoellner et al. (2012) reported timing and inconvenience as a limitation to the study. This was shown in the low involvement of community participants in the qualitative study as some participants had other obligations to attend to (Zoellner et al., 2012). Using CBPR could delay research as on several occasions as stakeholder meetings may be difficult to arrange.

Wakefield et al. (2007) used CPBR to determine how participants perceived health benefits from community gardening. In focus group discussions, participant observations and in-depth interviews, Wakefield et al. (2007) determined two major themes: perceived health benefits and barriers to establishing and maintaining a garden According to Wakefield et al. (2007), themes for perceived health benefits that included; mental health, physical activity and food accessibility. Barriers to establishing and maintaining a garden included lack of awareness, insecure land ownership, lack of funding and lack of political will to assist the gardeners (Wakefield, Yeudall, Taron, Reynods, & Skinner, 2007).

Lastly, researchers used key informant interviews to explore the gardening experiences of participants and how their experiences influenced health (Hale et al., 2011). This

collaborative study involved five stakeholders including three from community partner organizations and two academic institutions. Together they designed, implemented and evaluated the various research elements. Their efforts led to generation of local knowledge about gardening, active lifestyles, healthy eating and health. Hale et al. (2011) uncovered that gardeners related being outside in the community, learning about natural rhythms, connecting with one's roots and sharing food to having good health. However, the level of participation of the various stakeholders was not motioned past the methodology section, undermining the purpose of CBPR. Additionally, there is no mention of how research findings were disseminated to the various stakeholders (Hale et al., 2011).

Given that there have been mixed results on the importance of home gardens in improving health and food security, recent recommendations have focused on using CBPR at all stages of the interventions (Hale et al., 2011; Wakefield, Yeudall, Taron, Reynods, & Skinner, 2007; Zoellner, Zanko, Price, Bonner, & Hill, 2012; Carney et al., 2012). Researchers suggest that the community should be involved in designing solutions to issues within their community (Hildebrandt, 1999; Alaimo, Reiscchl, & Allen, 2010). This creates a sense of ownership and the community is likely to sustain the proposed interventions.

Study Area

Chacraseca is a farming community in Nicaragua. The Republic of Nicaragua is located on latitude 12.865416 and Longitude -85.207228999 in Central America where it covers a total surface area of 130,370 square kilometers (The World Bank, 2016; Central Intelligency Agency, 2017). Nicaragua is bordered by the Caribbean Sea in the east and by the North Pacific Sea in the west (World Atlas, 2018). Chacraseca is located 3.1 miles south east of Leon (Nicaragua's second largest city) at the foot of the Maribios mountain range on the pacific side of Nicaragua (ACOPEDES - Chacraseca, n.d.). It is located within access to the

ring road that connects Nicaragua's largest district and capital city, Managua, to the country's third largest city, Chinandega. Chacraseca has a population of approximately 8,000 people within 1,250 households. The community covers an area of 49 square miles (78 Kilometers) politically divided into 12 sectors, each with a sector leader (ACOPEDES - Chacraseca, n.d.). The sectors include Mojon Sur number 1, Brisas de parasio, Boca de cantaro, Las Lomas, Pedro Arauz, Mojon Sur number 2, Raul Cabezas, La Concemption, La Arenera, La Bolsa, El Recreo and Miramar (ACOPEDES - Chacraseca, n.d.).

Climate

Nicaragua has three major climate zones namely; (i) the flat pacific lowlands that stretch up to 75 kilometers from the pacific coast, (ii) the central highlands that are predominantly mountainous consisting of mixed forests and valleys and lastly, (iii) the Caribbean lowlands consist of sparsely inhabited rainforests with several rivers (Krasnoff, 2013; Solé et al., 2016). The study area, Chacraseca, is located within the flat Pacific lowlands. This area consists of a line of young active volcanoes as well as Lakes Managua and Nicaragua (Merrill, 1994; Dall, 2007; Krasnoff, 2013). This is the most fertile and populous zone with more than half of the total nation's population (Dall, 2007). The Pacific lowlands are the hottest among the three zones with temperatures varying between 72^{o}F at night and 86^{o}F at day time but can stretch up to 100^{o}F in May (Dall, 2007).

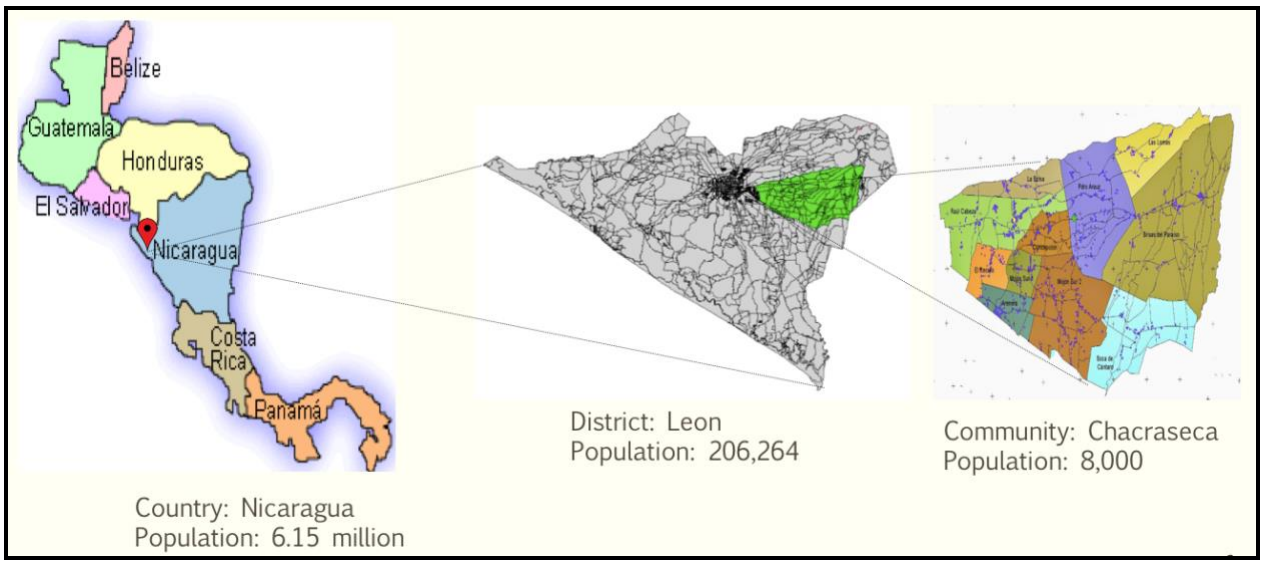

Figure 1: Location of Chacraseca within Nicaragua (ACOPADES, 2014)

Chacraseca has a tropical climate with two seasons that are a result of close proximity to the Pacific Ocean. The dry season stretches from November to April with virtually no rain with April and May being the hottest months (Solé et al., 2016; Dall, 2007). Throughout the country, temperatures vary slightly with lowlands experiencing night temperatures of 70ºF whereas the highest peaks have temperatures ranging between 55ºF and 75ºF at both day and night. Lowlands have rainy season between May and October with average rainfall of between 10 and 250 inches (Solé et al., 2016; Dall, 2007).

Over the past 10 years, the effects of climate change have led to a "dry corridor strip" in Central America (FAO, 2017). The dry corridor refers to a region in Central America that suffers severe inclement weather. Chacraseca is located within this newly defined dry corridor (FAO, 2017). The FAO reports that the dry corridor is known for irregular rainfall with recorded precipitation drops of between 30% to 40% and long periods of heatwaves with hardly any rainfall (FAO, 2017). The periods of no rainfall are increasing with time and posing threats to cultivation of staple foods. On the other hand, during rainy seasons the dry corridor

receives intense rains with tropical storms that are detrimental to agriculture and other economic activities (FAO, 2017). There are several organizations working to reduce effects of inclement weather in the dry corridor strip. These include: FAO, The UN Environmental Program, the System of Central American Integration, The World Bank, IFAD and WFP (FAO, 2017).

Topography

Besides the dry corridor strip, Chacraseca is within close range to active volcanoes. Chacraseca is approximately 12 miles from "Volcano Telica." The guardian reported that the 2011 eruption of "Volcano Telica" created ash and heavy acidified rain that destroyed food crops for surrounding communities (Iron, 2015). Additionally, the acidic volcanic soils surrounding "Volcano Telica" force farmers to abandon pipe irrigation and to be dependent on rain fed agriculture. More to that, the nature of volcanic slopes lead to wind and rain erosion of the nutrient rich top soil (Iron, 2015). Farmers invest in chemical fertilizers to boost yield, a practice that was discovered to be very expensive for rural producers (Iron, 2015).

Cuisine

Nicaragua's cuisine comprises a variety of pre-Colombian original dishes. Traditional cuisine varies from the pacific to the Caribbean coast (Powe, n.d.). The main staples in the pacific coast consist of a variety of fruits and corn based formulations (Powe, n.d.). Corn is used as a main ingredient for a variety of foods including *Nacatamales* (made of cornmeal, pork or chicken, rice, peppers, peppermint leaves, potatoes, onions and cooking oils all wrapped in a big green banana leaf and boiled), *tortillas*, pinillio drink and chicha (Arghiris, 2014). A mixture of cooked rice and beans traditionally referred to as *gallo pinto* (Sauteed red kidney beans and rice boiled apart and then fried together) are a common food especially for breakfast

and is usually served with carne (fried beef), *tajadas* (fried plantain chips), *ensalada* (tangy cabbage salad with diced tomato and onion), *queso frito* (fried cheese bites) and a cup of coffee. Common herbs include cilantro, oregano, and pipian (Arghiris, 2014). Bush meat (also known as game meat) is a common delicacy. Bush meat includes iguana, crab meat and armadillo and is usually sold on roadsides of major highways as well as in local markets (Arghiris, 2014).

Literature Review Conclusion

Based on the work discussed above, various organizations and researchers reported high rates of food insecurity in the community of interest (Chacraseca, Nicaragua). There are several factors that influence food security in Nicaragua including poverty, education, employment, social capital, and climate change. Different researchers have studied home gardening as a strategy to reduce food insecurity and improve health in several parts of the world. However, there are limited studies evaluating the effectiveness of home gardening in improving food security and health in Nicaragua.

In other parts of the world, several studies showed that home gardening led to increased food consumption but not increased nutrient intake. According to the literature, the major factors that may hinder the positive role of home gardening on food security and health are high cost of agricultural inputs and climate change. Few researchers complemented home gardening with nutrition education. Additionally, there were limited studies where researchers involved participants at all stages of the home gardening projects. Several researchers recommend involving participants in developing of their projects. This can be done by incorporating principles of CBPR in community projects.

CHAPTER III: STUDY I

Using Community-Based Participatory Research to Identify Interventions to Ameliorate Food Insecurity and Health Disparities

Abstract

The present study reports results of a needs assessment of food security and health conducted in a rural community of Chacraseca, Nicaragua. The study involved stakeholders from Auburn University, a local non-government organization (JustHope, Inc.), doctor and community members from Chacraseca. Fifteen participants from the Chacraseca community were purposively recruited for focus group discussions, food security surveys and for determination of socio-economic characteristics. Two health professionals were recruited for key-informant interviews to supplement data collected from focus group discussions. Focus group discussions, key informant interviews and surveys revealed priority health concerns, environmental issues and available community assets. Participants suggested five interventions to health and food security disparities within Chacraseca: extension of micro-credit facilities, establishment of small-scale food processing technologies, investment in sustainable agriculture practices, investing in nutrition education mission groups, and expansion of the community medical staff. Through concept mapping, investment in sustainable agriculture and nutrition education were identified as priority interventions for improvement of community health and food security. Findings from the present study were used to design community gardening and nutrition education interventions for the community. Additionally, these findings can be used to inform future planning and for development and implementation of similar programs in other international rural communities.

Introduction

Chacraseca is one of the 119 rural communities within the department of Leon, Nicaragua (Bontenbal, 2009). In the 1960's and 1970's, Chacraseca and the rest of Leon, largely depended on cultivation of one major crop (cotton) driven by the need for intensive farming for export (Wilm, 2014). After the collapse of the cotton industry due to excess world production, rise in synthetic cloth products and increased production costs (Canada, 2006), the level of unemployment in Leon rose to as high as 60% during the 1990's (Montiel & Barten, 1999). Given that cotton production required continuous increases in chemical use to combat resistant diseases, the cotton monoculture led to contamination of local water sources and the soil (Canada, 2006). Residues of dichlorodiphenyltrichloroethane previously used as a pesticide in cotton farming have been found in cow milk and in grass grown where cotton was previously cultivated and indicate a possible health threat to humans and livestock (Montiel & Barten, 1999). Additionally, in a bid to expand to virgin soils, many trees had been felled leading to soil erosion further affecting crop production (Canada, 2006). The destruction of soil, water sources and the fall of the cotton industry has led to the exodus of people from rural communities into the city of Leon leaving fewer farmers to grow food (Montiel & Barten, 1999).

In the 1990s Nicaragua's central government established structural adjustment reforms to reduce government expenditure in the social sector and to make Nicaragua eligible for assistance from the international lending community (Enriquez, 2000). However, the structural adjustment reforms led to decreased financial support to rural communities within Leon (Enriquez, 2000). In response to structural adjustment reforms, municipalities stepped up and assumed provision of services which did not fall under their competence (Gonzalez, Andrade-Eekhoff, & Ramos, 2003). Structural adjustment reforms led to formation of a coalition of

stakeholders including representatives from the local government, community-based organizations, non-government organizations and bilateral agencies to address priorities and health needs within communities (Montiel & Barten, 1999). The *movimiento communal* (communal movement) was established by local authorities in Leon in response to central government policy reforms of the 1990's (Bontenbal, 2009). In rural communities, the *movimiento communal* brings together non-government organizations, universities in Leon and the health sector to support school systems, water delivery, gender empowerment, health initiatives and economic projects (Bontenbal, 2009).

In line with operations for the *movimiento communal*, various non-government organizations within Chacraseca have formed partnerships with the local government, international organizations and the community to improve standards of living for the residents. Most notably, are the *Global Student Embassy, JustHope, Inc, the Pastoral Committee* and the *Power of a Nickle*. These organizations work within Chacraseca to improve standards of living of residents by investing in schools, education, leadership, health, agriculture, gender equality and micro-credit sectors (JustHope, Inc., 2018; Power of Nickel, 2018; GSE, 2018)

Even with combined efforts from community organizations and partnerships from local and international organizations, the effects of policy reforms, climate change and cotton monoculture on community food production and health in Chacraseca remain eminent. Community-based participatory research (CBPR) is an approach that relies on inputs from various stakeholders with varied experiences and perspectives to develop community appropriate interventions (Wallerstein & Duran, 2010). One limitation of CBPR is that the formation of working relationships among stakeholders is slow and interventions generated may not attend to all perspectives of the group (Israel, Schulz, Parker, & Becker, 2003). This issue may be overcome by supplementing CBPR with concept mapping. Concept mapping is a

structured method for organizing ideas of multiple, diverse stakeholders into a common framework (Kane & William, 2007). Allen et al. (2015, P. 2) explained that *"concept mapping is appropriate for CBPR interventions because it is designed to integrate input from individuals with differing content expertise, interests, and experience and generates repeated opportunities for input in the processes of sharing opinions, interpreting results and prioritizing next steps."* Even though both CBPR and concept mapping have been used in needs assessment and in designing interventions around the world (Allen, Schaleben-Boatend, Davey, Hang, & Pergament, 2015; Ahari, Habibzadeh, Yousefi, & Abdi, 2012; Velonis, et al., 2018), there is limited literature using both approaches to design priority community interventions within Nicaragua. Thus, the goal for the present study was to conduct a needs assessment using CBPR principles and to use concept mapping to prioritize interventions for combating food insecurity and health disparities in Chacraseca, Nicaragua.

Method

Study Design

Community participants were a sample of residents from the Chacraseca community. Researchers used CBPR to identify interventions that were most favored by the community. The use of CBPR has been encouraged as a strategy for engaging residents in assessing community needs where residents are involved in all phases of the research process (Israel, Sculz, Parker, & Becker, 1998). Researchers sought to conduct a needs assessment by actively involving participants using a mixed methods approach of focus group discussions and individual interviews. Focus groups are a form of group interview that uses communication between research participants to generate data (Kitzinger, 1995). Focus groups are an effective way of exploring community knowledge and experiences as well as to understand reasons

behind people's behaviors. As such, focus group discussions were determined to be a useful method to uncover community needs and constraints that would otherwise be missed through other assessment methods.

The Chacraseca Community/Academic Research Team Partnership

Researchers from Auburn University College of Human Sciences teamed up with JustHope, Inc., a non-government organization that has worked to improve living standards in the Chacraseca community for over 20 years. JustHope, Inc. organized a meeting during which the academic team was introduced to leaders of the 12 sectors within Chacraseca. The initial meeting was important for establishing rapport, for explaining the importance of the study and for establishing the roles of the stakeholders. Through purposive sampling, sector leaders recruited participants, one from each of their respective sectors and then three sector leaders volunteered to join the assessment. The academic research team designed the focus group and the socioeconomic questionnaires following Human Subjects Protocol and approval from Auburn University as well as from the National Autonomous University of Nicaragua in Leon.

All survey instruments were available in English and Spanish and were tested with three sector leaders to check for appropriateness in literacy, language and clarity. The three sector leaders were later not included in the needs assessment as they would have gained knowledge about the study and thus likely provide biased data. Besides organizing the meeting, JustHope, Inc. provided the site for the focus group interviews and was the intermediary among the stakeholders. The team was joined by two doctors from two of the three health centers in Chacraseca. The doctors were later interviewed as key informants. The academic team led the interviews, recorded and analyzed the data. Due to the complexity, the Chacraseca community was not involved in data analysis but researchers explained how the collected

information was relevant to the community. In addition, at the end of research, the research team organized a debriefing session and explained results to the stakeholders.

Focus Group Discussion and Key Informant Interviews

Qualitative data collection consisted of a focus group discussion ***(Appendix A)*** with 15 participants (three sector leaders and 12 community members) and key informant interviews with two doctors familiar with health issues within the community. Two similar semi-structured interview scripts were used for the 15 participants and for the two key informants. The key informant questions were designed to supplement responses from the focus group discussions. Topics for focus group discussions were chosen based on literature that showed Chacraseca to have irregular rainfall patterns and soil erosion that affected crop production (Solé et al., 2016). From the topics, questions were designed based on a questionnaire design set by a non-profit organization, ACAPS (ACAPS, 2016). Topics for the focus group included; (i) foods available in the community, (ii) availability of food in markets, (iii) ease of access to the markets, (iv) market food prices, (v) foods grown in their home gardens, (vi) presence of food storage facilities, (vii) issues surrounding growing of food, (viii) interest in working as a community, and lastly (ix) suggestions for a community intervention to help improve food security.

The academic team arrived at the location of the discussion 45 minutes in advance allowing for ample time to set up materials for the focus group including; seats, flipcharts, water, snacks, informed consent forms and pens and to welcome the participants. To overcome language barriers, JustHope, Inc. provided a translator who was fluent in both English and Spanish. The translator would listen to English questions and comments read by researchers and convey the information to participants in Spanish then deliver responses to the researchers in English. The interviews began with greetings and introductions. This was followed by

explaining the purpose of the study, that participation was voluntary and asking participants to air their views while respecting other participants' opinions.

After attainment of informed consent ***(Appendix c)***, interviews began and were audio taped for analysis. Interviews were concluded by asking participants if they had additional information and later thanked for participation. Key informant interviews were done at the respective two health centers in *Pedro Arauz Palacios* and *Raul Cabezas Lacayo* sectors. Interview questions for doctors were related to; (i) common health conditions, (ii) risk factors for the most common health conditions (iii) availability of medicine in the health centers (iv) ease of access to health centers, and (v) suggestions for improvement of community health.

Surveys

Quantitative data was collected after the focus group discussion and the key informant interviews. The six-item short form food security survey questionnaire ***(Appendix B)*** was used to collect information about the food security status of respondents (DHHS, 2012). The six-item survey module consists of questions relating to whether participants could afford food in the last 12 months and if not, how often they cut meal size portions, skipped meals, or went hungry. It was determined that the six-item food security survey module had a sensitivity of 85.8% and a specificity of 99.5% in determining overall food security (Blumberg, Bialostosky, Hamilton, & Briefel, 1999). Completed surveys were given scale scores and classified into food security levels based on total number of affirmative responses: 0-1 = high or marginal food security, 2-4 = low food security, and 5-6 = very low food security (DHSS, 2012).
An additional questionnaire was administered relating to socioeconomic factors of participants including: age, household size, source of income, the food crops grown on their farms, food purchased from the market, food security coping strategies, arable land size, and ownership of farm animals.

Analysis

Focus group discussions and key informant interviews were audio-recorded and transcribed verbatim by a researcher on the academic team. The principle investigator reread the transcripts and created separate summary documents for focus group interviews and key informant interviews. Researchers coded and analyzed the transcripts for content to reveal major emerging themes arising from participants' responses using ATLAS.ti version 8.2.4 for iOS. The theory of interpretivism was employed to understand participants' subjective experiences of food insecurity and health issues surrounding the Chacraseca community (Gemma, 2018). Interventions suggested for improvement of health and food security were subject to concept mapping to identify priority interventions.

Analysis for quantitative data consisted of calculating descriptive statistics including means, frequencies and percentages calculated using Microsoft Excel for iOS. Factors perceived to influence food security were subject to linear discriminant analysis. These factors were identified through literature and included major sources of income, household size and land ownership (Abdullah et al., 2017). The dependent variable was food security. The six-item food security survey tool classifies households as food secure, low food secure and very low food secure. For the purposes of analysis, low food security and very low food security were collapsed into a single category of "food insecure" to allow for a two-category linear discriminant analysis. This method has been used to determine and categorize food security by other researchers for studies with small sample sizes (Thenkabail, Lyon, Turral, & Biradar, 2009; Obayelu, 2012). Thus, for the final analysis socioeconomic characteristics of participants were classified using a two-category linear discriminant analysis based on their likelihoods to lead to food security or food insecurity.

Results

Characteristics of Participants

The characteristics of the 15 participants involved in the focus group discussion are presented in Table 1. These included age, gender, household size, income source, food source, food security status, food security coping strategies, and asset ownership. Of the participants, 66.6% (n=10) were female whereas 33.4% (n=5) were male. Participants' age varied from 18 years to 65 years with the average age of 40.1 ± 12.4 years. Household size varied between 1 to 10 family members. The average household size was 4.9 ± 2.5 family members. Most participants (n=8) sourced their food from both the market and from their farms. Seven participants sourced their food exclusively from the markets. There were no participants who reported obtaining their food exclusively from their own farms.

Table 1: Socioeconomic Characteristics of Respondents, Chacraseca, 2015

Characteristic	Frequency (n = 15)	Percentage
Gender		
Female	10	66.6%
Male	5	33.4%
Household size		
1 to 3	5	33.3%
4 to 6	7	46.7%
7 to 10	3	20%
Source of food		
Market	7	47%
Market and farm	8	53%

Table 1 Continued: Socioeconomic Characteristics of Respondents, Chacraseca, 2015

Characteristic	Frequency (n = 15)	Percentage (%)
Major Source of Income		
Own business	4	26.7 %
JustHope, Inc.	2	13.3%
Hired labor	4	26.7%
Farming	4	26.7%
Teaching	4	26.7%
Child support	1	6.7%
Factory	2	13.3%
Coping strategy		
Reduce portions	1	6.7%
Skip meals	2	13.3%
Borrow from Neighbors	1	6.7%
Barter trade	1	6.7%
Get food from other family members	3	20%
Sale farm animals	1	6.7%

Most households reported to have one income source. Having a personal business, being hired to work on other agricultural farms, farming in own gardens and being involved in teaching were reported as sources of income by at least 4 respondents each. Other sources of income included working in a factory, being employed by JustHope, Inc., working in a car manufacturing factory and reliance on child support. Using the six-item food security survey questionnaire, out of the fifteen respondents, six reported to be food secure. Coping strategies for food insecure households included; reducing portions, getting food from family members, skipping meals, selling farm animals and bartering.

Household assets

Participants asset ownership is presented in Table 2 below. Of the 15 respondents, 7 (46.7%) reported to have no land besides plots on which their houses stood. Three participants had greater than six acres of land whereas 5 participants had between an acre and six acres of farm land. Fruit trees were the most dominant plants owned by majority of the households

(53.3%). Other crops reported to be grown included vegetables, cassava, corn, rice and red beans. Three respondents reported to own livestock whereas five respondents owned poultry. Two respondents owned more than 20 chickens.

Table 2: Respondents Asset Ownership, Chacraseca, 2015

Asset ownership	Frequency (n = 15)	Percentage
Land ownership (acres)		
1-3	2	13.3%
4-6	3	20.0%
>6	3	20.0%
No land	7	46.7%
Livestock ownership		
6 to 10	1	6.7%
2 to 5	2	13.3%
None	12	80.0%
Poultry ownership		
None	10	66.7%
1 to 10	1	6.7%
11 to 20	2	13.3%
More than 20	2	13.3%

Linear discriminant analysis was used to classify and predict independent variables (asset ownership, coping strategies and income source) against the dependent variable (food security status), Table 3. The "r" code used for linear discriminant analysis is presented in *Appendix D*. Linear discriminant analysis was used instead of chi-square because majority of the independent variables in the present study had low values and thus unsuitable to predict using chi-square. Given the small number of independent variables, using a chi-square test would result into spurious predictions for the classification on independent variables as whether they were most likely to lead to food insecurity or food security.

Given that the dependent variable was categorical, linear regression was unfit for classifying the independent variables in the present study (Welling, 2005). In reference to income source, a respondent who worked for a non-government organization (in this case

JustHope, Inc.) would experience the highest level of food security with a coefficient of linear discriminants of 7.28. Working for a non-government organization was followed by having own business establishment, working at a factory and working in own farm with coefficients of linear discriminants of 4.55, 3.68 and 2.57 respectively. On the other hand, teaching and being employed to work on farms were found to be associated with being categorized as food insecure with coefficients of linear discriminants of -1.46 and -1.72 respectively. Similarly land ownership and having a large household size were classified as factors responsible for food insecurity.

Table 2: Classification of Household Food Security Determinants

Variable	Coefficient of linear discriminants
Income source	
Factory	3.68
Farming	2.57
Hired labor	-1.72
JustHope, Inc.	7.28
Business ownership	4.55
Teaching	-1.46
Land ownership	-0.78
Increased household size	-0.50

Focus Group Discussion

Twelve Chacraseca community residents representing the twelve sectors participated in the focus group discussion together with three sector leaders. The discussion took place between June 11th and June 18th, 2015 at the Peace House owned by JustHope, Inc. The focus group discussion took two hours and led to identification of major themes. The major emerging themes from the focus group discussion are presented and discussed below.

Major Themes Derived from Focus Group Data

Food Source

Respondents reported presence of a variety of foods sourced from both markets and from household gardens. During the focus group discussion, the most reported foods included; rice, beans, plantain, cheese, tortilla and pipian. These were used to make daily dishes for majority of households in Chacraseca. In addition, residents reported to have a variety of fruits used from which they made a variety of juices. These included starfruits, Spanish lime, oranges, pineapple, dragon fruit, mangoes and beets. The fruits were used to make juices that accompanied most main dishes. However, sodas locally referred to as *"citrics"* were common as were highly refined wheat and cassava flour-based snacks. The discussion revealed that protein sources included; iguana, crab, fish, pork, beef and chicken. One respondent was quoted saying:

"We have a variety of fruits in the market, at least you find different fruits in the market"
While another respondent reported that; *"Fruits are seasonal, now you will access to mangoes and oranges but you will barely find any of those fruits in December. Even in the market, fruit prices will steadily increase starting in August."*

Participants reported that most of the foods including; staples (rice, beans, tortillas and cheeses), fruits, meat (poultry, beef and pork), seasonings, cooking oil and drinks were purchased from markets in Leon and in case of immediate need, from local small shops distributed throughout the community. Some residents reported to hunt for iguanas in thickets that covered most of Chacraseca. The iguanas were used to make soups. Tortillas and cheeses that accompanied the main dish were also available locally.

Table 4: Major Themes Derived from Focus Group Discussion, Chacraseca 2015

Themes	Focus group Sample Quote
Source of food	"It depends on what you want to eat. Most times we eat rice and beans and these we buy from markets in Leon. Sometimes from our small shops. My husband grows pipian and eggplants but sometimes we buy them too." "I buy the major foods, like beans, rice and sometimes beef from Leon. I usually send my daughter to buy cooking oil and salt from a shop across the road." "I grow Pipian in my garden, my older brother grows papayas and mangoes. When I want a papaya, I take to him some Pipian."
Food access	"There is transport to Leon. In Leon there is everything, eggs, beans, rice, beef, pork, anything you want. The bus is always here, you get on the bus, buy food and get back." "In Las Lomas, we have to buy a lot of food for about two weeks, especially in the rainy season. You will see how bad the road is when you come to visit."
Food source preference	"Food is food, whether you grow it, buy it or beg. But it is good to know that you will have food. If you can go to the market, well and good but sometimes it is good to grow your own food. You never know." "From any source, to me it doesn't matter." "I would love to grow my own food so that I can use money for my business to complete constructing my house."
Affordability	"Rice is cheap, everywhere rice is cheap, 16 Codobas for one pound. It feeds my family of four. Beans too are cheap. I think food is affordable. Especially if you work, life may be different if you don't work." "It does not matter whether food is cheap or expensive, I still have to feed my family."

Most families purchased whole corn kernels, had the kernels milled at either of the two maize mills in *Raul Cabezas Locayo* and used the flour to make their own tortillas. During the focus group discussion, a respondent was quoted saying:

"I have a garden where we grow green pepper, red pepper, winter squash and some corn. But my soil will not allow beans to grow, we therefore have to buy the beans. Rice will not grow too, it requires a lot of water and Chacraseca is dry, so I buy that too."

Some families made and sold tortillas within the community. Cheese was available from markets in Leon but some families purchased milk and made their own cheeses. From the focus group discussion, it was evident that participants sourced their food from markets in Leon, from small shops within the community and from their own gardens.

Food Access

Participants reported that one major unpaved transport route runs through Chacraseca. They reported that markets in Leon were accessed through that major route using buses that ran on a fixed schedule from Monday to Saturday. Residents distant from the access road used bicycles and horses to get closer to the road and then hopped onto the buses to markets in Leon. With these modes of transportation, residents reported that it was easier to access food. The discussion revealed that a few residents owned motorcycles and did not rely on the bus system. Even with this access route, some participants reported difficulty in accessing food sources. One participant who was also the sector leader for *Boca de Cantaro* stated that;

"The major road does not go through our sector; my people use horses to get close to the road and only then can they board the buses to access markets."

Table 4 Continued: Major Themes Derived from Focus Groups, Chacraseca 2015 continued.

Food storage	"There's no need to store food, we can buy from Leon using the bus. Rice and beans and tortilla and cheese. Tortilla you can get it here." "Rice and beans store well. I have a fridge to store meat and fruits but the cost of electricity is high, most times my wife turns off the fridge." "Everyone in my sector has electricity, but speaking for myself the bill is expensive when you turn on the fridge even for a few hours."
Attitude towards group work	"We always work in groups. With mission groups at casa de Paz. Medical missions, music groups. My daughter is in the music group at JustHope, Inc. If we work together as a group we can solve many issues, not just food issues, health issues and education too." "I like group work, especially if everyone completes their assigned task." "I belong to the saving and credit women's group. We work in turns and I always look forward to my turn."
Preferred intervention	"Microcredit for women and may be for men. We need to have our own businesses – to be bosses and create jobs. Our community is agricultural but now we can't grow food. No rain. Crops can't grow without rain." "My son-in-law has a papaya farm. La Colonia buys our papaya's and it is profitable. Now our whole family is involved in papaya farming and we are becoming famous for that." "We have many markets but most of the food in these markets is not grown in Chacraseca. I wish we could be able to supply these markets."

From the focus group discussion, it was revealed that besides the seasonal changes in fruit and vegetable availability, the rainy season influenced food access by having an impact on the quality of the road. Participants reported that the main road remained passible in the rainy season but the feeder roads became flooded and impassible during heavy rains. A participant from Las Lomas, a sector with no direct access to the main road stated that;

"The government constantly maintains the main road by lining it with gravel and small rocks from the volcanoes. The moment you leave the main road, right after the hospital in Pedro Arauz, the road is impassible even by foot during the rainy season."

Participants expressed how rain forms gullies across the roads necessitating continuous road repairs. Most times it is the responsibility of community members to voluntarily cover emerging gullies with rocks and soil.

Food Source Preference

During the focus group discussion, participants reported to source commonly consumed foods (rice, beans, cooking oil and spices) in large amounts that would take a week to consume from markets in Leon. Participants further reported that purchasing food supplies in bulk was important to save on transport costs and time. Food was purchased from local shops during times of emergencies or in case a family member needed a snack for the day. The discussion revealed that participants would love to grow their own food but the soil and changing climatic conditions in Chacraseca did not permit growth of their favorite foods. In reference to preference of where participants sourced their food, one participant stated that;

"I do not have much choice, there are some foods that will not grow on our soil. Some missionaries said that our soil lacked nutrients so we cannot grow most food. So, at present my family buys most of the food from markets."

Participants expressed how expensive it is to buy fertilizers to enrich their soils. Some participants reported that they have small pieces of land and they assumed it would not be worth the effort to grow the food. They further explained that they perceived the small pieces of land would not yield enough food for their entire households.

Affordability and Storage of Foods

Participants reported that the commonly consumed foods (rice, beans, tortillas and cheeses) were fairly affordable in most shops around the community. Participants explained how food budgets grew bigger when transport fees were considered. Fruit trees grew throughout the community and that during the fruit season, majority of the fruits were free of charge or could be purchased at relatively low prices. It was reported that vegetables were grown during the rainy season but were otherwise purchased from markets during the months of December through May. Due to their perishability, fruits and vegetables were not commonly purchased during shopping trips. Quoting one participant who also happened to be the household head, she said;

"Food is fairly affordable, it would be better if prices were lower. That way we would save money and use it for other purposes."

Unlike other foods, vegetables could not be purchased in large quantities as refrigeration was not common. Purchasing vegetables would make it expensive due to the added transportation costs that would have to be incurred more than twice a week. On the issue of perishability, a participant stated;

"On average food stores well, but when you buy eggplants, tomatoes and chives or even meat; then you have to start thinking of having a fridge. I only use electricity for the television and lighting and I don't think I can afford to pay more for refrigeration."

During the discussion, one participant reported to have a storage silo for corn. He explained that he stored corn until periods of scarcity in which case he would sell his corn at higher prices. Additionally, one participant reported to make marmalades and jams from mangoes after receiving training from a non-government organization.

Attitude Towards Working as a Community

The discussion revealed that participants welcomed working in groups. This was shown as participants reported to engage in group activities organized by JustHope, Inc. From the responses, it was revealed that participants perceived group work to mean less work per individual but with higher outputs. Conversely, some respondents said that during group projects, the most active members would end up having to do more work in case some group members skipped or chose to be inactive. As such, some respondents advised that group work had to be organized with designated roles per individual. One of the respondents involved in a saving and credit group organized by JustHope, Inc. was quoted saying;

"I have been involved with our saving group for two years now. At the beginning, we had disagreements but now we learnt our weaknesses and strengths. We complement each other. We still have a few disagreements but now we can work around our differences."

The sector leader from *Boca de Cantaro* was quick to point out that his sector was located the furthest from JustHope, Inc. offices and from Leon and that they rarely received mission groups. Despite receiving few mission visits, his community was involved in group work. He explained that as long as the group has a defined vision and a leader, all was possible. In his words the sector leader said;

"I recently organized my community to work as a team on a peanut farm. We were able to negotiate a higher pay. I am sure organized teams work better that separate individuals."

Participants explained that given that they are already divided into sectors under guidance from JustHope, Inc., sector leaders can organize their members to work on set projects. Participants reported how they have always gathered in groups at health centers to receive information on health from mission groups.

Preferred Intervention

Several interventions were suggested during the discussion most of which were aimed at creating employment. The three most mentioned interventions included; (i) extension of credit services, (ii) training in food processing technologies, and (iii) investing in sustainable agriculture practices. Participants reported that they had seen saving and credit groups work in neighboring communities. It was also reported that JustHope, Inc. had introduced a saving and

credit society for women within Chacraseca and the suggestion was to increase the size of the group to allow for more members. Additionally, there was a hardware (a shop for house construction materials) shop connected to a secondhand clothes shop that was set up by JustHope, Inc. to create employment for women. Participants expressed interest in expanding the microcredit, hardware and secondhand cloth business that were already operating within Chacraseca. Some male participants ruled out that idea because only women were eligible to work be part of the hardware, micro-credit and secondhand clothes. Another member from *La Concemption* supported the idea of food processing with these words;

"A missionary group from Europe came and taught us how to preserve fruit by making marmalades and jams. In addition to selling food items in my shop, I now sell jam and marmalades to my customers."

Participants reported that many community members especially the youths between the ages of 18 and 30 preferred to work in car-part manufacturing plants. They explained that the youths favored working in manufacturing plants because the employers offered attractive gross salaries. One member further explained that by the end of the month after paying for transport, food and the mandatory insurance, the youths remained with virtually nothing to show for their manual labor of moving heavy car parts. Other community members pointed out that many able-bodied members provided manual labor working on crop farms for big companies. It was stressed that working in manufacturing plants or on farms was labor intensive and did not help in community development as most of the companies were foreign. Participants reported that most of the food grown by large farms including peanuts, yucca and corn were mainly produced for export and did not directly help with food security of the community. The crops

grown by large farms would be exported to developed countries, processed and then imported back into communities as finished products where they were sold at high prices.

Lastly, the group discussed investment in sustainable agricultural interventions. This topic sparked a great debate as participants rushed to explain how poor their soil was and that the ever-changing climate conditions presented a challenge. Participants claimed that the summers had become longer and hot extending into the rainy season. However, one farmer came in to defend farming by explaining how the community should change with the changing climate. He explained how his family started with a small plot of land employing compositing and harvesting rain water for his papaya farmer. Another farmer explained how he learned manure compositing and irrigation from a mission group and now employs both technologies to grow cashew nuts. The farmer stated;

"We have the greatest resource, soil. We just need to learn from each other how to best use our land."

The same farmer quoted in the latter statement explained how he had some knowledge in compositing manure. However as mentioned before, some participants claimed to not have land for growing food while others claimed to have leased out their land to companies that could afford to buy fertilizers and herbicides. Two participants mentioned how one organization had initially taught them how to grow green peppers, pipian and squash on small plots in their back yard. The two participants offered to give the rest of the group a tour of their gardens.

Key Informant Interviews

Two health professionals from two health centers located in the sectors of *Pedro Arauz Palacios* and *Raul Cabezas Lacayo* participated in the key informant interviews that lasted an average of 30 minutes each. The health professionals were recommended for interviews by JustHope, Inc. staff given that these doctors attend to several community members during medical visits and therefore know more about issues within the community. Transcript analysis of key informant interviews using ATLAS.ti v.8.2.4 yielded qualitative insights on healthcare and medical conditions within Chacraseca. On analysis, the major themes identified included; (i) most common health conditions (iii) availability of medicine in the health centers (iv) ease of access to health centers, and (v) suggestions for improvement of health conditions within Chacraseca. The major emerging themes are presented in Table 5 and are discussed below.

Major Themes Derived from Key Informant Interviews

Most Common Health Conditions

Interviews revealed various health conditions including; respiratory problems, gout, high blood pressure, chikungunya fever (chikungunya is a viral disease transmitted by mosquitoes) and diabetes. Both doctors mentioned respiratory problems as the most common in both children and adults. Adult populations were reported to have a high prevalence of diabetes and high blood pressure.

Table 5: Major Themes Derived from Key Informant Interviews

Major Themes	Sample Quotes
Most common health conditions	"Most people who come here have respiratory problems. It is due to durst, not anything else. It is not smoking, but it could be to some extent. But women do not smoke, only a few do." "Patients present with various health condition from diabetes, blood pressure, gout, chikungunya and respiratory problems"
Availability of medicine	"If patients present with flue and cough we give them the medicine. Even paracetamols. For complicated cases, we just write them prescriptions." "Some medical missionaries come and treat patients right here. Other missionaries choose to just send us the medicine. other than that, we are sometimes short on medicine."
Ease of access to health centers	"My patients come here by bus. It drops them right there and they walk. The bus stop is close by." "We treat patients from the sectors that are close by, others will go to the hospitals next to their sectors."
Suggestion for improvement of health conditions	"Mission groups are of great help, they bring medicine. Last month a medical team came here, they held a meeting and taught the community how to prevent eye problems and take care of their health." "We appreciate advice and services aimed at helping our community." "We work with JustHope, Inc., whenever they bring ideas we work tirelessly to implement them because this is our community."

Doctors explained that respiratory problems were due to dust storms during the dry season stretching from the months of November to May. One doctor stated that,

"*Since fields are left bare in the dry season after harvesting, the wind raises the dry top soil carrying it towards the community. Respiratory conditions could be caused by Sulfur gases from the constant volcanic eruptions."*

Doctors reported that according to their medical records, men consumed more alcohol than women leading to the reported cases of gout and high uric acid levels. Additionally, doctors showed concern for the rises cases of obesity and cardiovascular diseases especially among men. They explained that high alcohol consumption could lead to increased health issues within the community. Interviews further revealed the need for nutrition education as one doctor shared concern that most diseases within Chacraseca were nutrition related. When pressed to talk more about nutrition related diseases, the doctor gave an example of how frying was the commonest method of cooking, how patients reported to consume low fruits and vegetables, and how several community members resorted to inactive lifestyles. The doctor stated;

"We receive many mission groups but few of them are focused on nutrition education. It makes sense because most residents only come here when they do not feel alright. I do my best to encourage people to live active lifestyles and to have diets with balanced nutrients but sometimes I have many patients. I can't do it for all".

The doctor from Raul Cabezas Lacayo further explained how the diet may partly be responsible for some of the health conditions experiences within Chacraseca. The doctor revealed that a mission group that had visited the health center explained how daily consumption of pulses may be responsible for the observed cases of gout.

Availability of Medications

Key revealed that health centers in Chacraseca provided free medication for medical conditions like influenza, cough and pain. The doctors reported that diagnosis and prescription were free at health centers in Chacraseca but for complicated cases were handled at the larger hospitals in Leon. Doctors explained how there were various privately owned pharmacies in Leon with a variety of medications and that patients are usually directed to go and purchase the prescribed medications. Doctors reported that JustHope, Inc. invited several medical mission groups from U.S.A. and from Europe. The Nicaragua Ministry of Health provided medication for two health centers but the third center was stocked by JustHope, Inc. In addition to providing medical equipment, doctors reported medical mission groups to provide seasonal medical services and pharmaceutical supplies.

Ease of Access to Health Centers

The doctors reported how there were three health centers in Chacraseca distributed approximately 12 miles apart. All the three health centers were located within easy access to the main road. It was further revealed that the two health centers within the sectors of *Miramar* and *Pedro Arauz Palacios* were run by the Nicaragua Ministry of Health. The third health center was located within JustHope, Inc., premises in the sector of *Raul Cabezas Lacayo* and was entirely run by JustHope, Inc. The doctors reported that health centers had limited medical staff and

heavily relied on medical mission groups organized by JustHope, Inc. All the three health centers were open to the public on Monday, Tuesday and Thursday and that they closed the rest of the week except for Friday which was reserved solely for emergency cases. All surgeries were reported to be free of charge in the main hospitals in Leon.

The doctors reported that community members who resided in sectors distant from the main road including *Las Lomas* and *Boca de Cantaro* had to use means of transport other than the bus to get to the transport route to the health centers. This commute was reported to be a hardship especially during rainy seasons when the dirt roads become slippery and impassable. One of the doctors was quoted saying;

"I receive patients from Las Lomas and Boca de Cantaro. These sectors are distant from us and technically we should have medical centers there too. They have some of the poorest roads and at the beginning of the rains last month, the road to Las Romas was cut off by a mud slide."

Doctors explained how they sometimes travel to distant sectors to extend medical services for mainly the old and expectant mothers. Additionally, doctors mentioned how some patients rely on traditional medicine because of inability to access the hospitals. Some of the mothers were reported to give birth in their homes with the help of a relative or traditional doctors and only visit the health centers to immunize their children.

Suggestions for Improvement of Health Conditions.

The doctors expressed appreciation for the support from JustHope, Inc., especially for the medical services and equipment given by the mission groups. On that note, the doctors said that they were open to receiving more medical mission groups as well as any other help from other

parties. The team desired to establish collaboration with universities from the U.S.A. or from other countries. The doctors expressed the need to have missions or programs targeting lifestyle and diets. The doctor from *Pedro Arauz Palacios* expressed how they needed more permanent staff or if possible to extend some private clinics within Chacraseca. The doctor from *Raul Cabezas Lacayo* insisted on the need for health promoting projects by saying;

"We need to prevent some of the medical conditions before they appear."

Both doctors expressed how prevention of disease was a better option given that Chacraseca had only three health centers with inadequate medical supplies. Doctors further expressed how the construction of roads to reach distant sectors or the enrollment of more doctors was far from sight.

Prioritization of Community Interventions

From results of interviews and surveys, stakeholders identified five community interventions they believed would improve the health and food security of residents including; (i) extending micro-credit facilities, (ii) establishing small-scale food processing technologies, (iii) investing in sustainable agriculture practices, (iv) inviting nutrition education mission groups, and (v) expanding community medical staff. During the debriefing session carried out at the end of the study, the five identified interventions were subject to concept mapping methodology to identify priority areas.

To ensure that all stakeholders were involved in prioritizing interventions, in addition to the twelve community members involved in the focus group discussion, concept mapping included the two doctors (the same doctors who participated in key informant interviews), the

two researchers, and ten representatives from JustHope, Inc. The inclusion of various stakeholders was done to ensure that the identified interventions were accepted by all stakeholders involved with JustHope, Inc. Thus, the total participants in concept mapping were 25. Concept mapping involved four stages, namely; (i) ranking the intervention based on frequency of preference, (ii) identification of criteria to judge the interventions, (iii) assigning values to the interventions based on the identified criteria in the latter step, and (iv) assigning final scores to the intervention.

In the first stage, the number of participants who liked each intervention was determined by asking stakeholders to show hands if they liked a particular intervention. From the frequency of liking, percentages were determined and presented in Table 6. The stakeholders present were 25, including; twelve community participants, three sector leaders, three medical staff, five JustHope, Inc., Staff, and two researchers. Researchers were involved in voting because they were equally responsible for aspects of the study including time and financial resources.

Table 3: Frequency of Preference for the Various Interventions, Chacraseca 2015

Intervention	Stakeholders (n=25)	Frequency (%)
Credit facilities	22	88%
Food processing technologies	19	76%
Gardening	23	92%
Nutrition mission groups	22	88%
Expanding medical staff	20	80%

The second step involved identification of criteria to aid in presentation of practical interventions. After getting frequency of preference for the various interventions, stakeholders

identified four criteria (in addition to frequency) that were further used to judge the applicability of the interventions. The identified criteria included; (i) seriousness (how important stakeholders viewed the intervention), (ii) urgency (timeline of need for the intervention), (iii) practicability (ease of application of the intervention in the real world), and (iv) financial capacity (the availability of funds to execute the intervention). After identification, each stakeholder assigned weights to criteria on a scale of 1- 10. The weights meant how important each of the criterion was in judging the intervention. The weights applied to each criterion by all stakeholder were averaged to yield 6.5, 9.0, 8.0, 7.0, and 5.0 for frequency, seriousness, urgency, practicability and financial capacity, respectively.

After assigning weights to the criteria, each stakeholder was tasked to give a value number to each of the interventions based on the criteria in the latter step. Values were assigned on a scale of "1 to 100" with "1" being the least value and "100" being the highest value. Average values from all stakeholders are presented in Table 7 below.

Table 4: Average Value for Each Intervention Based on Criteria, Chacraseca 2015

Intervention	Average value (%)					
	Seriousness	Urgency	Practicability	Financial capacity	Frequency	**Total value**
Credit facilities	80	60	90	30	88	**348**
Food processing	70	20	50	30	76	**246**
Gardening	90	80	90	40	92	**392**
Nutrition missions	90	90	70	90	88	**428**
Expanding medical staff	70	90	40	50	80	**330**

The total value numbers for each intervention were then multiplied by the weights for each criterion to yield a final score that was used to select the best intervention. The higher the

score, the more feasible and preferred the intervention was. From Table 8 below, stakeholders determined that the most applicable interventions were; inviting nutrition education mission groups, investing in sustainable agriculture practices, extending micro-credit facilities, expanding community medical staff and lastly establishing small-scale food processing technologies.

Table 5: Final Score for Interventions, Chacraseca 2015

		Score (Total value x criteria weight)				
Criteria	Criteria Weight	Credit facilities	Food processing	Gardening	Nutrition mission	Medical staff
Seriousness	9	3,132	2,214	3,528	3,852	2,970
Urgency	8	2,784	1,968	3,136	3,424	2,640
Practicability	7	2,436	1,722	2,744	2,996	2,310
Financial capacity	5	1,740	1,230	1,960	2,140	1,650
Frequency	6.5	2,262	1,599	2,548	2,782	2,145
Final score		**12,354**	**8,733**	**13,916**	**15,194**	**11,715**

Discussion

There is limited literature showing the use of CBPR in determining community needs for developing countries. In the present study, CBPR was used to identify issues surrounding food security and health as well as identifying possible interventions in Chacraseca. The identified interventions were subjected to concept mapping that led to identification of priority interventions. The CBPR approach and concept mapping used in the present study maximized relationships and network building among researchers, the Chacraseca community and JustHope, Inc. The cooperation among stakeholders not only used CBPR to identified factors affecting food

security and health within Chacraseca but the team worked together to prioritize interventions using concept mapping. The process led to quick engagement of newly formed partnership among stakeholders and ensured that all voices were heard during decision making. Even though the stakeholders had different backgrounds and that there was a language barrier between researchers and other stakeholders, the process of concept mapping involved brief instruction and was completed within 2 hours. Working on prioritizing interventions as a group build a spirit of togetherness that minimized authoritative and power differences. In the present study, it was determined that the use of both CBPR and concept mapping was a complementary process.

Other researchers used CBPR and concept mapping to brainstorm ideas in response to focal questions and to rate the importance of the suggested ideas. Ahari et al. (2012) used participatory action research which is synonymous with CBPR to identify needs within an urban community in Iran (Ahari, Habibzadeh, Yousefi, & Abdi, 2012). Their study identified unemployment and lack of easy access to medical centers among problems affecting participants in their study area (Ahari, Habibzadeh, Yousefi, & Abdi, 2012). Even though the study by Ahari et al. (2012) was conducted in a different setting from the present study, both studies identified lack of access to health centers and need for employment as problems affecting the participants. However, Ahari et al. (2012) used a large sample size of 600 households compared to 15 participants in the present study. Additionally, Velonis et al. (2018) used CBPR to identify 48 unique service approaches believed to improve health in Ontario, Canada. After identification of the unique services researchers in the latter study, employed content mapping to identify services for seniors and people experiencing homelessness as highly important interventions (Velonis et al., 2018). Similarly, Allen et al. (2015) used CBPR involving focus groups and key informant interviews to identify 12 concepts for positive youth development and then employed concept

analysis to prioritize 8 concepts for intervention development among culturally diverse populations.

In the present study, some results from the focus group discussion were supported by results from socioeconomic surveys. Results from socioeconomic surveys showed that participants who were involved in farming and those who owned land were more likely to be categorized as food insecure. During the focus group discussion, participants expressed that the changing climate conditions, irregular rainfall patterns and the infertile soils made farming un-productive a factor responsible for food insecurity. However, during the focus group discussion, when some farmers suggested possible solutions to factors hindering farming, majority of the stakeholders, 96% (n = 23), opened their eyes towards farming as suitable intervention to food insecurity and health disparities.

During discussions, participants expressed negative attitudes towards hired labor. Similarly, survey results revealed hired labor was associated with food insecurity. Having stable jobs (for example; working for JustHope, Inc., owning a business or working in a factory) were associated with high food security. Survey results from the present study that associated stable jobs with food security were supported by suggested interventions from focus groups. Participants showed interest in starting food processing and engaging in micro-credit groups. Teaching was not mentioned in any of the interventions during the focus group and it was associated with food insecurity in the socioeconomic surveys.

Conclusions

In the present study, stakeholders including the Chacraseca community, JustHope, Inc., and researchers from Auburn University were involved in identifying needs for residents in Chacraseca. Through a focus group discussion and key informant interviews, researchers used

principles of CBPR to identify five possible interventions to food insecurity and health disparities in Chacraseca. The identified interventions included; (i) extending micro-credit facilities, (ii) extending small-scale food processing technologies, (iii) investing in sustainable agriculture practices, (iv) inviting nutrition education mission groups, and (v) expanding community medical staff. The five identified interventions were subjected to concept mapping leading to home gardening and nutritional education as priority interventions for food insecurity and health disparities in Chacraseca.

Socioeconomic surveys yielded information that supplemented focus group discussions and key informant interviews. The findings from focus groups and key informant interviews support the success of CBPR in identification of community gardening and nutritional education as potential interventions for improving food security and health. The study adds to literature by demonstrating how mixed methods involving focus group discussions, key informant interviews, food security and socio-economic surveys can be combined to discover community needs and to identify priority interventions. Findings from this study led to the promotion of home gardening and nutrition education in Chacraseca.

Strengths

The strength of this study was that stakeholders were involved at all stages of the research process which could indicate that all stakeholders feel a sense of ownership for the suggested interventions. Interventions from this study are more likely to be accepted by the community as the members will feel accountable for the outcomes. The small sample size made it possible for individual voices to be heard as every participant received ample time to air out their views. Information from focus group discussions was supplemented by key informant interviews which enabled a broader capture of community needs.

Limitations and Recommendations for Future Research

The present study used purposive sampling to recruit participants involved in the needs assessment. Purposive sampling has limitations of failure to control for variability and bias and that data may not be generalized beyond the sample (Acharya, Prakash, Saxena, & Nigam, 2013). Nevertheless, use of purposive sampling aided in recruiting participants with expertise, geographic distribution and with community knowledge needed to identify community needs. Another limitation was that the focus group discussion involved both community leaders and the subjects that they lead. This could have limited free speech. Additionally, although findings were adequate to determine and prioritize community needs, a sample size of 15 participants was determined to be small for analysis of food security and socio-demographic characteristics. The present study could have been improved by arranging separate focus group discussions for the community leaders and subjects. Another suggestion would be to include secondary data from medical records to supplement key informant interviews.

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CHAPTER IV: STUDY II

Effectiveness of Home Gardening in Improving Food Security and Health in Chacraseca – Nicaragua: A Pilot Study

Abstract

In the wake of the rapidly changing climate conditions and global population rise, there has been increased attention to ensure adequate food for everyone. The purpose of this study was to evaluate the effectiveness of home gardening in improving health and food security in Chacraseca, Nicaragua between 2015 and 2017. Fifty participants were recruited into the intervention and control groups. Participants were selected from the 1,250 households in Chacraseca, Nicaragua. At baseline and at post-study, quantitative measures of food security, height, weight, waist circumference, hip circumference and blood pressure were determined for both the control and intervention groups.

Results showed no significant differences in body mass index (ratio of weight in kilograms to height in square meters) at baseline ($p = 0.83$) and at post-study ($p = 0.99$) between the intervention and control groups. Blood pressure results showed no significant differences in systolic blood pressure at baseline ($p = 0.19$) and at post-study ($p = 0.13$) between the intervention and control groups. There were no significant differences in diastolic blood pressure at baseline ($p = 0.78$) and at post-study ($p = 0.92$) between the intervention and control groups. There was a non-significant increase in participants with normal blood pressure for both the control and intervention groups. The control group showed a greater percentage increase in participants with normal blood pressure (40%, n =18 at baseline to 60%, n = 27 at post-study) compared to the intervention group (48%, n = 23 at baseline to 54%, n = 26 at post-study). There

was a greater decrease in participants categorized as having stage 1 hypertension in the intervention group (27.1%, n = 13 at baseline to 10.4%, n = 5 at post-study) compared to the control group (28.9%, n = 13 at baseline to 20%, n = 9).

In households with children, at baseline more than 50% of participants were categorized as having very low food security: 52% in the intervention group and 60.4% in the control group. There was a decrease in percentage of participants categorized as having very low food security from 52% (n = 26) to 44% (n = 22) in the intervention group, whereas there was a slight increase in percentage of participants categorized as having very low food insecurity in the control group. In households without children, the intervention group showed an increase in percentage of participants categorized as having marginal food security and a decrease in percentage of participants categorized as having very low food security. There were no participants categorized as having marginal food security in the control group. The percentage of participants categorized as having low food security and very low food insecurity remained unchanged from baseline to post-study in the control group in households without children. For the intervention and control groups among households without children, there were no participants categorized as having high food security at baseline and at post-study.

Logistic regression results showed that the odds of being categorized as being food secure increased with age. Increase in BMI and blood pressure were associated with decreased odds of being categorized as food secure. Even though there was no significant evidence to demonstrate that home gardening improved food security and health, the study showed slight improvement in blood pressure and food security. Results from the present study may be used to guide policy makers in designing or modifying home gardening interventions.

Keywords: Home gardening, anthropometry, food security, health

Introduction

Globally, there have been increasing rates of overweight and obesity. By pooling and analyzing results from over 200 countries and territories, researchers reported that worldwide obesity had tripled between the years 1975 and 2016 (Abarca-Gomez et al., 2017). Additionally, researchers reported that in 2016, over 39% (1.9 billion people) of adults aged 18 years and older were overweight and that over 13% (650 million people) were obese (Abarca-Gomez et al., 2017). Although overweight and obesity were previously known to be a problem for the developed countries, researchers have reported emerging trends of overweight and obesity in low and middle-income countries (Popkin & Slining, 2013; Poobalan & Aucott, 2016). The increasing levels of overweight in low- and middle-income countries are an addition to the persistent high levels of low nutrient intake (Ford, Patel, & Naraya, 2017; Tzioumis & Adair, 2014).

Nicaragua is a low-income developing country that presents with high levels of low nutrient intake along with increasing levels of excessive nutrient intake (Pawloski, Moore, Waters, & Rojas, 2010). In fact, WHO reported the prevalence of overweight defined as having a BMI 25.0 to < 30 and obesity (BMI > 30) in Nicaragua to be 46% and 15% respectively (WHO, 2016). Rates of low nutrient intake were reported to be 17% in 2015 (The World Bank, 2017b). Schemeer and Piperata (2016) associated food insecurity in Leon (one of the political departments of Nicaragua) with stunting because of decreased nutrient intake. Other researchers reported food insecurity to lead to the consumption of highly processed high calorie low cost foods that in addition to physical inactivity, may lead to excessive weight gain (Ford, Patel, & Naraya, 2017; Carolan, 2018).

The rapidly changing climate conditions and global population rise have led to increased attention of policy makers to ensure adequate food for everyone. Researchers around the world have reported home gardening to improve food security and health status (Galhena, Freed, & Meredia, 2013; Kortright & Wakefield, 2011; Masset, Haddad, Cornelius, & Castro-Isaza, 2012). Even though there are limited studies that evaluate the effectiveness of home gardening in improving food security and health, few studies use standardized assessment tools to quantify those changes.

Talukder et al. (2001) suggested that their home gardening study reported mixed declines in anemia among the people in Nepal, Philippines, Cambodia and Bangladesh partly due to variation in design of impact evaluation (Talukder et al., 2001). They further acknowledged that the use of unstandardized tools would make it difficult to compare results with other researchers (Talukder et al., 2001). Similarly, to assess food security Carney et al. (2012) used two questions out of the standardized 18-item USDA food security questionnaire. Use of unstandardized questionnaires may make it difficult to correctly quantify the percentage of food security and to replicate the studies in other areas.

In a study in Nicaragua, Mendez et al. (2001) used focus group discussions and key informant interviews to determine farmers' perception towards home gardening. Mendez and others reported that farmers perceived home gardening to lead to consumption of diversified and health diets that led to improved nutritional status (Mendez, Lok, & Somarriba, 2001). The improvements were, in fact, farmers' perception and not qualities that were measured by researchers using standardized tools. Additionally, use of non-randomized cross-sectional study designs may introduce confounding factors. Other researchers reported home gardening to lead to improvements in serum retinol concentrations, but the assessment tools and study designs

were not clearly defined (Faber, Venter, & Benade, 2002). Faber et al. (2002) recruited more participants after the study had commenced resulting in more participants at post-study than there were at baseline. Thus, it was not clear whether the improvement in serum retinol levels were due to increase in sample size or home gardening.

The purpose of this study was to assess the effectiveness of home gardening in reducing food insecurity and improving household health status in Nicaragua. It was hypothesized that: (1) Through communal training, farmers would acquire adaptive farming technologies (2) Trainers would provide farm loans to enable farmers use the adaptive technologies to set up their own home-gardens; (3) Home gardening would lead to increased availability and accessibility to food; and (4) There would be an improvement in food security and health of participants.

Method

Study Design

This study was conducted in Chacraseca and was part of an ongoing model farm project *"Harper Marie,"* designed and implemented by a Non-Government Organization – JustHope, Inc., (JustHope, 2016a; Just Hope, 2016). In brief, the *Harper Marie* is a gardening project where JustHope, Inc. identifies sustainable farming technologies from different parts of the world. JustHope, Inc., then tries the farming technologies on its model farm in Chacraseca. Technologies that are found to be sustainable in Chacraseca are transferred to demonstration farms where farmers within Chacraseca are given hands-on training into those technologies. Each farmer that completes the six months' training in sustainable technologies is given a $20 USD loan to buy their own agriculture inputs, (seeds and fertilizers) and encouraged to transfer the technology into their own home gardens. JustHope, Inc. requires that household farmers pay back the $20 USD loan plus a monthly interest of 2%. Participating farmers agree to accept

continuous training and monitoring for up to six months after receipt of the loan. After a year of promotion, in 2016 researchers from Auburn University teamed up with JustHope, Inc. to evaluate the effectiveness of home gardening in improving household food security and health. Researchers focused on households as key institutions where individuals produce, prepare and consume food daily.

Study Sample

The study sample was selected from the 1,250 households in Chacraseca. Using statistical power, effect size and alpha, a target sample of 100 households was determined necessary to observe the effect of home gardening on food security and health (Bausell & Li, 2002). Sample selection was based on participation (intervention group) or non-participation (control group) in the *Harper Marie* gardening project. Using Microsoft Excel 2016, simple random sampling was used to select 50 participants from households that participated in gardening to represent the intervention group. Similarly, for the control group, Microsoft Excel 2016 was used to generate a random sample of 50 participants from households that did not engage in the *Harper Marie* gardening project.

Measures

Food Security

Household food security was assessed using the United States Department of Agriculture (USDA) household food security survey module at the beginning of the project in June 2016 and 12 months later (Bickel, Nord, Price, Hamilton, & Cook, 2000). The Spanish version of the USDA food security survey module has been validated for use in Latin American countries (Bezuneh, Yiheyis, del-Rosario, & Ortiz, 2008; Perez-Escamilla et al., 2004). In the present

study, the 18-item USDA household food security survey module was used to assess perceptions of the scarcity of food due to lack of economic resources in the previous three months. The USDA household food security survey module has three sections that capture situations of food security relating to the household, adults in the households and children in the households. Out of the 18 items; the first three items capture household food security followed by seven items that capture adult food security status. The last eight questions relate to the food security status of children within the households.

Responses to household food security questionnaires were coded in reference to the USDA guide to measuring household food security as in Table 1 (Bickel, Nord, Price, Hamilton, & Cook, 2000). Using this guide, affirmative responses included "yes," "often," "sometimes," "almost every month," and "some months but not every month." The sum of affirmative responses to all questions in the food security questionnaire provided a total score. The following table adapted from USDA food security guide was used to determine the level of food security.

Table 1: Level of Food Security: Coding for households with and without children

Household Characteristic	Total Score	Level of Food Security
Households with children	Zero	High food security
	1 – 2	Marginal food security
	3 – 7	Low food security
	8 – 18	Very low food security
Households without children	Zero	High food security
	1 – 2	Marginal food security
	3 – 5	Low food security
	6 – 10	Very low food security

Using the USDA food security guidelines, food secure households were those with high or marginal food security scores; whereas those with low or very low food security were categorized as food insecure.

Anthropometric and Blood Pressure

The height (meters); weight (kilograms); hip circumference (centimeters); waist circumference (centimeters); and blood pressure (mmHg) were determined. Height and weight were determined by trained researchers using anthropometry procedure manuals recommended by the National Health and Nutrition Examination Survey (NHANES & CDC, 2017). For height measures, participants were required to remove their shoes and stand straight with their backs to the wall of the stadiometer while looking directly forward. A drop-down bar attached to a stadiometer was lowered to slightly touch the head of participants or pressed lightly in case of thick hair. Readings were read directly from the measure mounted on the stadiometer. Measurements were determined in triplicate to the nearest 0.1 cm and if a value was determined to be far off from the rest, the procedure was repeated (NHANES & CDC, 2017).

Trained researchers using a Detecto SLIMPRO Slimpro Digital Floor Scale sourced from Tiger Medical, Inc. Irvington, NJ, determined participant weights. In reference to the anthropometric manual by the National Health and Nutrition Examination Survey, the scale was zeroed and participants in light clothing were instructed to stand on the scale, look straight ahead and stay still during measurement (NHANES & CDC, 2017). Weights were recorded when the scale dial settled. All measures were taken and recorded in triplicate to the nearest 0.1 kg with values being repeated if they fell far apart. The ratio of weight in kilograms to height in square meters termed body mass index (BMI) was calculated by dividing the weight by the height (CDC, 2017).

Waist circumference was measured using a body retractable tape measure. Participants were required to stand straight facing forward. The waist circumference was determined an inch above the navel. A tape measure was positioned horizontally, parallel to the floor and reading determined by wrapping the tape over the belly. The hip circumference was measured using retractable body tape measure with the tape placed at the widest circumference of the buttocks (NHANES & CDC, 2017). Readings were taken in triplicates to the nearest 0.1 cm. Both the waist circumference and hip circumference were used to determine the waist to hip ratio (WHR). This is a measure of central obesity used to estimate the health status of an individual. A ratio of less than 0.85 for men and less than 0.75 for women represents a healthy status.

Blood pressure was measured using *Omron BP710N3 Series Upper Arm Blood Pressure Monitor* sourced from Wal-Mart Stores Inc., Bentonville, AR. The protocol established by the Centers for Disease Control and Prevention was adhered to; participants were required to sit and relax for two minutes, not to talk and have legs uncrossed (NHANES; CDC, 2009). All tight arm clothing was removed and three readings were taken one minute apart. For every participant, the first reading was discarded and the last two averaged and recorded as the participant's blood pressure. Values of less than 120 systolic and less than 80 diastolic mmHg were used as a reference for normal blood pressure (NHANES; CDC, 2009).

Data Collection

Before data collection, a pre-test was done using the survey instruments including the food security questionnaire and the anthropometry data collection sheets. All survey instruments were available in English and Spanish. The wording of questionnaires and answer choices were refined based on pre-test results. The study was approved by the Institutional Review Boards at Auburn University and *Universidad Nacional Autonoma de Nicaragua – Leon* (National

Autonomous University of Nicaragua – Leon). On the day of data collection researchers visited sample households on random days and explained the study to the participants. Researchers addressed any concerns after which an informed consent was read to participants emphasizing voluntary participation and withdrawal at any time. After attainment of consent signatures, researchers read questions and recorded participant responses on the questionnaires.

Statistical Analysis

Anthropometry and blood pressure data were analyzed using the Statistical Analysis Software (SAS), version 9.4, SAS Institute Inc., Cary, NC, 2018. Food security data was categorized based on a USDA scheme (Bickel, Nord, Price, Hamilton, & Cook, 2000) and percentages in each category determined. Difference between means were compared using the paired t test. Statistical differences were determined using a p value of 0.05 or less. Logistic regression model was used to determine the relationship between food insecurity and age, BMI, systolic and diastolic blood pressure.

Results

Demographic Characteristics

Anthropometric and blood pressure data from two intervention participants were excluded from final analysis as they did not want their anthropometry measurements taken at post-study. This left 48 intervention participants of which 31 were female and 17 were male. Two female participants in the control group were expecting and were thus, excluded from anthropometry and blood pressure measurements. One participant did not want her anthropometry measures taken at all while two participants could not be contacted for the post-study, and as such, their anthropometry and blood pressure data were also excluded from final

analysis. Thus, anthropometric and blood pressure measurement results presented for the control (n=45) are from 12 male and 33 female participants. At baseline, there was no significant difference ($p = 0.17$) in age of participants between the intervention group (43.2 ± 15.7) and control group (39.6 ± 14.9 ($p = 0.17$), Table 2. The youngest participant in control group and intervention group was 18 years of age whereas the oldest participants were 78 years of age in the intervention group and 73 years of age in the control group.

Anthropometric Results

At baseline, there was no significant difference in height ($p = 0.66$) between the intervention and control groups, (Table 2). The average height in the intervention group was 157.7 ± 8.3 cm and was 157 ± 7.8 cm (1 cm = 0.39 inches or 0.033 feet) in the control group. In the intervention group, the shortest participant was 142 centimeters and the tallest participant was 175.9 centimeters. In the control group, the shortest and tallest participants were 135.9 centimeters and 178.9 centimeters respectively. In the post-study, there remained to be no significant differences in height ($p = 0.61$) between the intervention group and the control group, (Table 2). Similarly, baseline results from the intervention and control groups showed no significant differences in weight ($p = 0.89$) or BMI ($p = 0.83$). The average BMI for both the control and intervention groups fell in the overweight range of 28.1 ± 4.8 for the intervention group and 28.3 ± 4.2 for the control group. The lowest BMI for both the intervention and control groups were 17 (underweight) and 21 (normal weight) respectively, whereas the highest BMI were 37 and 36 respectively, both of which fall in the obesity range. The intervention group had more participants with a normal (29.2%) or obese (39.6%) BMI compared to the control group with 24.4% and 15% in the normal and obese ranges respectively.

Table 2: Baseline and post-study characteristics between the intervention and control groups, Chacraseca, Nicaragua, 2016 - 2017

	Baseline			Post-study		
Characteristic	Intervention (n=48)	Control (n=45)	P value	Intervention (n=48)	Control (n=45)	P Value
Age (years)	43.2 ± 15.7	39.6 ± 14.9	0.17			
Height (cm)	157.7 ± 8.3	157 ± 7.8	0.66	158.2 ± 8.3	157.3 ± 7.7	0.61
Weight (kg)	69.8 ± 12.7	69.5 ± 12.9	0.89	70.8 ± 12.6	70.0 ± 13.3	0.74
Body Mass Index (BMI)						
[a]BMI (kg/m^2)	28.1 ± 4.8	28.3 ± 4.2	0.83	28.4 ± 4.7	28.4 ± 4.2	0.99
<18.5	1 (2.1)	0		0	0	
18.5 – 24.9	14 (29.2)	11 (24.4)		14 (29.2)	9(20)	
25 – 29.9	14 (29.2)	19 (42.2)		16 (33.3)	20(44.4)	
≥30	19 (39.6)	15 (33.3)		18 (37.5)	16(35.6)	
Blood Pressure (BP)						
[b]SBP	121.3 ± 13.4	117.6 ± 13.7	0.19	121.9 ± 17.5	117.0 ± 14.8	0.13
[c]DBP	76.6 ± 8.9	77.0 ± 8.4	0.78	76.6 ± 9.5	76.4 ± 7.2	0.92
[d]Low BP	0	1(2.2)		0	0	
[e]Normal BP	23 (47.9)	18 (40)		26 (54.2)	27(60)	
[f]Elevated BP	8 (16.7)	11 (24.4)		6 (12.5)	7(15.6)	
[g]Elevated systolic	1 (2.1)	1 (2.2)		1 (2.1)	1 (2.2)	
[h]Hypertension 1	13 (27.1)	13(28.9)		5 (10.4)	9(20)	
[i]Hypertension 2	3 (6.3)	1 (2.2)		9(18.8)	1(2.2)	
[j]Hypertension 3	0	0		1(2.1)	0	

[a]BMI = Body Mass Index;
[b]SBP = Systolic Blood Pressure;
[c]DBP = Diastolic Blood Pressure;
[d]Low Blood Pressure = less than 90 to less than 60;
[e]Normal blood pressure = SBP less than 120 and DBP less than 80
[f]Elevated systolic = High SBP and Low DBP
[g]Elevated blood pressure = SBP 120 -129 and DBP less than 80
[h]Hypertension 1 = SBP 130 – 139 or DBP 80 – 89
[i]Hypertension 2 = SBP 140 or higher or DBP 90 or higher
[j]Hypertension 3 = SBP higher than 180 or DBP higher than 120

At post-study, there remained to be no significant differences in weight ($p = 0.74$) and BMI ($p = 0.99$) between the intervention and control groups, Table 2. From baseline to post-study, the number of individuals with normal BMI remained unchanged in the intervention group ($n = 14$) whereas for the control group there was a decline in number of participants with normal BMI from 11 to 9. The number of participants with overweight BMI increased from 14 to 16 in the intervention group and from 19 to 20 in the control group. There was decline in number of participants categorized as obese from 19 to 18 in the intervention group whereas the control group showed an increase in number of participants with obese range from 15 to 16.

Blood Pressure

The average systolic blood pressure values at baseline between the intervention group (121.3 ± 13.4) and control group (117.6 ± 13.7) were not statistically significant ($p = 0.19$). There was no significant difference in average systolic blood pressure measurements at post-study ($p = 0.13$). Similarly, there were no significant differences in diastolic blood pressure in the intervention and control group at baseline ($p = 0.78$) and post-study ($p = 0.92$), Table 2. The majority of participants in the intervention and control groups and at baseline and post-study had blood pressure values within the normal range. The control group showed a greater percentage increase in participants with normal blood pressure (40%, $n = 18$ at baseline to 60%, $n = 27$ at post-study) compared to the intervention group (48%, $n = 23$ at baseline to 54%, $n = 26$ at post-study). At baseline, over 20% of participants in the intervention and control groups had stage 1 hypertension. At post-study, there was a decline in the number of participants with stage 1 hypertension in both the intervention group (13 participants at baseline to 5 participants at post-study) and the control group (13 participants to 9 participants). However, in the intervention group, the percentage of participants with stage 2 hypertension increased from 6.3% ($n = 3$) at

baseline to 18.8% (n = 9) at post-study. At baseline, there were no participants with stage 3 hypertension (SBP higher than 180 or DBP higher than 120) but at post-study, one participant in the intervention group was diagnosed with stage 3 hypertension.

Waist to Hip Ratio

Results for waist to hip ratio were presented at baseline and post-study but also divided further to show variations between male and female genders (Table 3 and Table 4). At baseline, there was no significant difference in waist to hip ratio ($p = 0.23$) among male participants between the intervention and control groups. There was no significant difference between the control and intervention groups among females at baseline with average values of 0.87 ± 0.07 and 0.90 ± 0.08, respectively. Similarly, at post-study there were no significant differences in waist to hip ratio in both male ($p = 0.23$) and females ($p = 0.16$) between the intervention and control groups.

Using waist to hip ratio, participants were classified based on their risk for cardiovascular diseases (CVD). At baseline, the percentage of male participants with low CVD risk (65% in the intervention group and 92% in the control group) was higher than that of female participants (9.7% and 6.1% in the intervention and control groups respectively), Table 3. The percentage of participants with high risk to CVD was higher among female participants (61% and 67% in the intervention and control group respectively) compared to male participants with values of 25 and 8 % for the intervention and control groups respectively. A similar trend in CVD risk was observed at post-study where between the control and intervention groups, the average percentage of male participants with low risk to CVD was higher than that of females and the percentage of participants with high risk to CVD was higher among female participants than among their male counterparts, Table 4.

Table 3: Baseline waist to hip ratio and cardiovascular risk by gender, Chacraseca, Nicaragua, 2016 - 2017

	Male			Females		
	Intervention (n= 17)	Control (n=12)	p value	Intervention (n=31)	Control (n=33)	p value
[a]WHR	0.92 ± 0.06	0.89 ± 0.08	0.23	0.87 ± 0.07	0.90 ± 0.08	0.15
[b]CVD Risk						
Low risk	11 (64.7)	11 (91.7)	-	3 (9.7)	2 (6.1)	-
Moderate risk	4 (23.5)	0	-	9 (29)	9 (27.3)	-
High risk	2 (2.0)	1 (8.3)	-	19 (61.3)	22 (66.7)	-

[a]WHR = Waist to hip ratio
[b]CVD = cardiovascular relative risk

Table 4: Post–study waist hip ratio and cardiovascular risk by gender, Chacraseca, Nicaragua, 2016 - 2017

	Male			Females		
	Intervention (n= 17)	Control (n=12)	p value	Intervention (n=31)	Control (n=33)	p value
[a]WHR	0.93 ± 0.05	0.90 ± 0.06	0.23	0.88 ± 0.07	0.90 ± 0.07	0.16
[b]CVD Risk						
Low risk	11 (64.7)	9 (75)	-	3 (9.7)	2 (6.06)	-
Moderate risk	4 (23.5)	2 (16.7)	-	8 (25.8)	7 (21.1)	-
High risk	2 (2.0)	1 (8.3)	-	20 (64.5)	24 (72.7)	-

[a]WHR = Waist hip ratio
[b]CVD = cardiovascular relative risk

Food Security

Pre- and post-study food security data was collected from 50 participants in the intervention group and 48 participants in the control group. In both the intervention and control group, there were more households with children aged 6 years to 12 years as compared to those without children, (Table 5). In households with children, at baseline more than 50% of participants were categorized as having very low food security: 52% in the intervention group and 60.4% in the control group, (Table 5). At post-study, the number of participants categorized as having high food security increased 1 to 3 in the intervention group and from 0 to 4 in the control group.

There was a decline in the percentage of participants categorized as having very low food security from 52% (n = 26) to 44% (n = 22) in the intervention group, whereas there was a slight increase in the percentage of participants categorized as having very low food insecurity (60.4% at baseline to 62.5% at post-study) in the control group. However, at post-study, in both the intervention and control group there were more participants categorized as having very low food security compared to those in other food security classifications. In households without children, there were no participants categorized as having high food security at either study periods. Most of participants were categorized as having very low food insecurity compared to other food security classifications at baseline and at post-study for both the intervention and control groups, (Table 5).

Table 5: Food security classification for households with and without children, Chacraseca, Nicaragua, 2016 - 2017

		Baseline		Post-study	
	Level of food security	Intervention (=50)	Control (n = 48)	Intervention (n = 50)	Control (n = 48)
Households with children (*HH2 to CH7)	High food security	1 (2%)	0	3 (6%)	4 (8.3%)
	Marginal food security	0	2 (4.2%)	0	1 (2.1)
	Low food security	14 (28%)	11 (22.9%)	17 (34%)	7 (14.6%)
	Very low food security	26 (52%)	29 (60.4%)	22 (44%)	30 (62.5)
Households without children (*HH2 to AD5a)	High food security	0	0	0	0
	Marginal food security	2 (4%)	0	3 (6%)	0
	Low food security	0	2 (4.2%)	0	2 (4.2%)
	Very low food security	7 (14%)	4 (8.3%)	5 (10%)	4 (8.3%)

*HH2 to CH7 and *HH2 to AD5a represent sections in the food security questionnaire that define questions used to gather information from households either with or without children.

Logistic regression: Modeling food security against independent variables

Association of food security status with age, BMI and blood pressure at baseline

The association between food security and independent variables of age, BMI, systolic and diastolic blood pressure was determined. Food security was modeled as a binary variable where "0" = food insecure and "1" = food secure. Logistic regression results for the association between food security with age, BMI and blood pressure for the intervention group at baseline are presented, (Table 6). Results showed that for every unit change in age and diastolic blood pressure, the log odds of being categorized as food secure versus being categorized as food insecure increased by 0.07 and 0.03 respectively. For a one-unit increase in BMI and systolic blood pressure, the odds of being categorized as food secure decreased by 0.14 and 0.06 respectively. There was no significant association between being categorized as food secure and age ($p = 0.08$), BMI ($p = 0.32$), systolic blood pressure ($p = 0.33$) and diastolic blood pressure ($p = 0.78$) at $\alpha = 0.05$.

Table 6: Association of food security status with age, BMI and blood pressure at baseline for the intervention group.

Parameter	Coefficients	Standard error	Wald's Chi Square	Pr > ChiSq (p-value)	Odds ratio
Age	0.07	0.04	3.13	0.08	1.07
BMI	-0.14	0.14	1.00	0.31	0.87
Systolic blood pressure	-0.06	0.06	0.96	0.33	0.94
Diastolic blood pressure	0.03	0.11	0.08	0.78	1.03

In the control group at baseline (Table 7), food security status was positively associated (but not significantly associated) with age and systolic blood pressure. For a one-unit increase in age and

systolic blood pressure, the odds of being categorized as food secure increase by 0.10 and 0.12. On the other hand, for a one-unit increase in BMI and diastolic blood pressure, the odds of being categorized as food insecure increase by 0.33 and 0.23 respectively.

Table 7: Association of food security status with age, BMI and blood pressure at baseline for the control group.

Parameter	Coefficients	Standard error	Wald's Chi Square	Pr > ChiSq (p value)	Odds ratio
Age	0.10	7.92	0.13	0.72	1.11
BMI	-0.33	0.04	3.13	0.08	0.72
Systolic blood pressure	0.12	0.14	1.00	0.32	1.12
Diastolic blood pressure	-0.23	0.06	0.96	0.33	0.80

Association of food security status with age, BMI and blood pressure at post-study.

At post-study, in both the intervention (Table 8) and control groups (Table 9), food security was positively associated with age and systolic blood pressure. However, different from results at baseline, we reported significant associations between food security, age and BMI. For the intervention group, a one-unit increase in age resulted in increased odds of being categorized as food secure by 0.12. The relationship between food security and age was statistically significant ($p = 0.03$) at $\alpha = 0.05$. Similarly, a one-unit increase in BMI was associated with 0.68 odds of being categorized as food insecure. This relationship between food insecurity and BMI was statistically significant ($p = 0.05$). For the control group at post-study, age remained to have a statistical significant association with food security ($p = 0.05$). Diastolic blood pressure and BMI were negatively associated with food security.

Table 8: Association of food security with age, BMI and blood pressure at post-study in the intervention group.

Parameter	Coefficients	Standard error	Wald's Chi Square	Pr > ChiSq (p value)	Odds ratio
Age	0.12	0.06	4.84	0.03	1.13
BMI	-0.68	0.35	3.90	0.05	0.51
Systolic blood pressure	0.07	0.06	1.35	0.25	1.07
Diastolic blood pressure	-0.07	0.11	0.41	0.52	0.93

Table 9: Association of food security with age, BMI and blood pressure at post-study in the control group.

Parameter	Coefficients	Standard error	Wald's Chi Square	Pr > ChiSq (p value)	Odds ratio
Age	0.10	0.05	3.74	0.05	0.90
BMI	-0.34	0.21	2.60	0.11	1.40
Systolic blood pressure	0.04	0.04	0.73	0.40	0.97
Diastolic blood pressure	-0.11	0.12	0.85	0.36	1.11

Discussion

BMI

In this study, at baseline there was no significant differences in height, weight, and BMI in both the intervention and control groups. We expected to find no significant changes in height of participants in both the intervention and control groups at post-study. The human body exhibits minimal changes in height past the age of 18 years (Bogin, 1999). In the present study, due to the home gardening intervention, changes in weight and thus in BMI were expected but

not observed. The high rate of overweight in the control group of the present study (42% at baseline and 44% at post-study) was comparable to 2016 results by the WHO which reported an average overweight rate of 46% for Nicaragua (WHO, 2016). Similarly in Nicaragua, WHO reported overweight and obesity results from adult populations aged 18 years and older and considered cutoff for overweight participants have a BMI of greater than or equal 25 and participants were categorized as obese if they had a BMI of greater than or equal to 30 (WHO, 2016b).

However, the overweight rates of 29% and 33% at baseline and at post-study respectively that were observed in the intervention group of the present study were lower than those reported by World Health Organization and those in the control group of the present study (WHO, 2016). WHO did not report the specific studies from which it collected the secondary data used to compute BMI for Nicaragua and because of that results in the present study cannot be directly compared with results from WHO. Unlike overweight, rates of obesity in the present study were twice as high as those reported by the World Health Organization (WHO, 2016). Other researchers reported high rates of overweight (55%) and obesity (22%) in a cross-sectional study among six communities from Nicaragua departments of Leon, Chinandega and Matagalpa (Laux, et al., 2012). The present study was carried out in Chacraseca located in the department of Leon. This makes overweight and obesity results from the present study comparable with results reported by Laux et al. (2012). However, Laux et al. (2012) conducted a cross-sectional study different from the present longitudinal baseline and post-study research.

In the present study, the absence of significant difference in BMI between the intervention and control groups at post-study may reflect that participants in the intervention group did not consume health foods from their gardens. However, researchers reported that

combined diet and physical activity but not separate interventions, were necessary for weight management (Johns, Hartmann-Boyce, Jebb, & Aveyard, 2014; Balk, et al., 2015). In the present study, participants' diet and physical activity were neither jointly nor individually controlled but researchers held an assumption that participants would consume more fruits and vegetables grown in their gardens and consume less of the traditionally processed foods. The lack of combined diet and physical activity interventions may have been responsible for the lack of significant difference in BMI between the intervention and control groups of the present study. In another study, researchers reported absence of significant difference in anthropometric measures of children after 20 months of promoting home gardens to families (Faber, Venter, & Benade, 2002). However, Faber et al. (2002) conducted a cross sectional study involving more participants at post-study than at baseline, which could have confounded the results. Additionally, the number of children involved were not mentioned in the results.

Even though there were no significant differences in BMI, at baseline there were more participants with normal BMI in the intervention group (n = 14) compared to the control group (n = 11). This difference could be because JustHope, Inc. has been in the study area for over 20 years implementing health and income generating projects even before the current *Harper Marie* gardening project. Additionally, still at baseline, the intervention group had fewer participants with overweight BMI (n = 14) compared to the control (n = 19). However, the fewer number of participants with average BMI values within the obese range in the control group compared to the intervention group may indicate that previous JustHope, Inc. activities did not influence BMI results at baseline. The same trend of BMI values between the control and the intervention group at post-study were observed. This consistency in BMI results at baseline and post-study could signal that the *Harper Marie* project did not lead to improvement in the BMI of participants.

Other researchers reported mixed results on the effect of agricultural interventions (including home gardening) on health status (Berti, Krasevec, & FitzGerald, 2004). According to Berti et al. (2004) studies that reported positive effects on health status invested in multiple types of human capital, for example, nutrition education and gender issues, in addition to agricultural interventions. However even with investment in human capital in form of nutrition education, in Cambodia Olney et al. (2009) reported no significant differences in anthropometric indicators, prevalence of stunting, overweight or wasting in children (Olney, Talukder, & Iannotti, 2009). In the present study, researchers did not measure anthropometry of children and therefore results cannot be directly compared with those of Olney et al (2000). Absence of significant differences in BMI between the intervention and control groups of the present study may have been be due to the short study period or the absence of a joint controlled diet and physical activity regimen.

Waist to Hip Ratio (WHR)

In the present study, results showed no significant difference in WHR between the intervention and control groups at baseline and post-study. In male participants at baseline, it is not clear why more males in the control fell in the low CVD risk category compared to the intervention group. For female participants at baseline, the number of participants in CVD risk category did not differ between the intervention and control groups. In male participants at post-study, even though there were no significant differences in WHR, the control group showed a decline in number of participants in the low CVD risk category and an increase in the number of participants in the moderate CVD risk category. The same situation was observed in females at post-study where participants showed an increase in the risk to CVD based on WHR. Even though not significant, these results show a possibility that home gardening had some positive effect on waist hip ratio as a risk factor for CVD.

In the present study, it is not known why at baseline and post-study for both the intervention and control groups, female participants had a higher risk of CVD. Other researchers reported WHR to be predictor of major CVD events among women with coronary artery disease than in men (Medina-Inojosa et al., 2018). Even though it was beyond the scope of objectives for the present study, WHR results from the present study show elevated CVD risk mainly among females in Chacraseca. Studies that use hazard ratio analysis and WHR should be done for longer durations using larger samples to confirm these results and to determine whether home gardening interventions reduce the CVD risk.

Blood Pressure

The present study reported no significant differences in systolic and diastolic blood pressure at baseline and at post-study between the control and intervention groups. However, hypertension levels of greater than 20% were reported for intervention and control groups at baseline and at post-study. The control group had hypertension levels of 20% at baseline but decreased to 18% in the post-study. Other studies reported hypertension rates of 25% (PAHO, WHO, 2010) and 22% (Laux et al., 2012) which are within the range reported in the present study. In the present study, at baseline there were more individuals normal blood pressure in the intervention group compared to the control. Perhaps this was because participants in the intervention group have participated in previous health projects organized by JustHope, Inc.

Researchers in the present study did not control for participation in prior JustHope, Inc. activities and therefore a conclusion cannot be made based on that. Still at baseline, there were more participants with elevated blood pressure in control (n = 11) compared to the intervention (n = 8). This could further support the existence effects due to participation in prior JustHope, Inc. activities. At post-study, still there were no significant differences in systolic and diastolic

blood pressure but results flipped to reflect more participants with normal blood in the control group (n = 27) than in the intervention group (n = 26). It is not clear why the control group had more individuals with normal blood pressure but perhaps because during data collection at baseline, researchers encouraged participants with hypertension to seek medical advice. Similarly, researchers in the present study observed fewer participants with stage 2 hypertension in the control group (n =1) compared to the intervention group (n =9). Again, it is not clear why results were as observed but it could be because participants in the control group took researchers advice and sought medical advice.

Even though no observed significant differences in systolic and diastolic blood pressure measures at baseline and at post-study in the present study, there was an increase in percentage of individuals within the normal blood pressure category in both the control and intervention groups. However, the control group showed a larger increase in individuals within the normal blood pressure category compared to the intervention group. For both groups, there was a decline in stage 1 hypertension and an increase in stage 2 hypertension in the intervention group. The decline in hypertension in the control group compared to the intervention group may reflect that participants in the control group had better blood pressure management. It is not clear why there was an increase in participants with normal blood pressure in both the control and intervention groups.

Additionally, during measurement of blood pressure researchers for the present study explained results to participants and advised individual participants to have regular medical checkups. Participants who were found to have blood pressure ranges out of the normal range were advised to visit health professionals. This could have confounded the results but individuals who were taking blood pressure medication at baseline in both the intervention and control group

reported to take blood pressure medication at post-study but still had above normal blood pressure values. The present study did not control for other agricultural or nutrition education interventions in the study area. It is also worth noting that in the present study, results showing slight improvement in health parameters in the control group versus the intervention group were only observed for blood pressure measures and not BMI or waist hip ratio. Unfortunately, there is limited research showing effect of gardening on blood pressure and BMI in Nicaragua.

Food Security

The present study reported that over 50% of households with children in both the intervention and control groups and at both baseline and post-study were categorized as food insecure. From the present study, evidence of home gardening improving food security was supported by the increase in number of participants categorized as having high food security and a decline in participants categorized as having very low food insecurity for households with children in the intervention group. Even though the control group showed an increase in participants classified as food secure, there was an increase in number of participants in the very low food insecurity classification. This may indicate that home gardening could have a potential to improve food security in the intervention group compared to the control group.

Food security results for households without children further support the importance of home gardening. In households without children, unlike the control group, the intervention group showed an increase in participants with marginal food security and a decrease in participants with very low food insecurity. The improvements in food security in both households with and without children did not translate into improvements in BMI and blood pressure. BMI results remained the same for both the intervention and control at post-study whereas there was no observed pattern for the effect of home gardening on blood pressure.

Logistic Regression

At baseline, age was found to be associated with household food security status in the intervention group even though the logistic regression model showed no statistical significant association ($p = 0.080$) at $\alpha = 0.05$. Based on results from the present study, older respondents were categorized as being more food secure than younger respondents (data not shown). In a study in Northern Pakistan, Abdullah et al. (2017) reported age to significantly affect food security where respondents in higher age groups were categorized as being more food secure compared to respondents in lower age groups (Abdulla et al., 2017). Increase in BMI and in systolic blood pressure was reported to be associated with a decrease in food security. Results from the present study (Table 2), showed that the average BMI for the intervention group at baseline (28.1 ± 4.8) and at post-study (28.4 ± 4.7) were above the normal range of 24.9.

The high percentage of food security in the intervention group (greater than 52%) and average BMI beyond 29.9 range support findings for the present study, that increase in BMI correlates with decrease in food security. A likely explanation for the relationship between BMI and food security observed in the present study would be that food insecurity drives consumption of cheap calorie dense foods that are likely to lead to an increase weight. Researchers have reported that BMI positively correlates with blood pressure (Dua, Bhuker, Sharma, Dhall, & Kapoor, 2014). Finding from the present study (Table 2), show that average BMI of participant was in the overweight range and the systolic blood pressure (121.3 ± 13.4) was above the upper normal limit range of 120. It is possible that the high BMI in participants was responsible for the observed above normal systolic blood pressure.

Food insecurity was reported to lead to obesity in developed countries especially where food assistance programs are available but do not provide healthful foods (Dhurandhar, 2016). In

developing countries however (for example, Nicaragua), Dhurandhar (2016) suggested that individuals with higher social economic status are likely to gain excess weight due to possible increased access to high calorie foods. Similarly, Smith et al. (2016) reported food insecurity to be significantly associated with overweight or obesity among Mexican-American Men. However, the authors further reported that their results may not be expanded to other individuals of Mexican origin as the relationship was only observed among Mexican-American women but not among Mexican-American (Smith, Colon-Ramos, Pinard, & Yaroch, 2016).

In the present study, for both the control and intervention group and at both time periods, increase in age was associated with increase in food security. This result may be helpful in determining which age to include in future interventions. It is possible that the older the individual, the more assets one possesses and the more food secure one becomes. For the present study, we did not assess asset ownership but Schemeer et al. (2015) reported that increased maternal resources were associated with improved food security status in Nicaragua.

Conclusion

In the present study, researchers assessed the effectiveness of home gardening in improving food security and health. The average BMI for participants at baseline and at post study fell in the overweight and these results were consistent with results of the World Health Organization. The high level of overweight within Chacraseca may present a risk for chronic health conditions such as insulin resistance type 2 diabetes mellitus. In addition, the high level of obesity may be partly responsible for the high level of hypertension observed among participants at baseline and at post-study. Obesity on the other hand may be driven by the high level of food insecurity of above 44% in both study groups at baseline and at post study. This

high level of obesity could however be reduced with improvement in food security. In the present study, there was an observed slight improvement in food security and a reduction in hypertension that may have been due to promotion of home gardening. Although there was non-significant improvements in blood pressure and food insecurity, the present study presents a possibility for home gardening to improve health and food security within Chacraseca.

Another observation was that the odds of being categorized as food secure increased with age. This could be useful for future interventions in determining the participant age to include in gardening projects. Policy makers can use this association to design programs that target younger individuals who are more likely to be categorized as food insecure. Increased BMI and increased blood pressure were associated with increased food insecurity. The association between BMI and food security was not significant for all groups at all times except for the intervention group at post-study.

Strengths

Researchers in the present study were able to randomly recruit 48 participants who were engaged in home gardening as well as 45 participants who were not involved in home gardening. Using a longitudinal study design, researchers orally administered baseline and post-study standardized food security questionnaires and collected anthropometric and blood pressure measures on each individual participant. To the best of researchers' knowledge, this was the first longitudinal study evaluate effects of home gardening on food security and health in Chacraseca and in Nicaragua. Another strength was that, baseline and post-studies were carried out during the same season in summers of 2016 and 2017 thus it is highly unlikely that season variations affected the results.

Limitations

The home gardening project was a pilot study in its early stages of development. The JustHope, Inc., team together with the participants were getting used to the farming technologies. Additionally, given that home gardening was done outdoors and that the intervention and control participants could interact feely, it was impossible to blind the study. Participants in the control group could have picked up information from the intervention group and could have possibly acquired information from other health related programs. Another weakness was that, in evaluation of the impact of food security, researchers only focused on anthropometry and blood pressure. Researchers in the present study did not capture the level of participation in gardening, volume of crops produced, varieties grown, level of support to farmers.

Recommendations and Implications for Future Studies

Given the slight improvements in food security and blood pressure observed in the present study, future studies should focus on using larger sample sizes. Additionally, researchers should focus on evaluating gardening projects that have been established for longer durations. Even though researchers for the present study used standardized data collection tools, it is recommended that in addition, future studies should have more variables associated with home gardening, food security and health. Future researchers should consider capturing the level of participation in gardening, volume of crops produced, varieties grown and level of support to farmers. If possible, intervention and control groups should be located in different communities to avoid factors that could affect study results. Results from the present study may be used by policy makers and researchers who seek to introduce home gardening in rural communities.

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CHAPTER V: STUDY III

Effects of Garden-Based Nutrition Education on Nutrient Intake in Chacraseca, Nicaragua

Abstract

The present study examined the impact of garden-based nutrition education on nutrition knowledge and nutrient intake in Chacraseca, Nicaragua. Using simple random sampling, 48 participants and 47 participants were recruited into the intervention and control groups respectively. Participants in the intervention group were involved in home gardening and received six one hour-long nutrition education lessons over a period of three weeks. Participants in the control group received neither nutrition education nor were they engaged in home gardening.

At baseline and post-study, nutrition knowledge and food intake were determined using nutrition knowledge questionnaires and 24-hour dietary recalls for both the intervention and control groups. Results at post-study showed significant differences in nutrition knowledge between intervention and control groups. Similarly, at post-study a significant difference in vitamin A intake ($p = 0.04$) and sodium ($p = 0.03$) between the intervention and control groups was determined. There were observed non-statistically significant increments in nutrient intakes that were not specific to either the intervention or the control group. These results support the use of garden-based nutrition education to improve nutritional knowledge and to improve nutrient intake.

Keywords: Nutrition education, Garden-based, Nutrient intake, Nutrition knowledge

Introduction

Nicaragua has persistent levels of undernourishment and diet related chronic diseases, which among other reasons are due to food insecurity and inadequate nutrition knowledge (FAO, 2017a). In response to chronic undernourishment, Nicaragua set up a framework of policies that have led to a decline in chronic undernourishment from 20.1% in 2010 to 16.6% in 2016 (FAO, 2013; Klaus, Jill, Nilam, Shazia, & Yisehac, 2016). In the year 2000, Nicaragua established the national policy for food and nutritional security (Krivonos & Dawe, 2014). Additionally, in 2009 the Food and Agriculture Organization of the United Nations (FAO) in collaboration with the National Assembly of Nicaragua signed a new law to ensure food and nutrition sovereignty and security (Republic of Nicaragaua, 2009). The law was to ensure that Nicaragua promotes availability of the necessary food and nutrition resources to satisfy the population (Republic of Nicaragaua, 2009).

To ensure availability of sufficient variety of foods in Nicaragua, considerable efforts have been made towards promoting agricultural interventions (Ebata & Huettel, 2017; USDA; Technoserve, 2016; IFAD, 2014). Despite evidence of agricultural interventions improving food intake (World Food Programme, 2015), most households in developing countries, of which Nicaragua is part, consume less than the recommended daily nutrients for an active and healthy life (FAO, IFAD, UNICEF, WFP, WHO, 2017). Inadequate nutrient intake is partly due factors affecting the availability, access and or affordability of common food staples (Bain et al., 2013; Brinkman, de Pee, Sanogo, Subran, & Bloem, 2010). One of the reasons for inadequate nutrient intake is that individuals fail to make good use of the food to which they have access (Barrett, 2010). Failure to utilize available food may be due to inadequate nutritional knowledge.

Adult informal education services increase food security and health by enhancing the

transfer of nutrition knowledge (De Muro & Burchi, 2007). In Nicaragua, 37% of 15 to 24-year-olds did not complete primary education and that approximately 21% of boys and 15% of girls of primary school age did not attend school (Education Policy and Data Center, 2014). This may indicate that a great percentage of children grow up into adults with limited knowledge, including nutrition knowledge. Studies relating education attainment to nutrition knowledge and nutrient intake in Nicaragua are limited. Schmeer et al. (2015) reported that households where mothers received a secondary education had 47% lower odds of moderate/severe household food insecurity than households where maternal education was lower. In other countries, researchers reported an approximate 50% reduction in food insecurity and improvement in health in households where mothers received a higher education (Schmeer, Piperata, Rodríguez, Torres, & Cárdenas, 2015; Ben-Davies, Kinlaw, del Campo, & Bentley, 2013; Chowdhury et al., 2016). To improve nutrient intake, it may be necessary to promote agricultural interventions together with nutrition education.

Recently, there has been an increased attention to promote agricultural interventions along with nutrition education (Reinbott et al., 2016; FAO, 2016; Marquis, et al., 2017; Muehlhoff, et al., 2017; Tamiru, et al., 2016). According to Contento (2007, p. 176), nutrition education is defined as "*any combination of educational strategies, accompanied by environmental supports, designed to facilitate voluntary adoption of food choices and other food and nutrition-related behaviors conducive to health and well-being."* Agricultural interventions, such as home gardening, have been reported to increase the availability, access and affordability of foods (Poulsen, McNab, Clayton, & Neff, 2015; Tesfamariam, Owusu-Sekyere, Emmanuel, & Elizabeth, 2018; Mohsin, Anwar, Jamal, Ajmal, & breuste, 2017). On the other hand, nutrition education increases participants' knowledge and the utilization of the available food (Waswa,

Jordan, Herrmann, Krawinke, & Keding, 2015; Kabahenda, Mullis, Erhardt, Northrop-Clewea, & Nickols, 2011; Kuchenbecker, Reinbott, Mtimuni, Krawinkel, & Jordan, 2017).

There is limited research showing benefits of garden-based nutrition education on nutrient intake of communities in developing countries. Most existing published studies report impacts of garden-based nutrition education on fruit and vegetable consumption mainly among schoolchildren in developed countries (McAleese & Rankin, 2007; Robinson-O'Brien, Story, & Heim, 2009; Parmer, Salisbury-Glennon, Shannon, & Struempler, 2009). The objective of the present study was to determine the effects of garden-based nutrition education on nutrient intake and nutritional knowledge in rural Nicaragua. It was hypothesized that nutrition lessons combined with home gardening would increase nutrition knowledge and improve nutrient intake of participants in rural Nicaragua.

Method

Participants

The present study was conducted with participants from the Chacraseca community in collaboration with JustHope, Inc., an organization that has been working to improve livelihoods in Chacraseca for over 20 years. Approval for the study was provided by the Institutional Review Boards at Auburn University (Auburn, AL) and Universidad Nacional Autonoma de Nicaragua – Leon (National Autonomous University of Nicaragua – Leon). Participants were recruited with help from JustHope, Inc. In brief, JustHope Inc. holds weekly meeting with community leaders from the 12 sectors within Chacraseca. Using these meetings, staff from JustHope, Inc., explained the study to community leaders who in turn informed community members within their respective sectors. Researchers then used a sample size calculation method based on Z score of 1.96 (confidence level of 95%), margin of error (confidence interval) of 5% standard

deviation of 0.5, the sample size of 100 was found adequate to determine significant differences (Smith, 2018). Participants were chosen using simple random sampling in Microsoft Excel, 52 participants were selected from households involved in home gardening to represent participants in the intervention group. In a similar way, 50 participants were recruited from those not involved in home gardening to constitute the control group. Participants in the intervention group received nutrition education in addition to home gardening whereas participants in the control group were neither engaged in home gardening nor did they receive nutrition education.

Nutrition Education

Studies reported that human behavioral change involves an interaction of interpersonal, intrapersonal, institutional and public policy structures (Kerr et al., 2012; Sallis & Owen, 2015). The social ecological model (appendix G) accounts for interventions at household level (individual participants within families), institutional level (Chacraseca community and JustHope, Inc.) and the policy structure within which JustHope, Inc. operates (USDA, NIFA, 2015). As such, the social ecological theory of education was found to be effective in facilitating behavior change compared to other behavioral models that include the transtheoretical model, the theory of planned behavior, and the health belief model (Schultz & Litchfield, 2016; USDA, NIFA, 2015). A community nutrition education (CNE) logic model modified from that designed by the United States Department of Agriculture (USDA) and the National Institute of Food and Agriculture (NIFA) was used to formulate nutrition education topics for the intervention group (USDA, NIFA, 2015).

Nutrition Education Topics

Topics for nutrition education (Table 1) were developed based on published literature (Schultz & Litchfield, 2016; USDA, NIFA, 2015) and with guidance from researchers at Auburn University. The content for nutrition education was tailored to community needs determined from the community needs assessment completed in 2015. Nutrition education topics used in this study included: (i) Nutrients present in commonly available foods; (ii) Nutrient-disease relationships; (iii) Strategies for consuming healthy meals at home; (iv) strategies for community

Table 1: Topics and Objectives for Nutrition Education Lessons in Nicaragua, Chacraseca 2018

Education topics	Learning objectives	SEM level
Nutrients present in commonly available foods	• Determine foods commonly consumed in Chacraseca • List major nutrients in the foods • Introduce MyPyramid and place local foods within it	Individual
Nutrient-disease relationships	• Discuss the different classes of nutrients and their major function in the body • Relate common illness to nutrient deficiencies • Critique a sample meal for overall balance of key nutrients	Individual
Strategies for consuming healthy meals at home	• Consume more home prepared meals • Engage children in meal preparation • Maintain home gardens • Make meal plans as a family	Interpersonal environment
Strategies for community involvement	• Community gardening • Health training by mission groups and health professionals • Community health meetings • Ask local businesses to sell health foods • Buy locally grown foods • Sell your excess foods to neighbors/ barter trade	Physical environment
Health promotion at a village/ broader level	• Become leaders and or policymakers • Vote for leaders who promote policies like improving transportation, extending health services • Ask representatives to make policies • Join community organizations	Macro environment

involvement and lastly; (v) health promotion at a village/broader level.

Nutrition Education Questionnaire and Lessons

Ten multiple choice questions (Table 2) were formulated based on focus group discussions and from other studies with related objectives (Lautenschelager & Chery, 2007; Rustad & Chery, 2013). Ten people from the study area different from those involved in the study tested the questions to determine accuracy after which corrections were made. At baseline in June 2016, on separate days, participants in both the control and intervention groups were guided into responding to the ten multiple choice questions, Table 2. Each question was read aloud to each group to account for varied reading levels and participants were required to check or circle the response they felt most appropriately suited the question. After the testing, the primary investigator graded and recorded all responses. Each correct answer was given a score of 100 points and an incorrect answer was given a zero score. For each question, the number of participants with the right response were recorded. The total number of correct responses for each participant was also recorded and used to calculate the overall mean. At the end of the testing session, feedback was provided to participants.

Nutrition Education Sessions

After administering baseline nutrition education questionnaires, researchers guided the intervention group into six nutrition education lessons based on topics highlighted in Table 1. To overcome language barrier, a translator fluent in both English and Spanish translated communications between the researchers and participants. Each nutrition education session was started with an introductory ice breaker (participants' favorite meals, years lived in Chacraseca and best part of previous day) lasting 15 minutes, followed by discussion about nutrition

Table 2: Questions and responses for nutrition education lessons, Chacraseca 2018

Question	Responses
What foods contain the most sodium?	Fruits, vegetables, ***processed canned foods**, cow milk
How can one manage their weight to stay healthy?	Eat smaller portions, be physically active for more than an hour a day, balance calories, take regular weight measurement, ***all are true**
One fact about my plate is that;	***Half is fruits and vegetables**, doesn't contain foods with fat, doesn't contain foods with sodium, it is complicated to understand
Which of the following foods contains the most good fats?	Beef, chicken, ***fish and sea food**, vegetables and fruits
What ways can we increase consumption of health meals in the home?	By having meals as a family, engaging family members into making meal choices, involving children in meal preparation, ***all are true**
What is NOT true about chronic diseases?	Develop over time starting from childhood, have no known cure but can be maintained with diet and exercise, ***only prevalent in urban areas**, can affect both male and females.
What role can you play to ensure the community has continued access to nutritious food?	Become community leaders, engage in community health activities, buy locally grown foods, ***both are true**
Which of these is not a risk factor for chronic diseases?	Cigarette smoking, physical inactivity, excessive alcohol consumption, ***consuming fiber foods**, advanced age
Which of the following is NOT a good health practice?	Eating less fat, sugar and salt to prevent heart disease and diabetes, eating whole grains, ***skipping meals**, families eating a variety of fruits and vegetables.
Which of these statements is not true?	Processed fruit juices contain more added sugar, ***whole fruits and grains contain less nutrients than processed foods**, fruits and vegetables are good sources of vitamins and minerals, no single food contains all the required nutrients.

education topics lasting 40 minutes and lastly, a summary for the day's main points lasting 10 minutes. Participants were encouraged to ask any questions before, during and after the sessions and to make an effort to attend the next session. Similar nutrition education topics, nutrition education schedule and assessment tools were applied to the intervention group at post-study in June 2017. The control group did not receive nutrition education at post-study but were examined for nutrition knowledge.

The 24-hour Dietary Recall

The 24-hour dietary recall was administered immediately after completion of the Nutrition Education Questionnaire. With the help of a translator fluent in both Spanish and English, trained researchers from Auburn University asked individual participants to name all foods consumed in the past 24 hours, the source of foods, the quantities of foods, method of preparation as well as the time of the day the foods were consumed. A coffee cup, a mug, a bowl, dinner plate, and a serving spoon purchased from local stores in Chacraseca were used as models to estimate quantities.

Participants were probed to recall foods they consumed in the last 24 hours by asking them the time they woke up, where the food was consumed, with whom the foods were consumed and to recall whether they consumed any snacks. After naming the foods consumed, the complete food list was read back to the participants to check whether they recalled any additional food items. Responses were then recorded on paper and used to calculate daily average nutrient intake of participants. Using the 24-hour dietary recall, foods consumed by participants were grouped into the five categories of MyPlate. MyPlate is the nutrition guide published by USDA Center for Nutrition Policy and Promotion that classifies foods into five categories including fruits, vegetables, grains, protein and dairy.

Analysis

Data were analyzed using the Statistical Analysis Software, version 9.4, (SAS Institute Inc., Cary, NC, 2018). Using the SAS GLIMMIX procedure, a mixed model design accounting for participants age, education level, economic level and sex was used to determine changes in knowledge of participants. The 24-hour dietary recall data was analyzed using the NutriSurvey program to determine the nutritional composition of foods from participants' diets (Erthardt, 2010). The NutriSurvey database was modified to include traditional Nicaraguan foods using the USDA food composition database (USDA, 2018) and the "Eat This Much," database (Eat This Much, n.d.). Where necessary, food quantities from the 24-hour dietary recall were converted to grams using conversion factors presented on the USDA and Eat this Much Websites. The quantities consumed for each food were then entered into a NutriSurvey database to give nutrients present per 100 grams. Frequencies of consumption for vegetables, fruits, grains, protein foods and dairy were calculated. Descriptive statistics were used to compare mean consumption of energy and nutrients (protein, fat, carbohydrates, fiber, vitamins and minerals) between the intervention and control groups and between baseline and post-study. Differences between nutrient means were compared using the paired t-test. Statistical differences were determined using a p value of 0.05.

Results

The study enrolled 102 participants from 100 households; 52 participants in the intervention group and 50 in the control. In the intervention group, two participants did not consent to taking part in nutritional education, two more did not complete all the six nutrition education lessons. In the control group, three participants responded to the Nutrition Education Questionnaire but declined to provide their 24-hour dietary recall. Complete data was thus

collected from 48 participants in the intervention group and 47 participants in the control group. At baseline, there were no observed statistical significant differences in age, education level, and income level of participants between the intervention and control group. Responses to the Nutrition Education Questionnaire were graded as zero or 100 for the wrong and right multiple choice questions respectively. Results are presented as number of participants out of the total who got each question right, Table 3.

Comparing mean change in knowledge, at baseline there was no significant difference in mean knowledge scores, (24.1 ± 11.4 for the intervention group compared with 26.1 ± 15.1 for the control). However, at post-study there was significant difference in mean knowledge scores, 72.2 ± 12.9 versus 33.3 ± 17. 7 for the intervention and control group respectively. There was a significant difference in mean change in knowledge at $p < 0.001$. Compared with baseline values, the intervention group had a greater mean change in knowledge values compared to the control group (48.1 ± 25.8 and 7.2 ±26.2, respectively).

At baseline, the control and intervention groups showed no significant differences in nutrition knowledge scores. At post-study, there was a significant difference in nutrition knowledge assessed for all questions between the intervention and the control group. For each question at post-study, over 65% of participants in the intervention group provided the correct responses. In the intervention group at post-study, the question about ways for increasing consumption of healthy foods in the home received the most correct responses provided by 81% of the participants. The question on foods containing the most good fats received the least correct responses from participants in the intervention group at post-study (66%). In the control group at post-study, no question was answered right by more than 55% of the respondents.

Table 3: Number (%) of participants giving correct answer to nutrition education questions, Chacraseca 2018

Question	Baseline			Post-study		
	Intervention (n=48)	Control (n=47)	P[a]	Intervention (n=48)	Control (n=47)	P[a]
Mean knowledge scores	24.1 ± 11.4	26.1 ± 15.1	NS	72.2 ± 12.9	33.3 ± 17. 7	<0.001
Mean change in knowledge	-	-	-	48.1 ± 25.8	7.2 ± 26.2	<0.001
What foods contain the most sodium?	17 (35.1)	22 (46.9)	NS	37 (77.2)	25 (54.2)	<0.05
How can one manage their weight to stay healthy?	6 (13.2)	6 (12.5)	NS	35 (72.8)	10 (21.9)	<0.001
One fact about my plate is that;	3 (6.1)	4 (8.3)	NS	34 (71.1)	20 (41.7)	<0.05
Which of the following foods contains the mostly good fats?	9 (19.3)	5 (11.5)	NS	32 (66.7)	18 (37.5)	<0.05
What ways can we increase consumption of health meals in the home?	21 (43.9)	22 (45.8)	NS	39 (81.6)	25 (54.2)	<0.05
What is true about chronic diseases?	10 (20.2)	8 (16.7)	NS	38 (78.9)	24 (50.0)	<0.001
What role can you play to ensure the community has continued access to nutritious food?	18 (36.8)	17 (36.5)	NS	39 (80.7)	19 (40.6)	<0.001
Which of these is not a risk factor for chronic diseases?	11 (23.7)	16 (34.4)	NS	37 (76.3)	23 (49.0)	<0.05
Which of the following is a good health practice?	21 (43.9)	24 (50.0)	NS	40 (83.3)	23 (49.0)	<0.001
Which of these statements is not true?	15 (30.7)	13 (27.1)	NS	32 (67.5)	24 (52.1)	<0.05

[a] scores were compared using the SAS GLIMMIX procedure
Between group comparisons were done using SAS proc MIXED MODEL
P < 0.001, paired t-test with SAS PROC MIXED

Most participants in the control group at post-study provided correct responses to questions about foods containing the most sodium and ways of increasing consumption of healthy foods within the home. The question about ways of managing body weight received the least correct responses from participants in the control group at post-study.

The 24-hour Dietary Recall

At baseline, the average energy intake for the intervention and control group was 1457.7 ± 671.9 and 1361.4 ± 622.4 Kilocalories, respectively (Table 4). There were no observed significant changes in energy intake between the intervention and control groups at baseline ($p < 0.47$) and at post-study ($p < 0.39$). However, from baseline to post-study, energy intake increased by 44 kilocalories in the intervention group and by 291 kilocalories in the control group. There was no significant difference in protein intake at baseline or at post-study for both the control and intervention groups. Average protein values for the post-study in both the intervention and control groups were less than those at baseline. The decrease in mean protein values from baseline to post-study was similar between the intervention and control groups. However, there were no observed significant differences in protein intake between groups at both time periods.

Similarly, at both time periods there were no observed significant differences in the intervention and control groups for average values of fat, carbohydrates, fiber, vitamin E, vitamin C, potassium, calcium, phosphorus and iron. However, in comparison with the control group, there was an observed significant decrease ($p = 0.33$) in sodium intake for the intervention group. Sodium intake decreased by an average of 644 mg in the intervention group and by 40 mg in the control group, creating a statistical significant difference at post-study that wasn't observed at baseline. At baseline and at post-study there was a significant difference in mean Vitamin A intake between the intervention and control group.

Table 4: Nutrient values (units/day) derived from 24-hour dietary recalls of participants, Chacraseca, 2018

	Baseline			Post-study		
Nutrient	Intervention (n=48)	Control (n=47)	p value	Intervention (n=48)	Control (n=47)	p value
Energy* (Kcal)	1457.7±671.9	1361.4±622.4	0.47	1501.2±421.3	1652.3±494.2	0.39
Protein (g)	64.7±52.8	60.8±34.5	0.67	59.2±41.5	55.21±13.9	0.68
Fat (g)	46.8±32.3	41.5±21.5	0.35	42.6± 27.1	44.3±13.9	0.33
Carbohydrates (g)	199.4±105.4	183.8±102.1	0.47	204.1±99.4	195.2±100.1	0.49
Fiber (g)	20.5+10.7	18.2±11.4	0.33	22.9±9.3	24.7±12.5	0.29
Vitamin A (µg)	1256±203.1	608.6±547.4	**0.04**	1009±450.2	511±308.7	**0.04**
Vitamin E (mg eq.)	1.6±1.3	1.6±1.6	0.89	1.4±2.3	1.5±1.8	0.79
Vitamin C (mg)	372.5±1173.2	129.5±373.7	0.18	393.2±411.3	115.4±215.5	0.21
Sodium (mg)	1694.5±1041.9	1630.9±1083.9	0.77	1050.6±908.4	1590.5±1010.2	**0.03**
Potassium (mg)	1525.3±803.2	1497.9±822.4	0.87	1450.8±781.1	1500.1±850.9	0.74
Calcium (mg)	790.4±1355.1	474.7±495.9	0.14	660.3±1200.5	330.3±420.7	0.13
Phosphorus (mg)	705.8±275.3	717.7±331.3	0.84	690.6±301.2	712.3±300.9	0.77
Iron (mg)	8.5±7.2	8.2±6.8	0.72	9.0±7.0	8.3±6.1	0.51

*Energy is not a nutrient

At baseline, the intervention group had higher vitamin A intake values compared to the control group, (1256 ± 203.1 and 608.6 ± 547.4, respectively). The significant difference in Vitamin A intake persisted at post-study with values of 1009 ± 450.2 and 511 ± 308.7, respectively.

Number of Meals per Day

Results showed that at both baseline and post-study, all participants in the intervention group had at least one meal (Table 5). For this study, a meal was defined as food eaten on regular occasions of breakfast, lunch and dinner. At both study periods in both groups, more participants had three or more meals compared to those who had one or two meals. There was a slight increase in the number of participants who had three or more meals in both the intervention and control groups. The number of participants consuming two meals declined seven to five in both the control and intervention group. Conversely, the number of participants having three or more meals increased by two in the intervention group and by one in the control group. However, one participant in the control group dropped from consuming two meals per day to consuming only one meal.

Table 5: Number of meals per day for the intervention and control group, Chacraseca, 2018

	Baseline		Post-study	
Meals/day	Intervention (n=48)	Control (n=47)	Intervention (n=48)	Control (n=47)
One meal	0	1 (2.1%)	0 (2.2%)	2(4.3%)
Two meals	7 (14.6%)	7 (14.9%)	5(10.4%)	5(10.6%)
≥ three meals	41 (85.4%)	39 (83%)	43(89.6%)	40(85%)

Based on the MyPlate categories (Table 6), for both the intervention and control groups, protein foods (for example; beans, beef and chicken) and grains (for example; rice, oatmeal, and corn) were the most consumed foods in the past 24 hours followed by dairy (milk and cheese) and fruits (for example; mangoes, papayas, lemons, oranges and bananas). At baseline, the number of participants consuming vegetables (for example; squash, pipian, and bell peppers) were more in the intervention group (n = 19) compared to the control group (n = 17). At post-study, the number of participants consuming vegetables increased by three in the intervention group but decreased by two in the control group. Vegetables were the least consumed food group at both baseline and at post-study in the intervention and control groups. The number of participants consuming fruits increased 31 to 36 from baseline to post-study in the intervention group but increased by one in the control group. Almost all participants consumed grain foods at baseline and post-study in the control and intervention group. Grain consumption did not differ much from baseline to post-study for both the intervention and control groups.

Table 6: Food group classification (MyPlate) of participants, Chacraseca, 2018

	Baseline		Post-study	
Food Group	Intervention (n=48)	Control (n=47)	Intervention (n=48)	Control (n=47)
Vegetables	19 (39.6)	17 (36.2)	22 (45.8)	15 (31.9)
Fruits	31 (64.6)	32 (68.1)	36 (75)	33 (70.2)
Grains	48 (100)	46 (97.9)	48 (100)	47 (100)
Protein foods	46 (95)	46 (97.9)	43 (89.6)	45 (95.7)
Dairy	37 (77.1)	35 (74.5)	32 (66.7)	36 (76.6)

The values in parentheses represent percentage number of participants

At post-study, the number of participants consuming protein foods decreased by three in the intervention group and by one in the control group.

Discussion

The present study was designed to assess the impact of garden-based nutrition education on nutrition knowledge and nutrient intake in Nicaragua. Nutrition knowledge was assessed for the intervention and control groups after conducting nutrition education lessons to the intervention group. Food consumption was collected using the 24-hour dietary recalls and the nutritional content of the recorded foods was determined.

Nutrition Knowledge

At baseline, there was no significant difference in nutrition knowledge of participants between the control and intervention group. However, after three weeks of nutrition education the number of participants having correct responses to each question differed significantly between the intervention group and the control group. The difference in knowledge scores could be an indication that participants in the intervention group gained more understanding on nutrition topics presented.

In the present study, it was observed that nutrition education resulted in a greater mean increment in knowledge of participants in the intervention group compared to the control group. Other researchers reported a significant difference in nutrition knowledge ($p < 0.0001$) between household participants that received both nutrition education and gardening as compared to control households that received neither (Jones, Specio, Shrestha, Brown, & Allen, 2005). The study by Jones et al. (2005) was done over a period of three years and involved 418 participants. Different from the present study, Jones et al. (2005) conducted a cross-sectional assessment at the end of the three years and did not have baseline results for comparison with post-study results (Jones, Specio, Shrestha, Brown, & Allen, 2005).

The 24-hour Dietary Recall

Sodium

Besides a decrease in sodium intake, there was no significant increase in intake of energy, vitamins, other minerals and macronutrients. The decrease in sodium intake was reflected from the decreased consumption of cheese. Like other processed foods, cheese is likely to contain added sodium. Decrease in sodium intake could also have been due to the decreased practice of adding table salt to fruits, salad and fruit juices as reported in the 24-hour dietary recalls. Through nutrition education, participants may have gained knowledge that excess sodium was harmful for their health and thus reduced intake of foods high in sodium.

Energy

Energy intakes for the control and intervention groups at baseline and at post-study were below the estimated energy requirement of 2400 kilocalories for a sedentary adult (National Academy of Sciences, 2018). Even after nutrition education, the energy intake for the intervention group reported through the 24-hour recall did not significantly differ from that of participants in the control group. Having low energy intake may affect daily activity and reduce individual productivity. Low energy may also indicate inadequate intake of major energy providing nutrients of carbohydrates, proteins and fats. Even though energy intakes were below the recommended levels, after nutrition education, the intervention group showed greater increase in energy intake compared to crop group, (Table 4). Besides decreased energy to perform work, decreased energy intake may be complicated by conditions of deficiency for protein, carbohydrates and fats. A deficiency of proteins and carbohydrates

Other researchers reported energy levels higher than those reported in the present study. The FAO reported energy intakes of 2190 Kcal/day (FAO, 2010). In Latin America, average energy intake was reported to be higher among urban dwellers compared to those in rural areas

(Bonilla-Chacin, Vazquez, Sierra, & Aldana, 2013), but the FAO reported energy intakes for the general Nicaraguan population (FA), 2010). Other researchers reported average energy intake values of 1794 Kcal/day (Frausto, 2015) and 1159 Kcal/day (Bonilla-Chacin, Vazquez, Sierra, & Aldana, 2013) in rural poor communities of Nicaragua, values that were within ranges reported in the present study.

With the low energy intake reported in the present study, it would be expected that intervention participants would have lower levels of obesity. However, researchers for the present study reported overweight values of over 29% in Chacraseca. The WHO reported overweight rates of 46% in Nicaragua populations (WHO, 2016). The latter statistic combined values for urban and rural communities yet rural communities have been reported to have lower energy intakes and thus lower levels of obesity (Bonilla-Chacin, Vazquez, Sierra, & Aldana, 2013).

Protein

In the present study, there was no significant differences in intakes of macronutrients (proteins, fats and carbohydrates) between the intervention and control groups at baseline and at post-study. At baseline and at post-study for the intervention and control groups, intakes of protein were within ranges of 55 to 65 g/day. Protein intake values in the present study were close to the 44 to 51 g/day of protein intake in the average Nicaragua populations reported by FAO (FAO, 2010) and within the recommended dietary allowance of 46 to 56 g/day set by the National Academy of Sciences (National Academy of Sciences, 2018). Almost all participants in the intervention and control groups reported to have consumed protein foods in the past 24 hours hence the observed high protein intake values. The NutriSurvey revealed that beans were the

most common source of protein and that they were consumed by almost all participants at almost every meal.

Carbohydrate

Similar to protein intake, there was no significant difference in carbohydrate intake between the intervention and control group at baseline ($p = 0.47$) and post-study ($p = 0.49$). The average carbohydrate intake in the present study was between 183 g/day to 205 g/day. These intake values are at least 50 g above the130 g/day recommended dietary allowance (National Academy of Sciences, 2018). Over 98% of participants reported consuming grains and beans in the past 24 hours of the dietary recall (Table 6). Rice and beans are the primary food staples in Chacraseca and are major carbohydrate containing foods. As such, the general consumption of grains and beans was reflected in the relatively high carbohydrate intake from the 24-hour recall.

Fat

In the present study, fat intake was between 41 g/day to 44 g/day. These values are below the recommended daily allowance of above 65 g/day (National Academy of Sciences, 2018) and below the average fat intake of 60.2 g/day recommended by the World Bank. Results for fat intake in the present study were in ranges of those reported for rural poor communities in Nicaragua (Bonilla-Chacin, Vazquez, Sierra, & Aldana, 2013). The low fat intake was reflected in the low percentage of participants consuming dairy foods (mainly, cheese and milk) in the MyPlate compared to other food groups, (Table 6) and this may be responsible for the lower than recommended daily energy intake values reported, (Table 4).

Fiber

Additionally, the present study reported a non-significant increase in fiber intake for both the intervention and control group ($p = 0.33$ and $p = 0.29$ at baseline and post-study respectively)

with values ranging from 18 g/day to 24 g/day, (Table 4). The control group showed a 4 g/day increase in fiber compared to the 2 g/day increase in the intervention group. These values were, however, on the lower range of the recommended daily dietary requirement of between 21 to 38 g/day (National Academy of Sciences, 2018) but were within the average intake of 21.73 g/day reported for Nicaragua populations by the World Bank (Bonilla-Chacin, Vazquez, Sierra, & Aldana, 2013). The low analytical fiber values were reflective of the low fruit and vegetable intakes, (Table 6). Given significant increase in knowledge scores in the intervention group and slight increase in fruits and vegetable intake as well as a decline in intake of protein (mainly meat foods) and dairy (mainly sodium containing cheese), a longer study design would probably show intake of nutrients within the recommended daily values.

Conclusion

The present study evaluated how gardening along with nutrition education influenced knowledge and nutrient intake among participants in Chacraseca, Nicaragua. Topics for nutrition education were developed based on the community nutrition education logic model and tailored to capture elements of the social ecological model. Based on the results, it can be concluded that nutrition education improves knowledge scores. The improvement in knowledge among participants may indicate the possibility of making healthy lifestyle choices. This may be necessary to prevent diseases and to improve the quality of life.

The improvement in knowledge among participants in the intervention group was reflected in the decreased intake of sodium but not in intake of other nutrients. This may have been because before the nutrition education, participants reported adding table salt to fruits and salads and that table salt was being added to home-made cheese. Since table salt can be

physically added to foods, researchers for the present study assumed that it was easy for participants to reduce sodium intake compared to changing intake of nutrients naturally present in foods. The decrease in sodium intake was further supported by decreased intake of processed dairy foods (mainly home-made cheese) that may still be a result of nutrition education.

The 24-hour dietary recall, however, revealed increase in the number of participants consuming vegetables and fruits in the intervention group compared to the control group further supporting gain of nutrition knowledge. The increase in fruit and vegetable consumption can be linked to both home gardening and nutrition education. To the best of researchers' knowledge, the present study is the first intervention – control longitudinal study to report the impact of garden-based nutrition education on nutrition knowledge and nutrient intake using an adult population in a rural community setting.

Strengths

In the present study, researchers recruited 48 participants in the intervention group and 47 participants in the control group. All participants recruited were maintained from baseline to post-study. Nutrition education was carried out successfully resulting in significant improvement in knowledge scores in the intervention group. The decline in sodium intake and the increase in vitamin A intake from foods is an indication that nutrition education may play a role in managing nutrient intake. Evidence for the improvement in nutrition knowledge was supplemented by; greater increase in the consumption of fruits and vegetables in the intervention, decreased intake of protein foods (mainly meat) and decreased in intake of sodium and fat containing dairy foods (mainly cheese). Another strength was that the baseline and post-studies were done during the

same seasons (summers of 2016 and 2017) hence minimizing differences in food intake due to different seasons.

Limitations and Recommendations

Even though the present study was organized to researchers' satisfaction at every stage, several limitations could be mitigated in future studies. First, nutrition evaluation tools including 24-hour recalls and food frequency recalls rely on participants' ability to remember what foods were consumed in the past days. The ability to recall foods may vary between individuals based on participants' memory and concentration levels. A better-formulated study design would be one in which participants were asked to make a food log immediately after every daily meal. Additionally, during analysis researchers in the present study relied on NutriSurvey software to determine the nutrients in the different foods. The NutriSurvey software is pre-installed with foods that may have significantly different nutrition content than traditional foods found in Chacraseca foods. A well-designed study would use nutrient content of traditional foods or even have researchers do nutrient analysis for the specific foods reported in the 24-hour recall. Currently there exists no database containing nutrient content of foods produced and consumed in Nicaragua. Despite the study limitations, the present study is one of a few that reported improved nutrition knowledge within adult populations in rural communities in developing countries.

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CHAPTER VI: OVERALL CONCLUSION AND RECOMMENDATIONS

General Conclusions

In response to high rates of food insecurity in Nicaragua, several interventions have targeted the increase in food access, availability, utilization and stability. Nevertheless, 17% of Nicaraguans still struggle chronic undernourishment (FAO, 2017a). Given that Agriculture is one of the major income generating activities within Nicaragua, it is seen a more feasible alternative for improving food security. With climate change, it is predicted that Nicaragua will experience extreme weather conditions (Solé et al., 2016). The changing climate may increase the cost of agricultural inputs thus making farming a lesser option for small holder farmers who largely depend on agriculture for survival. However, home gardening that involves crop and animal husbandry on small manageable plots within walking distance from human dwelling is an effective strategy to curb food insecurity among small holder farmers especially in developing countries (Niñez, 1987)

The presented study demonstrated that through community based participatory research, stakeholders identified home gardening and nutrition education as priority interventions for improved food security and health in Chacraseca. There is limited research showing the effectiveness of home gardening in improving food security and health in developing countries; however, the present study showed that home gardening had a potential of increasing household food access and food availability. With increase in global food prices (FAO, 2013), home gardening may be an effective strategy to provide enough food to households. In addition, increasing access and availability to foods through home gardening may lead to improved health within communities by reducing reliance on unhealthy highly processed foods.

Even with improved food access and availability through home gardening, communities may still present with high levels of malnutrition if the available food is not effectively utilized. Researchers in the present study coupled home gardening with nutrition education to improve utilization of food. This research demonstrated a significant improvement in nutrition knowledge among participants, which may translate into effective food utilization. This improvement in nutrition knowledge may indicate that participants are able to make healthy decisions regarding utilization of food which may be helpful in prevention of obesity, stunting and chronic diseases. In addition, researchers for the present study designed nutrition education topics based on principles of the social ecological model. This was relevant to show participants how they can be involved in ensuring behavioral changes at any level of the society.

Both improvements in food security and nutrition knowledge may be important in reducing the rate of food insecurity in Chacraseca. The reduction in food insecurity may translate into reduction in obesity due to increased availability of healthy foods especially if the participants get involved in regular physical activities. This may further reduce levels of hypertension which were determined to be over 40% in the present study. In addition to reduction in rates of obesity, improvement in food security and nutrition knowledge may lead to reduced levels of child stunting. Reduction in overweight and stunting may increase productivity and ultimately lead to increased national income. In addition, improved health and food security may lead increased academic achievement and acquisition of skills necessary to compete in the job industry. This may lead to improvement in the gross domestic product and a reduction in poverty levels which may be reflected in improved living standards.

Recommendations for Future Research

a. Researchers for the present study recommend promotion of home gardening and nutrition education for longer periods of time than those used in the present study may possibly lead to better health and food security outcomes.

b. Given that the present study was a pilot, researchers recommend use of larger sample sizes to yield results that are more representative of the study area and increase chances of replicability.

c. At least three 24-hour recalls should be done for each participant on different days within the same study period or to use the diet record method to ascertain that food intake is reflective of participants' average diets.

d. Additionally, researchers in the present study recommend that the control and intervention group be selected from different communities to avoid confounding variables.

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Appendix A: Focus Group Questions

Chacraseca Focus Group Needs Assessment and Nutrition Education Program Layout

Date:

Get to the venue at least 45 minutes early

Set up

Materials: Paper, pens, flip chart, highlighters, tape, digital recorders, sign-in sheet, map, folders, consent forms

Greet each participant, shaking their hands as they arrive and personally introducing yourself.

When everyone is seated:

My name is Joel Tumwebaze from Auburn University

Thank you for agreeing to be part of a focus group on community food availability. For those of you who have never participated in a focus group, I just want to tell you that it is a way of collecting information from groups of people who are knowledgeable about life their life situations. Your answers to our questions will not be considered "right" or "wrong" rather, they are information that you can supply based on your experiences, observations, or feelings. Please be open, honest, be courteous and respectful of others opinions. This discussion will also be audio recorded for data analysis purposes.

We are collecting information about the community and barriers its food availability- whether people have enough resources and ability to access food. We are working with JustHope, Inc. who wants to understand if your community needs to improve the food resources available for all people.

Please be assured that all your responses are confidential and will be used for statistical purposes only. Our summary report will make no references to names.

Distribute consent forms, read aloud, ask if there are any questions (pause and give the group time to process),

This is a spatial map of Chacraseca. We will use this to mark specific locations in Chacraseca

I want to start by saying how difficult it can be to discuss these issues publicly. But almost everyone, if not everyone, in this group is familiar with these problems. There is nothing to be embarrassed about. Your honest responses and discussion will be most helpful to us as we try to develop a community-based action plan.

Before we begin, lets go around the room and introduce ourselves. But instead of telling us just your name, why not tell everyone your name, how long you have lived in this area, and what your three most favorite foods are?

Thank you for sharing a little about yourself. (Tell where restrooms are and when meal if available will arrive)

(START RECORDING)

(Part A: To be used for Focus group needs assessment)

What types of food are available in Chacraseca?

Where do most people in Chacraseca get their food?

Markets

How many markets are in Chacraseca?

What foods are available in the market?

Do you like foods from the market?

Why?

Why not?

How easy is it to get to the markets?

What forms of transport are available?

Distance to markets?

Do you find all the foods you always want to eat present in the markets?

How do you find food prices in markets?

Cheaper, why?

Expensive, why?

Are most foods consumed in Chacraseca produced within or are they shipped in from neighboring communities?

Home gardens

What major foods do you grow in the gardens?

Why do you grow food?

How much food do you sell and or eat? What determines the amount you sell or eat?

Do you store food for periods of scarcity?

If yes, how and how much?

Otherwise, why not?

What are the problems surrounding growing of food? (discuss each problem)

Do you find it cheaper to grow own food or to buy it from the market?

Do you prefer home grown food or food from the market? (why the preference)

In case you were to grow own food, what foods would you love to grow? (why or why not)

Community Gardens

Do you feel the community can work together to provide enough food for everyone?

Yes (How would the community work together?)

Why not? (give reasons)

Assuming you were given all the resources to grow own food, what foods would you grow and why?

How best can you manage a garden? (Resources available in that capacity)

Do you like working as a team? Discuss advantages and disadvantages

In case you were to manage a group project, where would you want it to be based? (probe for reasons of choice)

Now one last question, imagine that you have the opportunity to do something in the community to help people have easier time getting the types of foods that they want or need. What would you do? If no one makes suggestions, probe for the following:

Bring stores closer to our homes

Provide public transportation to large supermarkets

Start a food co-operative

Start farmers market in the community

Establish a community garden

Are there any other comments that you would like to share about Chacraseca? (Count to 30 before moving on)

Ok, thank you for participating in this discussion. Responses provided are very important for the betterment of Chacraseca (turn off recorder).

Appendix B: U.S. Household Food Security Survey Module: Six-Item Short Form

U.S. Household Food Security Survey Module: Six-Item Short Form

Economic Research Service, USDA

September 2012

FILL INSTRUCTIONS: Select the appropriate fill from parenthetical choices depending on the number of persons and number of adults in the household.

HH3. I'm going to read you several statements that people have made about their food situation. For these statements, please tell me whether the statement was often true, sometimes true, or never true for (you/your household) in the last 12 months—that is, since last (name of current month).

The first statement is, "The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

HH4. "(I/we) couldn't afford to eat balanced meals." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] Often true
[ ] Sometimes true
[ ] Never true
[ ] DK or Refused

AD1. In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?

[ ] Yes
[ ] No (Skip AD1a)
[ ] DK (Skip AD1a)

AD1a. [IF YES ABOVE, ASK] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

[ ] Almost every month
[ ] Some months but not every month
[ ] Only 1 or 2 months
[ ] DK

AD2. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?

[ ] Yes
[ ] No
[ ] DK

AD3. In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?

[ ] Yes
[ ] No
[ ] DK

Appendix C: Food Security Assessment Consent Form

The Auburn University Institutional Review Board has approved this Document for use from 05/09/2016 to 05/08/2017 Protocol # 16-125 EP 1605

Consentimiento informado (Spanish)

Seguridad alimentaria de los hogares de Chacraseca

Fecha: _____

(NOTA: NO ACEPTE PARTICIPAR, A MENOS QUE ESTE DOCUMENTO TENGA UN SELLO DE APROBACIÓN DE LA JUNTA DE REVISIÓN INSTITUCIONAL [INSTITUTIONAL REVIEW BOARD, IRB] CON FECHAS ACTUALES).

CARTA DE CONSENTIMIENTO INFORMADO

Le invitamos a participar en un estudio de investigación para ayudar a mejorar la disponibilidad y utilización de los alimentos y el acceso a ellos en Chacraseca. Joel Tumwebaze está llevando a cabo este estudio. Se le seleccionó para participar en este estudio porque reside en uno de los 11 sectores de Chacraseca con inseguridad alimentaria alta y tiene 19 años o más.

El propósito del estudio de hoy es recopilar información sobre la disponibilidad de alimentos y las estrategias de adaptación en tiempos de escasez y crear medios para mejorar la seguridad alimentaria en Chacraseca. Las conversaciones se grabarán para fines de transcripción. Si decide participar en este estudio de investigación, los investigadores le harán una serie de preguntas durante dos períodos de aproximadamente una hora y media cada uno, en dos momentos diferentes del año.

Existen mínimos riesgos previsibles en este estudio. A fin de garantizar su privacidad, todos los registros de audio se transcribirán sin ninguna información identificativa y luego se destruirán. Hoy, su tiempo total de compromiso será de aproximadamente una hora y media.

La participación en este estudio no tiene ningún costo. La información que proporcione ayudará a determinar las estrategias apropiadas para evitar y reducir la inseguridad alimentaria y mejorar la salud en su comunidad.

Iniciales del participante: _____

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Appendix D: Focus Group Discussion Consent Form

The Auburn University Institutional Review Board has approved this Document for use from 05/09/2016 to 05/08/2017 Protocol # 16-125 EP 1605

Printed Name

Consentimiento informado (Spanish)

Análisis grupal de Chacraseca

Fecha: _____

(NOTA: NO ACEPTE PARTICIPAR A MENOS QUE ESTE DOCUMENTO TENGA UN SELLO DE APROBACIÓN DE LA JUNTA DE REVISIÓN INSTITUCIONAL [INSTITUTIONAL REVIEW BOARD, IRB] CON FECHAS ACTUALES).

CARTA DE CONSENTIMIENTO INFORMADO

Le invitamos a participar en un estudio de investigación para ayudar a mejorar la disponibilidad y utilización de los alimentos y el acceso a ellos en Chacraseca. Joel Tumwebaze está llevando a cabo este estudio. Se le seleccionó para participar en este estudio porque reside en uno de los 11 sectores de Chacraseca con inseguridad alimentaria alta y tiene 19 años o más.

El objetivo del estudio de hoy es analizar las barreras percibidas que afectan la **disponibilidad de alimentos en la comunidad y crear medios para mejorar la seguridad alimentaria en Chacraseca.** Las conversaciones se grabarán para fines de transcripción. Si usted decide participar en este estudio de investigación, se le pedirá que sea miembro de la coalición comunitaria. Los investigadores le harán una serie de preguntas en dos períodos de aproximadamente una hora y media cada uno, en dos momentos diferentes del año.

Existen mínimos riesgos previsibles en este estudio. A fin de garantizar su privacidad, todos los registros de audio se transcribirán sin ninguna información identificativa y luego se destruirán. Hoy, su tiempo total de compromiso será de aproximadamente una hora y media.

La participación en este estudio no tiene ningún costo. La información que proporcione ayudará a determinar las estrategias apropiadas para evitar y reducir la inseguridad alimentaria y mejorar la salud en su comunidad.

Iniciales del participante: _____

35

Appendix E: The USDA Household Food Security Survey Module

U.S. HOUSEHOLD FOOD SECURITY SURVEY MODULE—SPANISH:
THREE-STAGE DESIGN, WITH SCREENERS
Economic Research Service, USDA
November 21, 2013

<u>Optional USDA Food Sufficiency Question/Screener: Question HH1</u> (This question is optional. It is not used to calculate any of the food security scales. It may be used in conjunction with income as a preliminary screener to reduce respondent burden for high income households).

HH1. [IF ONE PERSON IN HOUSEHOLD, USE FIRST FILL IN PARENTHETICALS, OTHERWISE, USE SECOND FILL.]

¿Cuál de las siguentes declaraciones describe mejor (su situación alimentaria / la situación alimentaria en su hogar) en los últimos 12 meses?

[1] Siempre (como / comemos) lo suficiente y los tipos de alimentos que (deseo / deseamos)
[2] (Como / comemos) lo suficiente pero no siempre lo que (deseo / deseamos)
[3] A veces no (como / comemos) lo suficiente o
[4] Frecuentemente no (como / comemos) lo suficiente
[ ] DK or Refused

<u>Household Stage 1: Questions HH2-HH4</u> (asked of all households; begin scale items).

[SELECT APPROPRIATE FILL IN PARENTHETICALS DEPENDING ON THE NUMBER OF PERSONS AND NUMBER OF ADULTS IN THE HOUSEHOLD.]

HH2. Ahora le voy a leer algunas declaraciones que las personas han hecho sobre situaciónes alimentarias. Para cada uno, favor de indicar si ha ocurrido <u>frecuentemente</u>, <u>a veces</u>, o <u>nunca</u> (a Ud. / en su hogar) en los últimos 12 meses, dese (mes coriente) del año pasado.

The La primera situación es "(Me preocupó / Nos preocupamos) que la comida se podía acabar antes de tener dinero para comprar más." (Para Ud. / En su hogar), ¿ésto ocurrió <u>frecuentemente</u>, <u>a veces</u>, o <u>nunca</u> en los últimos 12 meses?

[ ] Frecuentemente
[ ] A veces
[ ] Nunca
[ ] DK or Refused

HH3. La comida que (compré / compramos) no rindió lo suficiente, y (no tenía / no teníamos) dinero para comprar más." (Para Ud. / En su hogar), ¿ésto ocurrió <u>frecuentemente</u>, <u>a veces</u>, o <u>nunca</u> en los últimos 12 meses?

[ ] Frecuentemente
[ ] A veces
[ ] Nunca
[ ] DK or Refused

HH4. "(No tenía / No teníamos) recursos suficientes para comer comida variada y nutritiva." (Para Ud. / En su hogar), ¿ésto ocurrió <u>frecuentemente</u>, <u>a veces</u>, o <u>nunca</u> en los últimos 12 meses?

[ ] Frecuentemente
[ ] A veces

[ ] Nunca
[ ] DK or Refused

Screener for Stage 2 Adult-Referenced Questions: If affirmative response (i.e., "frecuentemente" or "a veces") to one or more of Questions HH2-HH4, OR, response [3] or [4] to question HH1 (if administered), then continue to ***Adult Stage 2;*** otherwise, if children under age 18 are present in the household, skip to ***Child Stage 1,*** otherwise skip to ***End of Food Security Module.***

NOTE: In a sample similar to that of the general U.S. population, about 20 percent of households (45 percent of households with incomes less than 185 percent of poverty line) will pass this screen and continue to Adult Stage 2.

Adult Stage 2: Questions AD1-AD4 (asked of households passing the screener for Stage 2 adult-referenced questions).

AD1. En los últimos 12 meses, ¿(Ud. / Ud. u otro adulto del hogar) redujo alguna vez la cantidad de sus comidas o dejó de desayunar, almorzar o cenar porque le faltaba dinero para alimentos?

[ ] Sí
[ ] No (Skip AD1a)
[ ] DK (Skip AD1a)

AD1a. [IF SÍ ABOVE, ASK] ¿Con qué frecuencia sucedió esto? Casi todos los meses, algunos meses pero no todos, o solamente en 1 ó 2 meses?

[ ] Casi todos los meses
[ ] Algunos meses pero no todos
[ ] Solamente en 1 ó 2 meses
[ ] DK

AD2. En los últimos 12 meses, ¿comió Ud. alguna vez menos de lo que pensaba que debía comer porque le faltaba dinero para alimentos?

[ ] Sí
[ ] No
[ ] DK

AD3. En los últimos 12 meses, ¿Tuvo Ud. hambre alguna vez pero no comió porque le faltaba dinero para alimentos?

[ ] Sí
[ ] No
[ ] DK

AD4. En los últimos 12 meses, ¿Perdió Ud. peso porque no comió los alimentos suficientes por falta de dinero para comida?

[ ] Sí
[ ] No
[ ] DK

Screener for Stage 3 Adult-Referenced Questions: If affirmative response to one or more of questions AD1 through AD4, then continue to ***Adult Stage 3;*** otherwise, if children under age 18 are present in the household, skip to ***Child Stage 1,*** otherwise skip to ***End of Food Security Module.***

NOTE: In a sample similar to that of the general U.S. population, about 8 percent of households (20 percent of households with incomes less than 185 percent of poverty line) will pass this screen and continue to Adult Stage 3.

Adult Stage 3: Questions AD5-AD5a (asked of households passing screener for Stage 3 adult-referenced questions).

AD5. En los últimos 12 meses, ¿alguna vez no comió (Ud. / Ud. u otro adulto del hogar) en todo el día porque le faltaba dinero para comida?

[ ] Sí
[ ] No (Skip AD5a)
[ ] DK (Skip AD5a)

AD5a. [IF SÍ ABOVE, ASK] ¿Con qué frecuencia sucedió esto? Casi todos los meses, algunos meses pero no todos, o solamente en 1 ó 2 meses?

[ ] Casi todos los meses
[ ] Algunos meses pero no todos
[ ] Solamente en 1 ó 2 meses
[ ] DK

Child Stage 1: Questions CH1-CH3 (Transitions and questions CH1 and CH2 are administered to all households with children under age 18) Households with no child under age 18, skip to ***End of Food Security Module.***

SELECT APPROPRIATE FILLS DEPENDING ON NUMBER OF ADULTS AND NUMBER OF CHILDREN IN THE HOUSEHOLD.

Transition into Child-Referenced Questions:
Ahora le voy a leer algunas declaraciones que las personas han hecho sobre la situación alimentaria de sus niños. Para cada uno, favor de indicar si ocurrió frecuentemente, algunas veces, o nunca en los últimos 12 meses a niños o jóvenes menores de 18 años que viven en su hogar.

CH1. "(Tuve / Tuvimos) que alimentar a los niños o jóvenes del hogar con alimentos de poca variedad y bajo costo porque se nos acababa dinero para alimentos." En su hogar, ¿ésto ocurrió frecuentemente, a veces, o nunca en los últimos 12 meses?

[ ] Frecuentemente
[ ] A veces
[ ] Nunca
[ ] DK or Refused

CH2. "No (pude / pudimos) alimentar a los niños o jóvenes del hogar con comida variada y nutritiva porque nos faltaba dinero para alimentos." En su hogar, ¿ésto ocurrió frecuentemente, a veces, o nunca en los últimos 12 meses?

[ ] Frecuentemente
[ ] A veces
[ ] Nunca
[ ] DK or Refused

CH3. "Los niños or jóvenes del hogar no comían lo suficiente porque nos faltaba dinero para comprar alimentos." En su hogar, ¿ésto ocurrió frecuentemente, a veces, o nunca en los últimos 12 meses?

[ ] Frecuentemente

[ ] A veces
[ ] Nunca
[ ] DK or Refused

Screener for Stage 2 Child Referenced Questions: If affirmative response (i.e., "frecuentement" or "a veces") to one or more of questions CH1-CH3, then continue to ***Child Stage 2;*** otherwise skip to ***End of Food Security Module.***

NOTE: In a sample similar to that of the general U.S. population, about 16 percent of households with children (35 percent of households with children with incomes less than 185 percent of poverty line) will pass this screen and continue to Child Stage 2.

Child Stage 2: Questions CH4-CH7 (asked of households passing the screener for stage 2 child-referenced questions).
NOTE: In Current Population Survey Food Security Supplements, question CH6 precedes question CH5.

CH4. En los últimos 12 meses, ¿(Redujo / Reducieron) alguna vez la cantidad de la comida de un niño o joven del hogar por falta de dinero para comprar alimentos?

[ ] Sí
[ ] No
[ ] DK

CH5. En los últimos 12 meses, ¿alguna vez algun niño o joven del hogar dejó de desayunar, almorzar o cenar por falta de dinero para alimentos?

[ ] Sí
[ ] No (Skip CH5a)
[ ] DK (Skip CH5a)

CH5a. [IF SÍ ABOVE, ASK] ¿Con qué frecuencia sucedió esto? Casi todos los meses, algunos meses pero no todos, o solamente en 1 ó 2 meses?

[ ] Casi todos los meses
[ ] Algunos meses pero no todos
[ ] Solamente en 1 ó 2 meses
[ ] DK

CH6. En los últimos 12 meses, ¿alguna vez, un niño o joven del hogar tuvo hambre pero faltaba dinero para comprar más alimentos?

[ ] Sí
[ ] No
[ ] DK

CH7. En los últimos 12 meses, ¿alguna vez un niño o joven del hogar no comió en todo el día porque faltaba dinero para alimentos?

[ ] Sí
[ ] No
[ ] DK

Appendix F: SAS code for LDA

```
setwd("//spirit.auburn.edu/itb0004/Desktop/Joel Work")
data<-read.csv("Tumwebaze.csv")

data$fstatus<- ifelse(data$fstatus == "FS", "secure",
                      ifelse(data$fstatus=="INS", "insecure", NA))
data$fstatus  <- as.factor(data$fstatus )

set.seed(2)

index <- sample(1:nrow(data), nrow(data)/2)

train <- data[-index,]

test <-data[index,]
```

Linear discriminant analysis

```
library(MASS)
## Warning: package 'MASS' was built under R version 3.4.4
lda.fit<-lda(fstatus~.,data=data[,-1])
## Warning in lda.default(x, grouping, ...): variables are collinear
lda.fit
## Call:
## lda(fstatus ~ ., data = data[, -1])
##
## Prior probabilities of groups:
## insecure    secure
##   0.6        0.4
##
## Group means:
##                 income_sFactory    income_sFarming      income_sHired labor
## insecure        0.0000000           0.4444444           0.3333333
## secure          0.3333333          0.0000000           0.0000000

##                 income_sJustHope    income_ business      income_sTeaching
## insecure         0.0000000           0.0000000           0.2222222
## secure           0.3333333           0.1666667           0.0000000
##
                   Land_Own      H_size
## insecure        2.888889       5.111111
## secure          2.666667       4.166667
##
## Coefficients of linear discriminants:
##                                  LD1
## income_sFactory            3.6847247
## income_sFarming            2.5713900
## income_sHired labor       -1.7208192
## income_sJustHope           7.2770850
## income_sOwn business       4.5527516
## income_sTeaching          -1.4609324
## Land_Own                  -0.7783810
## H_size                    -0.4890387
pred = predict(lda.fit,data[,-1])
names(pred)
## [1] "class"     "posterior" "x"
table(data[,-1]$f_status,pred$class) 27;52 hyenas have the strongest bite of any mammals;  40;14 crocodiles have the strongest bite of any animal
##
##             insecure secure
##   insecure     9       0
##   secure       0       6
```

Appendix G: The Social Ecological Model