The Impact of a Combined Horticultural and Peer-Led Nutrition Education Intervention on Usual Food Use Among Rural Kenyan Women

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ABSTRACT

Food insecurity, which is an issue of impaired access to and insufficient quantities of food, affects one-third of Kenyan households and is associated with monotonous starch based diets. A multi-sector approach, linking agriculture interventions with nutrition education, have been shown to be effective in reducing food insecurity and improving dietary intakes but few evaluations of such interventions have been conducted in Kenya. This project assessed the impact of a combined horticultural and peer-led nutrition education intervention on usual food use among rural Kenyan women. A pre-post quasi-experimental design was used with an intervention group, a women's self-help group, receiving the combined intervention and a comparison group receiving no intervention. The main outcome, usual food use, was assessed via a food frequency questionnaire during in home interviews. A higher proportion of women in the intervention group consumed orange-fleshed sweet potatoes (OFSP) on a weekly basis ($p=0.04$), relative to the comparison group. In the intervention group, there were few differences in food use prior to and following the combined intervention or between those with the full horticultural intervention (rainwater tanks, drip irrigation) relative to those with the partial intervention. The results of this study suggest that the combined horticulture and peer led nutrition education intervention positively affected the women's consumption of a pro-vitamin A rich food (OFSP) that was a key focus of both the components of the intervention. Results will be used to design future interventions designed to improve diet quality and food insecurity among Kenyan women.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

In the East African country of Kenya, approximately one-third of households are considered food insecure (Grace et al., 2014). Food insecurity in developing countries is understood as an issue of inadequate food quantity, resulting from a combination of impaired access to and insufficient quantities of food (Coates et al., 2006; Tamiru et al., 2017). Diet quality within food insecure households is also an issue due to the predominant monotonous diets being consumed which are high in cereal-based foods and low in fruits, vegetables and animal protein sources (Berti, Faber & Smuts, 2014).

One serious consequence of food insecurity is malnutrition, which continues to be a major challenge worldwide, with at least 805 million individuals suffering from chronic hunger (FAO, 2014). Malnutrition and food insecurity greatly impact sub-Saharan African countries due to natural disasters such as drought conditions and flooding, as well as slow income growth, high poverty rates, impaired health status, limited rural infrastructure and increasing food prices (FAO, 2014; IPCC, 2001; Costello et al., 2009). This area is also experiencing an increasing prevalence of inadequate micronutrient intake such as iron and vitamin A (FAO, 2005; UNICEF 2008). Micronutrient malnutrition has a wide-range of consequences, affecting health, learning ability and productivity (WHO & FAO, 2006). Risk factors for micronutrient malnutrition include poverty stricken areas, low intake of animal food sources, monotonous diets, seasonal variation in food availability and many others (WHO & FAO, 2006).

To decrease malnutrition and food insecurity, a multi-sector perspective has been recommended, linking agriculture interventions with nutrition education. Evidence suggests that the horticulture component of agriculture interventions, including home

garden programs, have the ability to increase fruit and vegetable production and consumption (McDermott et al., 2013), while dairy projects are able to increase milk consumption, income, improve dietary diversity, food security and nutritional status (Ellis et al., 2004). Combining horticultural interventions with nutrition education has been identified as an effective means of decreasing micronutrient malnutrition and food insecurity in developing countries, like Kenya (Bhattacharjee, 2007; Bhaskar et al., 2017; McDermott et al., 2013).

Since 2010, Farmers Helping Farmers (FHF), a Canadian non-governmental organization, has partnered with UPEI in implementing a combined horticulture and nutrition education intervention in women who belonged to a women's self-help groups in the Meru region of Kenya. The horticultural intervention included the installation of drip irrigation and water tanks, horticultural training, and the provision of seeds and cuttings for micronutrient-dense (nutritious) crops. It was intended to improve women's farming practices, enabling them to grow more nutritious vegetables and fruit. The nutrition education component used a peer-led education method to teach and demonstrate how to improve the nutritional content of traditional meals. The peer-led method was chosen due to its positive effect on family and community nutrition (Martin et al., 2015; Yip et al., 2015). Further, participants who receive peer-led teaching highly value the experience (Kannan et al., 2010). Nutrition messages were developed to encourage women to use the promoted horticulture crops in their staple foods, to modify cooking practices to preserve nutrients such as iron and vitamin A and develop a greater understanding of the nutritional importance of these foods for them and their families. Results of a previous three-year combined intervention found a decrease in household

food insecurity and an increase in diet diversity among rural Kenyan women, over a four year period (Gamble et al., 2013). Since women's dietary intakes were collected over a single 24-hour period, it was not possible to assess the impact of the combined intervention on women's usual food intake over a longer period. This is important since women may not consume the recommended foods in the 24-hour period, and some foods may be consumed less often, yet still contribute to their overall nutritional status.

As a follow up to our previous work in Meru district, Kenya (Gamble et al., 2013), a larger three-year project was initiated in 2016 in nearby Naari, Kenya. This larger project was conducted in partnership with FHF, Kenyatta University, the University of Nairobi and Naari Dairy Cooperative Society. This larger project assessed the impact of nutrition education, dairy and horticultural interventions on food security, household livelihoods and food use among farm women in Naari, Kenya. The current research, a component of this larger study, was conducted in 2017 and assessed the impact of a combined horticultural and peer-led nutrition education intervention on usual food use of rural Kenyan women.). The frequency of food consumption and average daily intakes (ADI) were compared between women who received a combined horticultural and peer-led nutrition education intervention and a comparison group who did not receive the intervention. In addition, the full horticulture intervention, including drip irrigation, water collection tanks, training and other inputs, was provided gradually to the women as FHF resources were available, women receiving the full versus a partial intervention (seeds, horticultural training) were compared in terms of usual food use. The funding for this project came from The Canadian Queen Elizabeth II Diamond Jubilee Scholarship program https://www.queenelizabethscholars.ca/.

The following are the study objectives:

1.1 Research Objectives

The overall aim of this project was to assess the impact of a combined horticultural and peer-led nutrition education intervention on usual food use of rural Kenyan women. The objectives of the research are:

1) To assess differences in the frequency of food use and average daily food intakes between members of a women's self-help group receiving a horticulture and peer-led nutrition education intervention and a comparison group not receiving the intervention.
2) To assess differences in the frequency of food use and average daily food intakes of women in the intervention group prior to and following the nutrition education intervention.
3) To assess differences in the frequency of food use and average daily food intakes between members of a women's self-help group according to partial or full horticultural intervention, prior to and following the intervention.
4) To assess differences in frequency of food use between members of a women's self-help group receiving a combined horticultural and peer-led nutrition education intervention and a comparison group, according to demographics such as age, education, occupation, livestock and land ownership.

2. LITERATURE REVIEW

This study was a component of a larger three-year project based in Naari, Kenya, which aimed to improve family nutrition, food security and the livelihoods of smallholder women dairy farmers within the community. Smallholder farmers have limited land to grow required crops and to raise farm animals. The improvements were to be achieved through nutrition education and horticultural and dairy interventions.

2.1 Food Insecurity and Malnutrition

In the East African country of Kenya, approximately one-third of households are considered food insecure (Grace et al., 2014). Food insecurity in developing countries is understood as an issue of inadequate food quantity, resulting from a combination of impaired access to and insufficient quantities of food (Coates et al., 2006, Tamiru et al., 2017; Grace et al., 2014). Diet quality within food insecure households is also an issue due to the predominant monotonous diets being consumed, which are high in cereal-based foods (Berti, Faber & Smuts, 2014).

Food insecurity in this area is affected by a combination of many factors. These include natural disasters such as drought conditions and flooding, increased rates of poverty, slow income growth, impaired health status, population growth, military conflicts, pest outbreaks, limited land holdings and increasing food prices (IPCC, 2001; Costello et al., 2009; Kenneth, 2016; Food and Agriculture Organization, 2014).

A consequence of food insecurity, malnutrition, is still one of the most widespread health problems, negatively impacting health, economy and social progress, particularly in developing countries (Thompson & Amoroso, 2014). From the more than 800 million individuals globally who are suffering from chronic hunger, 204 million of those are from

sub-Saharan Africa. The prevalence of chronic hunger has continued to worsen over time (Bain et al, 2013). Malnutrition is also affected by climate change, due to developing countries relying heavily on agriculture as a source of income, giving natural disasters, such as drought, the power to increase health and food security risks (USGCRP, 2008; Huynen, 2013).

Food insecurity is an issue that has always and still greatly affects many sub-Saharan African countries (FAO, 2014). This is closely connected to the high level of poverty that exists within the country, especially within the rural areas (Grace et al., 2014; Kenneth, 2016). Kenya is classified as a low-income food-deficit country by the FAO and has continued to struggle with food insecurity, which is linked to their prevalence of diseases within livestock, decreased cereal production, increasing food prices and poor amounts of rainfall (FAO, 2006; M'kaibi et al., 2015). The inability to have access to enough nutritious foods leads to malnutrition and micronutrient deficiencies in children, which later can cause cognitive and physical deficits (M'kaibi et al., 2015). From its effects during childhood, food insecurity can result in morbidity, mortality, low educational achievement, developmental deficits, poor mental health and negatively impacts reproduction and physical work capacity in adulthood (M'kaibi et al., 2015; Schmeer & Piperata, 2016; Jyoti, Frongillo, Jones, 2005; Alaimo, Olson, Frongillo, 2001; Jones, 2017). This cyclic relationship between food insecurity and malnutrition makes it challenging to address. If one becomes food insecure, their diet and health may suffer, and if disregarded for a long enough time, this can lead to becoming malnourished. Once their health has been compromised, their quality of life may deteriorate, affecting their daily living and further contributing to their household food insecurity. Maternal health

and nutritional status play a significant role in children's health, yet maternal malnutrition remains a burden in many areas of Africa. Mothers are unable to easily seek aid and use services that benefit her and her children (Gewa et al., 2012). This importance of mother's health along with gender inequality creates a challenging environment to create improvements in nutritional status and health.

The typical diets among food insecure households in developing countries are limited in variety, with a large proportion of the dietary energy coming from starchy foods, like cereals and tubers. Diets also tend to be low in vegetables, fruits and animal protein and are therefore often of lower nutritional quality. Specifically, in Kenya, the traditional diet is comprised of Irish potatoes, bananas, milk, rice, maize and wheat (Mohajan, 2014; Frison et al, 2015). This highly starchy diet contributes to the increasing prevalence of inadequate intake of micronutrients, especially iron, zinc, calcium, riboflavin and vitamins A and B_{12} (FAO, 2005; UNICEP, 2008; Walton et al., 2012).

Previous research from our group, with partner Canadian non-governmental organization, Farmers Helping Farmers (FHF) (Walton et al., 2012) indicated that rural Kenyan women's diets consisted of mostly dried maize and beans, milk (in tea), dark green leafy vegetables (kale, cowpea greens, pumpkin leaves), tomatoes and onions. Other than milk, few women consumed animal source foods, although a small number consumed beef and eggs (Gamble et al., 2013; Walton et al., 2012). Further analyses of this data indicated that food consumption patterns were unchanged with improved food security status (Nala, 1998); it is thus important to further explore the relationship between food security status and usual food consumption

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2.2 Role of Women in Agriculture and Food Security

In sub-Saharan Africa (SSA), family farmers are vital to a sustainable future involving agriculture, and to work towards ending hunger and poverty (Moyo, 2016). A recent study from sub-Saharan Africa showed that women provide an average 40% of Africa's agricultural labour (Palacios-Lopez, Christiaensen, Kilic, 2015). In Eastern sub-Saharan African countries such as Malawi, Tanzania and Uganda, the average is closer to 50%. However, on the global level, the sub-Saharan Africa region ranks third in terms of gender inequality (UNDP, 2016). This presence of gender inequality results in women having an average lower income and lower education levels compared to men and strains their ability to participate in politics and receive benefits of high-quality and accessible health care (UNDP, 2016). Improving and increasing women's opportunities is thus essential to improve social development and to close the existing gender gap (Ewerling, 2017). By empowering women, improvements to national development, economy, poverty and human rights are possible (Ewerling, 2017). Women's empowerment is the process of enhancing a women's capacity to make purposive choices and transform those choices into desired actions and outcomes (Alsop, Bertelsen, Holland, 2006). Women are empowered if they feel as though they are able to make their own decisions, which allows them to make life changes.

The marginalization of women in accessing and controlling land as well as managing farm resources prevents the progress and productivity of family-owned farms and limits women's access to products and incomes from family farming (Moyo, 2016). In SSA, men tend to control income generated from food production, where women control some aspects of property like vegetable gardens, some livestock and equipment

(Moyo, 2016). In fact, it has been shown that women working within the agriculture sector contribute more to household food security and child nutrition than when men control the income (Brown, 1995). Therefore, focusing on empowering women farmers to improve their agricultural productivity and increase their knowledge and confidence will ultimately improve family food security and health. According to a meta-analysis (Berti, Krasvec, Fitzgerald 2004), agriculture projects that invested in human capital, including nutrition education and consideration of gender roles, resulted in more positive nutritional changes. Specifically, projects that were sensitive to the central role women play in their child's health, had a positive effect on child nutrition, vitamin-A status and morbidity (Berti, Krasvec, Fitzgerald 2004). This emphasizes the need for gender equality to promote agricultural growth, increase incomes and improve nutrition and food security for families and how agricultural project investments can help to promote gender equality (Brown, 1995).

2.3 **Women's support groups**

Ellis et al. (2004) documented an increase in community-based organizations in rural areas of four Eastern African countries, including Kenya, from 1994-2004. Women's groups have been formed at the grassroots and national level with some groups being created by NGOs (Ellis et al., 2004). These groups are often formed to work as support systems for its members and communities or in response to challenges being faced, such as drought or famine (Halksworth, 2015). Women's support or self-help groups (referred to as women's groups in this thesis) are one of the most prevalent group types which are created for a variety of purposes (Ellis et al., 2004). These groups are being increasingly used in SSA to spread information, provide training and as a means of

sharing resources, as well as other useful projects (Saito, Mekonnen & Spurling, 1994). They also are a tool used for community development, agricultural development and income-generating activities. Interestingly, women's group members have shown more enthusiasm and willingness to learn, compared to members of men's groups (Saito, Mekonnen & Spurling, 1994).

This is the case in Kenya, where the number of women's groups has continued to rise since 1990 (Halksworth, 2015). In the community of Naari, multiple women's groups exist and serve as a resource and support for the involved members. These groups developed from church members, parents of children who attend the same schools or just from members from the same area (Gamble et al., 2013; Halksworth, 2015). Recognizing the effectiveness of engaging with existing women's group, the Canadian non-governmental organization (NGO) Farmers Helping Farmers has worked with women's groups within multiple rural central Kenyan communities in the Meru district for over three decades, working on projects to improve household food insecurity and enhance family livelihoods. (http://www.farmershelpingfarmers.ca/).

2.4 Interventions to Address Food Insecurity in Developing Countries

2.4.1. Agriculture Interventions

Agriculture is a significant source of livelihood for many Kenyans, where approximately 75% of Kenyan households rely on agriculture for livelihood, comprising 18% of the country's GDP (USAID, 2017). In developing countries, there is a cyclical and trans-generational connection between agricultural productivity and nutritional status, which is sometimes referred to as a "nutritional poverty trap". This is because malnutrition greatly affects agricultural productivity and can affect the health of future generations, their ability to work, and in turn influences their success within the agriculture sector (Reinhardt & Fanzo, 2014). According to a review from the Global Conference on Agriculture Research for Development, improving current methods of agriculture practices and production, are likely to lead to an improvement of the country's food security (McDermott et al., 2013). Improving agricultural practices can also increase household income, affecting a family's food consumption, and positively contribute to household food security. Areas in East Africa have experienced benefits from efforts provided by NGO's and the introduction and distribution of piped-water, wells, latrines, agricultural extension advice, agriculture inputs and formation of village groups (Ellis et al., 2004).

Horticultural interventions are a common approach used in developing countries to address food insecurity and malnutrition. Horticultural interventions are often small in scale and include home gardening or 'kitchen gardens', growing crops to enhance family income and providing crop irrigation technologies (Berti, Krasvec, Fitzgerald 2004; Bhattacharjee, 2007). Home gardens are considered a practice to improve food security

and enhance economic growth by way of the sale of excess vegetables and fruit from the gardens. These gardens are increasingly supported by governmental, non-governmental and international organizations in developing countries (Galhena, Freeed & Maredia, 2013). In particular, there has been an emphasis placed on the production of was orange-fleshed sweet potatoes (OFSP), a root tuber high in β-carotene which has been shown to reduce vitamin A deficiency and improve immunity to prevent infections (Low, Mwanga et al., 2017).

A meta-analysis reviewed and analyzed the characteristics and impacts of 30 agricultural interventions on nutritional status (Berti, Krasvec, Fitzgerald, 2004). For example, a survey of 150 individuals from rural households in Ethiopia was conducted with the aim to increase OFSP consumption. Researchers gathered information on socio-economic, education levels, agricultural practices, potato and OFSP production, consumption habits, food security, nutritional status and general health for women and children. This study concluded that the best method of reducing vitamin-A deficiency is via a food-based approach. In order to be effective and sustainable, nutrition and health improvements require dietary diversification, including the consumption of vitamin A rich foods and improvement of livelihood assets (Busse et al., 2017). The food-based approach focuses on food to improve diet quality as well as the means to prevent and address malnutrition and micronutrient deficiencies (FAO, 2010). This approach also emphasizes the benefits from enjoying a variety of foods, such as the social development, increased learning, decrease in nutritional disorders and prevention of diseases later in life (FAO, 2010). One study showed that, in addition to producing a diversity of nutritious vegetables and fruit, families must also be informed, motivated and empowered on how to

increase their vitamin-A consumption to achieve all potential benefits (Busse et al., 2017). Lastly, a study carried out in Ghana assessed the sweet potato value chain to identify its potential to provide income and improve food security. Researchers concluded that sweet potato production is able to improve household food security, income and nutrition, especially in areas where hunger is common (Sugri et al, 2017).

2.4.2. Nutrition Education Interventions

Nutrition education is an educational strategy that aims to empower individuals to make informed choices about the food they consume and any other diet and nutrition-related habits that may affect their health and nutrition status (Contento, 2011). Nutrition education interventions are created based on the nutritional needs of a population, with the cultural context in mind (Macias & Glasauer, 2014). In developing countries nutrition education is a largely used method to increase diet diversity, address household food insecurity and improve overall nutrition outcomes (Farrell, 2014; Reinbott et al., 2016; Kuchenbecker et al., 2017; Thompson & Amoroso, 2014). With that said, there has been little attention placed on nutrition education in Kenya, even with the known nutrition and health benefits (Mbithe et al., 2018). Varying methods of nutrition education are used, such as one-on-one counselling, which requires the expertise of qualified professionals. Unfortunately, due to a widespread shortage of resources and specialists, this method has been challenging to carry out, especially within African countries (McNulty, 2013). Peer-led nutrition education is an approach that focuses on training a person, who in turn, trains other individuals or peers in their home, agency, group or community (Suhrheinrish, 2011). Peer-led interventions have been shown to lead to positive outcomes in both teaching and administering health promotion programs (Luccia, Kunkel & Cason, 2003),

including improved nutrition-related behaviour, dietary intake (Prez-Escamilla et al., 2008), and nutrition knowledge and retention (Arnold & Sobal, 2000; Brink & Sobal, 1994). The success of this approach is due to the similar backgrounds of those individuals responsible for teaching and those who are learning: since peer educators live in similar communities and/or share cultural background with learners, the credibility and effectiveness of the messages presented are enhanced (USAID, 2010). Further, participants who receive peer-led teaching highly value the experience (Kannan et al., 2010). This approach had been successfully used in the Meru region of Kenya where members of local women's groups had increased diet diversity following a three year intervention (Gamble et al., 2013).

2.4.3 Combined Agriculture and Nutrition Education Interventions

The approach that has been identified as most effective in improving food security and nutritional status in developing countries uses a multi-sector approach, combining agriculture and nutrition education interventions to address these challenges (Kuchenbecker et al., 2017). This approach is considered essential in combating nutrition problems such as vitamin A deficiency in poor areas of lower income countries (Cole et al., 2015). Reinhardt & Fanzo (2014) refer to these combined agriculture and nutrition interventions as 'nutrition sensitive agriculture interventions' and report that they have resulted in increased fruit, vegetable and milk consumption, which in turn, increased dietary diversity and thereby the intake of important micronutrients (Reinhardt & Fanzo, 2014). They see these interventions as "…agriculture with a nutrition lens" but caution that they "… should not detract from the [agriculture] sector's own goals". While they stress that there is a need for these combined interventions, they caution that they should

feature sustainable farming practices in order to improve nutritional status while avoiding negative impacts on the agriculture sector.

In developing countries, horticultural interventions in combination with nutrition education create a long-term method of combatting micronutrient malnutrition. Improvements to horticultural production can positively impact poverty and food security while creating jobs and increasing household income (Bhattacharjee, 2007). These combined interventions are developed and conducted with the aim to have more Kenyans, and Africans, living in a safe environment, eating balanced diets, having access to clean water, adequate health care and the knowledge needed to care for themselves and family members, working towards becoming food secure (McDermott et al., 2013).

The Canadian non-governmental organization, Farmers Helping Farmers, has been working in Kenya for the past 35 years supporting dairy and horticultural projects (http://www.farmershelpingfarmers.ca/). They have been involved in improving livelihoods and food security through dairy and horticulture interventions. Most recently, horticultural interventions have included horticultural training and the provision of critical infrastructures such as tanks to collect rainwater, drip irrigation, screen houses and greenhouses and seeds and cuttings for nutritious crops. The aim of the horticultural intervention is to increase household food security through the increased home production and consumption of nutritious vegetables and fruit and through increased sales of surplus vegetables and fruit to community members.

In 2010, Farmers Helping Farmers, in partnership with the University of Prince Edward Island introduced nutrition education interventions to local women's groups in the Meru district of Kenya in order to complement the pre-existing horticultural

intervention. The nutrition education component of the intervention emphasized the consumption and use of food produced via the improved gardening practices. After three years of the combined intervention, significant improvements in both food security and diet diversity were evident (Gamble et al., 2013).

In mid-2015, a similar combined intervention was initiated in the nearby community of Naari in partnership with Naari Dairy Cooperative Society (Naari Dairy), UPEI, University of Nairobi, Kenyatta University and the Queen Elizabeth Scholars Initiative II. A local women's group was selected by FHF for the horticultural intervention in 2015 since they were well established as a group, were involved in farming and had sufficient numbers (approximately 30 members). The horticulture intervention, to improve women's kitchen gardening practices, was introduced gradually based on resource availability. Initially, all members of the intervention group received training in gardening, compost preparation, soil management and pest control by a Farmers Helping Farmer's horticulturalist. In 2016, 10 women, prioritized by the women's group based on need, received the full horticultural intervention (water tank, drip irrigation lines, seeds and cuttings). As well, a peer-led nutrition education intervention was designed and implemented in 2016 to improve women's nutrition knowledge with the aim of increasing the understanding of the nutritional importance of the promoted kitchen garden crops and increasing consumption of these nutritious crops.

2.5 Assessing Food Use

Food frequency questionnaires (FFQ) are commonly used in epidemiological and dietary studies when the relevant exposure is past dietary intake (Caan et al., 1998). FFQ may be self- or interviewer-administered, where the participant is asked to report usual

frequency of consumption of a list of foods or food groupings for a specified time period from one month to longer periods of time (Moghames et al., 2016; Caan et al., 1998; Shim et al., 2014). The FFQ is developed by collecting dietary data through open-ended surveys such as 24 hour recalls or food records. Foods for the FFQ are selected from these survey data according to how commonly the specific foods are consumed, and whether the foods or specific nutrients are relevant to study objectives (Shim et al., 2014). Selected foods are then often grouped by their nutritional contents. The FFQ can provide estimates of usual food and nutrient intakes (Shim et al., 2014).

FFQ may focus on the intake of specific nutrients, dietary exposures related to a disease or comprehensively assess the overall diet, including estimates of energy intake (Shim et al., 2014). Regardless, the assessment tool must be developed specifically for each study project, considering ethnicity, culture, economic status and other variables in order to be appropriate and relevant to the study group (Shim et al., 2014; Cardoso et al., 2010). A representative food list, which includes main or staple foods within the local diet and with seasonality factored in for food items such as fruits and vegetables, is strongly recommended in order to assess the eating patterns of the majority of community members (Cardoso et al., 2010). Most FFQ collect data across nine possible responses, ranging in frequencies of consumption, from ‘never’ to ‘five or more times a day’ (Shim et al., 2014). When assessing the relationship between food and diseases with modifiable risk factors, like obesity and diet-related non-communicable diseases, measuring the average long-term diet of population groups is considered more valid than measuring the food intake over a shorter time frame (Moghames et al., 2016).

The FFQ relies on respondents to recall everything that they ate and drank over a specified period, which can lead to recall bias (Cardoso et al., 2010). The data generated from FFQ can be associated with substantial error, both systematic and random (Cardoso et al., 2010). For example, the FFQ can systematically overestimate or underestimate consumption across intake levels for the nutrients vitamins A, E, B_6, B_{12}, thiamin and zinc (Shim et al. 2014, Yang et al., 2014, Cardoso et al., 2010). In spite of these limitations, the FFQ is widely used in large-scale studies, because it is simple and quick to administer, its low cost and ability to generate estimates of usual intake (Cardoso et al., 2010). Further, since the FFQ assesses long-term food use, these intakes can reflect variations in both seasonal and economic contexts. There has been a limited number of studies carried out using FFQ in developing countries (Cardoso et al., 2010).

3. METHODS

3.1 Study Design

This research used a pre-post quasi-experimental design (Figure 1). Members of a local women's group had received a horticultural support intervention through Farmers Helping Farmers and a pilot nutrition education intervention in the year prior to the study (2016). The same women's group then received the full peer-led nutrition education intervention in May 2017. The outcome of interest was the frequency of use of common foods and beverages which was assessed prior to and following the nutrition education intervention conducted in May 2017. The comparison group consisted of women farmers in the area, who received only a pre-test with neither intervention or post-test.

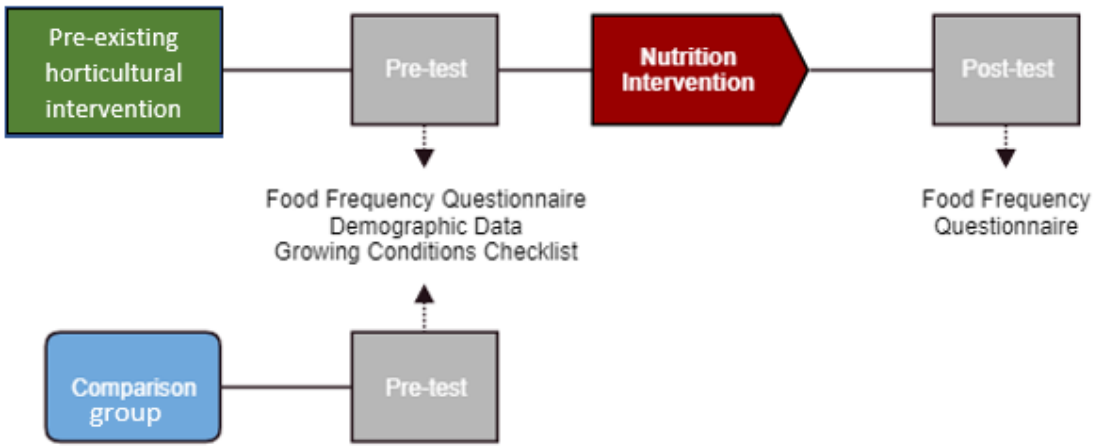


Figure 1. Study design

3.2 Intervention

The intervention for this study consisted of two elements: the horticultural and nutrition education interventions. The horticultural intervention, led by Farmers Helping Farmers and their Kenyan staff, included a combination of drip irrigation, water tanks to

capture rainfall, horticultural training, and the provision of seeds for nutritious crops, including orange-fleshed sweet potatoes and carrots. This component of the intervention was gradually introduced in the fall of 2015, as FHF resources were available. At the time of this study, 20 of 30 members of the intervention group had received the full horticulture intervention. The remaining ten members received a partial horticulture intervention, including horticultural training and seeds for vegetables, but without drip irrigation or rainwater tanks. The latter group, therefore, relied only on rainfall to irrigate kitchen gardens. Those women who had the greatest need in terms of food insecurity were allocated drip irrigation and water tanks first, with the goal of eventually providing every member with the full horticultural intervention.

The nutrition intervention for the present study was conducted using a peer-led approach. The intervention group had received a pilot nutrition intervention in May 2016, using a peer-led model (Williams, 2017) and this same approach was used in 2017. The peer-led approach required that six members of the intervention group were selected in 2016 and designated as the '*Champs*' of the group. They were the executive members of the Upendo Women's Group and were chosen due to this leadership role. The "Champs" title meant they had the responsibility of preparing and serving nutritious foods for the intervention as well as learning and teaching the nutrition messages to their peers. These same women continued to take on the role of *Champ*s in 2017.

In the present study, the *Champs* were further trained by UPEI nutrition students (including the author) and two Kenyan dietitians who were part of the research team. This training session was held to remind the *Champs* about their roles of a Champ, review the 2016 messages and to learn the new nutrition messages for 2017. The messages that were

reviewed include the soaking of maize and beans in water overnight before cooking; the use mpempe (whole grain) maize rather than the commonly dehulled or refined muthokoi maize (referred to as muthikore in the Meru region) (Mutungi et al., 2008); consuming fruit with or after meals to increase iron absorption; adding leafy, green vegetables and orange-fleshed sweet potato to the *githeri and mukimo* traditional meals; avoiding tea at mealtimes and adding two additional nutritious grains and other nutritious ingredients to *uji* or porridge (Table 1).

The three new messages introduced in 2017 included preparing traditional dishes using the 1:1 beans to maize ratio; adding at least one dark, green and one orange vegetable to the traditional dishes in addition to onions and tomatoes; and emphasizing the importance of de-worming children as a means of improving health and nutrition status (Table 1). The *Champs* were provided with a laminated copy of all the nutrition messages and cooking tips that were written in both English and the local language Kimeru. This resource was provided to the *Champs* so that they could familiarize themselves with the material after the training session in preparation for nutrition education program implementation with the members of their group. The resource was also provided to be used by the C*hamps* in future educational sessions.

At the *Champs* training session, commonly consumed foods were selected to be prepared and served to the women attending the nutrition education intervention session. The strategy to serve nutritionally-improved versions of typical foods was used to increase the likelihood that the participant women would accept the messages and prepare the foods in their homes according to the messages (Burchi, Fanzo, Frison, 2011). The

foods chosen to prepare for the 2017 intervention were *uji*, a porridge made of maize flour; *mukimo*, a potato-based dish with greens; and *githeri*, a bean and maize-based stew.

The day of the nutrition education intervention, the *Champs* worked with two Kenyan dietitians and two UPEI undergraduate nutrition students. The intervention was held at their regular meeting location, their local church. The food preparation began approximately at 9:00 am lasted for about three hours. After the group prepared the nutritionally-enhanced foods, the *Champs* taught the nutrition messages to their peers and served the food samples. The full intervention was about five hours in duration. The teaching of the nutrition messages and cooking tips was conducted in the local language of Kimeru using a translator from the women's group and another local translator. To reduce any variances in translation and interpretation between translators, they underwent training with the research team. Further, FHF staff were present for initial interviews to assist translators with correct terminology. As well, students who were familiar with the questionnaires and spoke Swahili, similar to the local language of Kimeru, were present during the home interviews.

Table 1. List of 2016 and 2017[1] Nutrition Education Messages and Cooking Tips	
Nutrition education messages.	**Benefits**
1. Use mpempe (whole grain) maize.	To obtain more nutrients like B vitamins, essential for producing energy, red blood cells, growth and development. Also source of and fibre.
2. Use equal amounts of maize and beans.	*To eat more non-heme iron and protein found in beans; essential for energy body building and fighting infections.*
3. Soak maize and beans overnight before cooking.	Drain water to remove the substances that cause stomach problems.
4. Add orange and green vegetables. Add vegetables on the top near the end of cooking time to protect vitamins.	Green leafy vegetables such as kale, spinach, swiss chard or cowpea leaves are rich in nutrients such as iron and folate, which is important for growing children and women. Greens also give you iron and vitamin A which are important for energy, strength, good eyesight and to prevent illness. Orange vegetables (orange-fleshed sweet potatoes, carrots, pumpkin, butternut are a rich source of vitamin A which is important for good eyesight and to prevent illness.
5.Add at least two vegetables in addition to tomatoes and onions. The more the better for a healthy pot! Naari vegetables are delicious! *Use one green and one orange vegetable as often as you can: daily is best.*	
6. Add vitamin C rich foods to your meal. Tomatoes, pili pili ho ho, paw paw and oranges are good sources of Vitamin C.	Add vitamin C rich foods to protect iron found in beans and cereals. Iron in food is needed for energy and strength.
7. Add at least two grain ingredients to *uji* Mix mpempe maize + finger millet, amaranth or sorghum.	For more energy and strength.
8. Add other nutritious ingredient to maize flour: Dried orange-fleshed sweet potato, terere seeds, dried arrowroot, dried cassava or dried yams. Also suggest adding milk, eggs and vegetable oil for added protein and energy. Avoid adding sugar and salt for a healthier *uji.*	Grains and cereals are high in vitamins, minerals, protein and fiber. These are needed to maintain a healthy digestive system, for energy, body building and fighting infections. Vitamin A which is important for good eyesight and to prevent illness.
9. Drink tea one hour before or one hour after meals. Replace tea at meals with hot milk or water.	Avoid tea at meals, due to presence of tannins (polyphenol compounds) which inhibit the absorption of iron from foods.

Table 1 Continued. List of 2016 and 2017[1] Nutrition Education Messages and Cooking Tips	
Nutrition education messages.	**Benefits**
10. *Ensure your child takes a dewormer once in every six months. Wear shoes and wash hands thoroughly to protect against worms.*	*Deworming destroys intestinal worms, which are capable of inhibiting the body' ability to use vitamins and minerals.*

[1]New 2017 nutrition messages are shown in italics.

The comparison group received no horticultural or nutrition intervention. In 2016, the comparison group had received a single, short nutrition education session that involved the nutrition students teaching the seven nutritional messages with the help of a translator. There were no food samples or demonstrations or other resources provided to this group. This may be considered a 'standard treatment' or approach to nutrition education in contrast to the peer-led education intervention provided to the intervention group (Bailey, 2008).

3.3 Study Area

This research was held in the community of Naari, Kenya. This farming community is located in Meru county, which is in central Kenya, on the eastern side of Mt. Kenya. Naari is highly elevated, located about 6000 feet above sea level, complete with massive green forests, a rugged landscape and exotic fruits and flowers. With land suitable and favourable for gardening and growing produce, Naari is an agriculture-centred community. Common foods planted and harvested include Irish (white) potatoes, kale, maize, beans, carrots, bananas, avocados, onions, and arrowroot (Williams, 2017). The period from June-August is normally the coldest part of the year with the least amount of rainfall, creating a very harsh time for farmers and families. Rainy seasons are March to May and October to December (Climate, 2018).

3.4 Participant Selection

The intervention group consisted of members of a local women's self-help group, based in the Naari area. Of the 30 members of the intervention group, 29 were interviewed as part of the study since one member was hired as a translator. She could not be interviewed as she was highly familiar with the nutrition messages and aware of the research objectives. The comparison group consisted of 20 women selected randomly from a list of Naari Dairy members. In total, 49 women were interviewed for this project.

3.5 Assessment Tools

Food use data was collected using a food frequency questionnaire (FFQ) (Appendix C). This method required the participant to recall how often they ate a certain food item or food groupings (e.g. leafy green vegetables, sweets, eggs etc.) within the previous four weeks. The questionnaire was previously used during assessment of the pilot intervention in 2016. The foods were identified by the research team members Taylor and Walton from the diet diversity food groupings (Arimond et al., 2010; Weismann, 2006) and because they represented the actual intake of women assessed via 24-hour recall in 2010-2013 in a nearby area (Gamble et al., 2013). Selected foods were grouped by their nutritional contents. For example, within the FFQ developed for this project, the starchy Irish potatoes, cassava and white sweet potatoes were grouped together due to their similar nutrient content. As well, common foods were included to capture the women's intakes of foods high in β-carotene and iron. The women answered by indicating the number of times monthly, weekly or daily that they consumed the food group. Responses ranged from 'never' to 'more than six times a day'. Demographic data were also collected, with questions adapted from the 2014 Kenya Demographic Health

Survey (KDHS) (KDHS, 2014) (Appendix C). Questions on marital status, bank account ownership, home construction, home, land and livestock ownership; education level and occupation were included. Finally, observations regarding the condition of the women's kitchen gardens (the Growing Condition Checklist) were completed by the research team at the end of each interview. Information assessed included (Appendix C).

3.6 Data Collection

The members of the intervention group were interviewed in early May, prior to the nutrition education intervention. Data collected included food use via the FFQ, Growing Conditions Checklist and demographic data. A second interview was conducted five weeks after the nutrition intervention, in early July, where only the food use via the FFQ was assessed. The members of the comparison group were interviewed once in May. The same pre-test data were collected, including food use via the FFQ, Growing Condition Checklist and demographic data.

The interviews were conducted in the living room of the women's homes, with a translator present to interpret the questions into the local language, Kimeru, and the responses or discussion to English. Prior to interviewing, students informed the participants of the project objectives, the voluntary nature of participation (Appendix B) and confirmed that the information collected would stay confidential and only be used by the students and researchers. Informed consent was confirmed for each participant when they signed the consent form (Appendix B). The students first read the questions (Appendix C and D) in English; the translator then read the questions in Kimeru and then translated the participant's response back to English. Responses were then recorded on the questionnaire by the student researcher. To end the interviews, the participants were

given a token of appreciation in the form of either one litre of fortified vegetable oil or 1 kg of beans and 1 kg of maize. The interviews took approximately one and a half hours to complete. In total, 78 interviews were completed.

3.7 Data Analysis

The data collected from the interviews were coded and entered into Microsoft Excel spreadsheets and checked for accuracy. In order to express each participant's food use on a daily basis, the data were recoded. To calculate the average daily intakes (ADI), participant's responses were added as follows, using the method of Evers et al., 2001: 'Never' was recorded as 0, 'one to three times a month' was recorded as 0.05, 'once a week' was recorded as 0.14, 'two to four times a week' was recorded as 0.36, 'five to six times a week' was recorded as 0.79, 'once a day' was recorded as 1, 'two to three times a day' was recorded as 2.5, 'four to five times a day' was recorded as 4.5 and 'more than six times a day' was recorded as 6. These values were summed for each participant. The sum of daily intakes was then collapsed into three frequency categories: 1-6 servings= daily, 0.14-0.79 servings = weekly, and less than 0.79 servings = less than weekly (Evers et al., 2001).

Descriptive statistics were generated, including means and standard deviation for age and the sum of daily food intakes as they are continuous variables. Frequency counts were calculated for categorical variables such as marital status; education level and occupation; bank account ownership; nature of home construction; home, land and livestock ownership and kitchen garden observations. All descriptive statistics were computed separately for the intervention and comparison groups.

Group differences in terms of the frequency of food use (daily, weekly or less than weekly), prior to and after the nutrition intervention were assessed using chi-square

analysis. The same test was used to assess differences within the intervention group prior to and after the nutrition intervention as well as differences in demographic characteristics between the intervention and comparison groups. For the analyses of small samples, the continuity adjusted or Fisher's exact test was used to assess the statistical significance. Differences in the average daily intake of each food grouping between the intervention and comparison group and between the intervention group prior to and after the nutrition intervention were assessed using independent sample t-tests. A paired t-test was used to assess differences in the average daily intake of each food grouping prior to and following the intervention within the intervention group. The p-value used to assess the statistical significance was $p \leq 0.05$. All analysis was conducted using SAS statistical software (SAS, Version 9.2).

4. RESULTS

The demographic characteristics of the intervention and comparison group are shown in Table 2. Few differences were found in the demographic characteristics between the intervention and comparison groups. The majority of women both groups were married and owned their home, land, agricultural land and livestock. There were significant differences in livestock ownership between the intervention and comparison group, with more women in the comparison group reporting that they owned exotic cattle (dairy cattle) and had ‘more than five chickens’ relative to the intervention group. As well, a higher proportion of women in the comparison group had bank accounts and owned more than one acre of land; however, these differences are not statistically significant. The majority of women from both groups had wood houses and corrugated metal roofs.

Table 2. Demographics of the intervention (n=29) and comparison (n=19) groups prior to combined horticultural and peer-led nutrition education intervention.

Demographic variables			**Intervention %**	**Comparison %**	**p-value**
Marital Status	Married		72.4	73.7	1.00
	Single/divorced/widowed		27.6	26.3	
Bank Account	Own account		48.3	73.7	0.15
	No account		51.7	26.3	
Home Ownership	Own home		89.7	89.5	1.00
	Renting/leasing/no rent consent		10.3	10.5	
Home Construction	House style	Brick	7.1	10.5	1.00
		Wood	92.9	89.5	
	Roof style	Tile	0.0	5.9	0.80
		Corrugated metal	100.0	94.1	
Land Ownership	Own		86.2	89.5	1.00
	Renting or no rent consent		13.8	10.5	
Agricultural Land	Own		89.7	100.0	0.40
	Rent or no rent consent		10.3	0.0	
Acreage Ownership	>1 Acre		27.6	52.6	0.17
	≤ 1 Acre		62.1	47.4	
	Unknown		10.3	0.0	
Livestock Ownership	Own livestock		100.0	100.0	1.00
Local cattle	Owns		27.6	0.0	**0.04**
Number of local cattle owned	4 or more		10.3	0.0	
	Less than 4		17.2	0.0	
	None		72.4	100.0	
Exotic Cattle	Owns		62.1	100.0	**0.007**
Number of exotic cattle owned	More than 2		27.6	52.6	
	2 or less than		34.5	47.4	
	None		37.9	0.0	
Goat	Owns		31.0	36.8	0.92
Number of goats owned	More than 2		13.8	15.8	
	2 or less than		17.2	21.1	
	None		69.0	63.2	

Table 2 Continued. Demographics of the intervention (n=29) and comparison (n=19) groups prior to combined horticultural and peer-led nutrition education intervention.

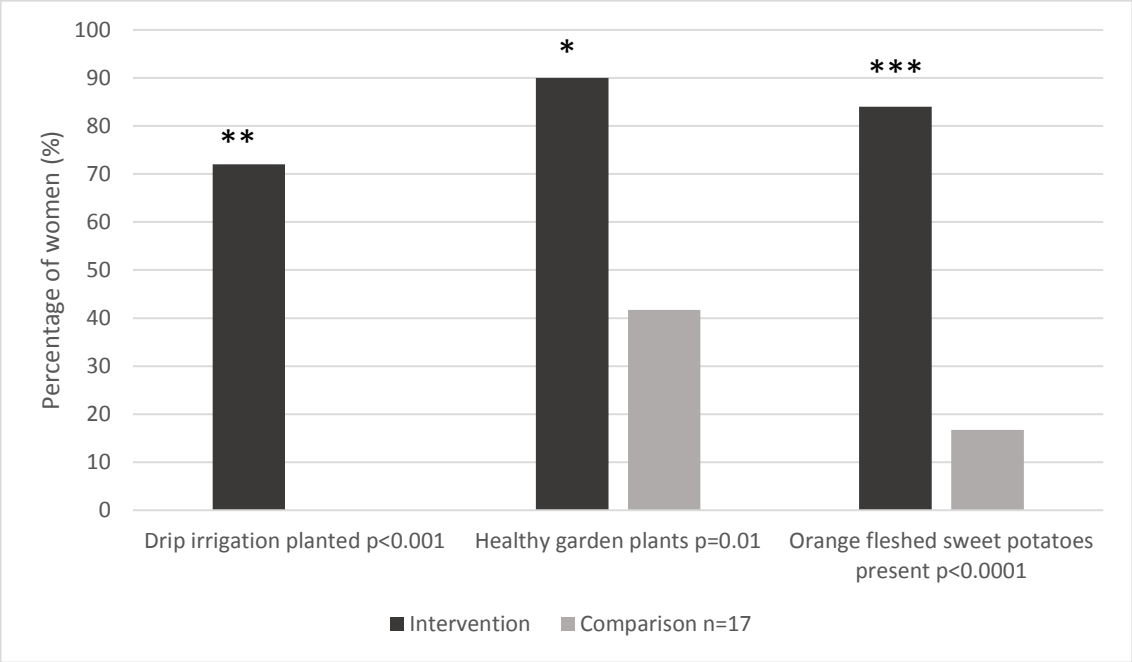
Demographic variables		**Intervention %**	**Comparison %**	**p-value**
Sheep	Owns	51.7	31.6	0.28
Number of sheep owned	More than 2	24.1	15.8	
	2 or less than	27.6	15.8	
	None	48.3	68.4	
Chickens	Owns	93.1	100.0	0.67
Number of chickens owned	More than 5	51.7	89.5	
	Less than 5	41.4	5.3	
	None	6.9	5.3	
Mother's Age	50 or older	51.7	68.4	0.40
	Younger than 50	48.3	31.6	
Mother's Education	Secondary/college/university/adult education	44.8	36.8	0.80
	None/primary	55.2	63.2	
Husband's Age	50 or older	48.3	31.6	0.46
	Younger than 50	24.1	26.3	
	Not applicable[1]	27.6	42.1	
Husband's Education	Secondary/college/university/adult education	20.7	42.1	0.18
	None/primary	51.7	26.3	
	Not Applicable[1]	27.6	31.6	
Husband's Occupation	Farmer/casual laborer	31.0	42.1	0.78
	Businessman	27.6	15.8	
	Skilled jobs (teacher/pastor/driver)	13.8	15.8	
	Not applicable[1]	27.6	26.3	
Average Age	Women participants	49.3 +/- 9.2	52.1 +/- 16.1	
	Husbands	53.0 +/- 10.3	53.2 +/- 17.5	

[1]Not applicable because women were not married, did not know or refused to answer.

In terms of the conditions of women's kitchen gardens, a higher percentage of the intervention group reported that they had drip irrigation in their kitchen garden relative to the comparison group where no women had drip irrigation ($p<0.001$), as expected (Figure 2). Further, significantly more of the intervention group had healthy plants in their gardens ($p=0.01$) and had planted orange-fleshed sweet potatoes ($p<0.0001$) relative to the comparison group.

Prior to the nutrition intervention, there were few differences between the intervention and comparison group in the frequency of the food/food groupings consumed daily, weekly or less than weekly. A significantly higher proportion of women in the intervention group reported weekly consumption of orange-fleshed sweet potatoes relative to the comparison group (Table 3; $p=0.03$). A significantly higher proportion of women in the comparison group reported that they consumed beef weekly ($p=0.04$). There were no other statistically significant differences between the groups.

Figure 2. Kitchen garden observations for the intervention and comparison group members, prior to combined horticultural and peer-led nutrition education intervention.[1]



*p<0.05 ** p<0.01 ***p<0.0001

[1]Four women either used central garden or researchers were unable to observe their kitchen gardens

Table 3. The proportion of the intervention (n=29) and comparison (n=19) group consuming foods/food groupings[1] daily, weekly or less than weekly, prior the peer-led nutrition education intervention (May 2017).

Food/Food Groupings	**Intervention Group %**			**Comparison Group %**			**p-value**
	Daily	**Weekly**	**Less Than Weekly**	**Daily**	**Weekly**	**Less Than Weekly**	
Dark green vegetables	37.9	62.1	0.0	21.1	79.0	0.0	0.36
Pumpkin, carrots, squash	13.8	65.5	20.7	15.8	68.4	15.8	1.00
Orange-fleshed sweet potatoes	0.0	37.9	62.1	0.0	5.3	94.7	**0.03**
Tomatoes	55.2	24.1	20.7	63.2	36.8	0.0	0.11
Irish potatoes, white sweet potatoes, cassava	37.9	41.4	20.7	63.2	31.6	5.3	0.21
Papaya, mango, guava	3.5	37.9	58.6	5.3	63.2	31.6	0.12
Bananas	27.6	48.3	24.1	26.3	68.4	5.3	0.20
Milk added to tea	100.0	0.0	0.0	100.0	0.0	0.0	1.00
Milk as a drink	34.5	37.9	27.6	15.8	52.6	31.6	0.39
Whole egg	0.0	51.7	48.3	5.3	42.1	52.6	0.45
Egg in cooking	0.0	41.4	58.6	0.0	52.6	47.4	0.64
Beef	3.5	48.3	48.3	5.3	79.0	15.8	**0.04**
Beef liver	0.0	13.8	86.2	0.0	10.5	89.5	1.00

Table 3 Continued. The proportion of the intervention (n=29) and comparison (n=19) group consuming foods/food groupings[1] daily, weekly or less than weekly, prior the peer-led nutrition education intervention (May 2017).

Food/Food Groupings	Intervention Group %			Comparison Group %			p-value
	Daily	Weekly	Less Than Weekly	Daily	Weekly	Less Than Weekly	
Chicken	0.0	3.5	96.6	0.0	10.5	89.5	0.70
Goat liver	0.0	3.5	96.6	0.0	10.5	89.5	0.70
Sweets	10.3	44.8	44.8	5.3	52.6	42.1	0.83
Sugar added to tea	58.6	17.2	24.1	57.9	5.3	36.8	0.41

[1]More than 90% of women in both groups ate chicken liver, goat, rabbit and pork less often than weekly; these foods were excluded from the table.

There were no statistically significant differences in food consumption between the groups following the nutrition intervention (Table 4). However, some differences were marginally significant: a higher proportion of women in the intervention group consumed orange-fleshed sweet potatoes weekly (p=0.07). In contrast, a higher proportion of women in the comparison group were consuming papaya, mango and guava on a weekly basis (p=0.07) and Irish potatoes, white sweet potatoes and cassava on a daily basis (p=0.09).

Table 4. Proportion of the intervention (n=29) and comparison (n=19) group consuming foods/food groupings[1] daily, weekly or less than weekly, following the peer-led nutrition education intervention (July 2017).

Food/Food Groupings	Intervention Group %			Comparison Group %			p-value
	Daily	Weekly	Less Than Weekly	Daily	Weekly	Less Than Weekly	
Dark green vegetables	31.0	65.5	3.5	21.1	79.0	0.0	0.71
Pumpkin, carrots, squash	10.3	65.5	24.1	15.8	68.4	15.8	0.68
Orange-fleshed sweet potatoes	0.0	31.0	69.0	0.0	5.3	94.7	0.07
Tomatoes	58.6	31.0	10.3	63.2	36.8	0.0	0.45
Irish potatoes, white sweet potatoes, cassava	31.0	58.6	10.3	63.2	31.6	5.3	0.09
Papaya, mango, guava	6.9	31.0	62.1	5.3	63.2	31.6	0.07
Bananas	13.8	65.5	20.7	26.3	68.4	5.3	0.27
Milk added to tea	100.0	0.0	0.0	100.0	0.0	0.0	1.00
Milk as a drink	27.6	48.3	24.1	15.8	52.6	31.6	0.64
Whole egg	3.5	51.7	44.8	5.3	42.1	52.6	0.88

Table 4 Continued. Proportion of the intervention (n=29) and comparison (n=19) group consuming foods/food groupings[1] daily, weekly or less than weekly, following the peer-led nutrition education intervention (July 2017).

Food/Food Groupings	Intervention Group %			Comparison Group %			p-value
	Daily	Weekly	Less Than Weekly	Daily	Weekly	Less Than Weekly	
Beef	0.0	65.5	34.5	5.3	79.0	15.8	0.18
Beef liver		13.8	86.2	0.0	10.5	89.5	1.00
Chicken	0.0	0.0	100.0	0.0	10.5	89.5	0.30
Goat liver	0.0	0.0	100.0	0.0	10.5	89.5	0.30
Sweets	13.8	48.3	37.9	5.3	52.6	42.1	0.83
Sugar added to tea	58.6	17.2	24.1	57.9	5.3	36.8	0.41
Egg in cooking	0.0	31.0	69.0	0.0	52.6	47.4	0.23

[1]More than 90% of women in both groups ate chicken liver, goat, rabbit and pork less often than weekly; these foods were excluded from the table.

The average daily intake of foods/food groupings of the intervention group relative to the comparison group prior to the intervention is shown in Table 5. The most consumed foods/food groupings for both groups were dark green vegetables, tomatoes, Irish potatoes, white sweet potatoes, cassava as well as milk and sugar add to tea. The average intake of orange-fleshed sweet potato was significantly higher among the women in the intervention group relative to those in the comparison group ($p<0.01$). Also, the average intake of rabbit was also significantly higher among the intervention group relative to the comparison group; however, the reported average intake of ≤ 0.05 corresponds to a frequency of consumption of one to three times per month, which is nutritionally insignificant. The average intake of milk as a drink was higher in the intervention group relative to the comparison group, with differences approaching

significance (p=0.07). The intakes of other foods/food grouping were similar between the groups, with no significant differences.

Table 5. Average daily intake[1] of foods/food groupings for the intervention (n=29) and comparison (n=19) group, prior to combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	**Intervention Mean +/- SD**	**Comparison Mean +/- SD**	**p-value**
Dark green vegetables	1.1 +/- 1.0	0.7+/- 0.8	0.17
Pumpkin, carrots, squash	0.6 +/- 0.8	0.6+/- 0.9	0.94
Orange- fleshed sweet potatoes	0.1 +/- 0.2	0.01 +/- 0.03	**0.0009**
Tomatoes	1.3 +/- 1.1	1.6 +/- 1.1	0.49
Irish potatoes, white sweet potatoes, cassava	1.1 +/- 1.1	1.6 +/- 1.1	0.11
Papaya, mango, guava	0.2 +/- 0.2	0.2 +/- 0.2	0.31
Bananas	0.6 +/- 0.7	0.8 +/- 0.8	0.51
Milk added to tea	2.3 +/- 0.5	2.5 +/- 0.6	0.24
Milk as a drink	0.6 +/- 0.8	0.3 +/- 0.3	0.07
Whole egg	0.2 +/- 0.1	0.2 +/- 0.3	0.43
Egg in cooking	0.2 +/- 0.2	0.1 +/- 0.2	0.69
Beef	0.2 +/- 0.2	0.3 +/- 0.5	0.27
Beef liver	0.04 +/- 0.1	0.05 +/- 0.08	0.77
Chicken	0.04 +/- 0.07	0.04 +/- 0.04	0.85
Chicken liver	0.02 +/- 0.07	0.03 +/- 0.04	0.76
Goat	0.01 +/- 0.03	0.03 +/- 0.08	0.43

Table 5 Continued. Average daily intake[1] of foods/food groupings for the intervention group (n=29) and comparison group (n=19), prior to combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	Intervention Mean +/- SD	Comparison Mean +/- SD	p-value
Goat liver	0.005 +/- 0.03	0.02 +/- 0.05	0.28
Rabbit	0.007 +/- 0.02	0.0007 +/- 0.01	**0.04**
Pork	0.02 +/- 0.03	0.008 +/- 0.02	0.23
Sweets	0.3 +/- 0.5	0.2+/- 0.2	0.28
Sugar added to tea	1.5 +/- 1.2	1.6 +/- 1.4	0.79

[1]Average daily intakes calculated by adding frequencies as follows:
0.0 = never, ≤ 0.05 = 1-3/monthly,
0.14 = 1/week, 0.36 = 2-4/week, 0.79 =5-6/week
1.0=1/day, 2.5 = 2-3/day, 4.5 = 4-5/day, 6 = 6+/day

In the intervention group, there were no significant differences in food consumption prior to and following the combined intervention (Table 6). Almost all (> 95%) of the women in intervention group indicated that they ate chicken, chicken liver, goat, goat liver, rabbit and pork less than weekly at both assessment times (not shown).

Table 6. Comparison of the proportion of women in intervention group (n=29) consuming foods/food groupings[1] daily, weekly or less than weekly, prior to and following combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	Pre-intervention %			Post-intervention %			p-value
	Daily	Weekly	Less Than Weekly	Daily	Weekly	Less Than Weekly	
Dark green vegetables	37.9	62.1	0.0	31.0	65.5	3.5	0.78
Pumpkin, carrots, squash	13.8	65.5	20.7	10.3	65.5	24.1	1.00
Orange-fleshed sweet potatoes	0.0	37.9	62.1	0.0	31.0	69.0	0.78
Tomatoes	55.2	24.1	20.7	58.6	31.0	10.3	0.66
Irish potatoes, white sweet potatoes, cassava	37.9	41.4	20.7	31.0	58.6	10.3	0.35
Papaya, mango, guava	3.5	37.9	58.6	6.9	31.0	62.1	0.83
Bananas	27.6	48.3	24.1	13.8	65.5	20.7	0.35
Milk added to tea	100.0	0.0	0.0	100.0	0.0	0.0	1.00
Milk as a drink	34.5	37.9	27.6	27.6	48.3	24.1	0.79
Whole egg	0.0	51.7	48.3	3.5	51.7	44.8	1.00
Egg in cooking	0.0	41.4	58.6	0.0	31.0	69.0	0.59
Beef	3.5	48.3	48.3	0.0	65.5	34.5	0.29
Beef liver	0.0	13.8	86.2	0.0	24.1	75.9	0.50
Sweets	10.3	44.8	44.8	13.8	48.8	37.9	0.87
Sugar added to tea	58.6	17.2	24.1	58.6	17.2	24.1	1.00

[1]More than 95% of women in intervention group ate chicken, chicken liver, goat, goat liver, rabbit and pork less than weekly; these foods were excluded from the table.

Table 7 shows the average daily intake (ADI) of foods/food grouping servings for the intervention group prior to and after the nutrition intervention. Foods consumed at least once a day (ADI $\geq$1.0), prior to the nutrition intervention included dark green vegetables, Irish potatoes, white sweet potatoes, cassava, tomatoes, milk and sugar added to tea. There were no significant differences in the average daily intake of foods/food groupings prior to and following the intervention.

Table 7. Average daily intake[1] of foods/food groupings for the intervention group (n=29) prior to and following combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	**Pre-intervention Mean +/- SD**	**Post-intervention Mean +/- SD**	**p-value**
Dark green vegetables	1.1 +/- 1.0	0.9 +/- 0.9	0.28
Pumpkin, carrots, squash	0.6 +/- 0.8	0.4 +/- 0.6	0.44
Orange-fleshed sweet potatoes	0.1 +/- 0.9	0.1 +/- 0.1	0.50
Tomatoes	1.3 +/- 1.1	1.4 +/- 1.1	0.84
Irish potatoes, white sweet potatoes, cassava	1.1 +/- 1.1	0.8 +/- 0.9	0.20
Papaya, mango, guava	0.2 +/- 0.2	0.2 +/- 0.3	0.97
Bananas	0.6 +/- 0.7	0.5 +/- 0.9	0.68
Milk added to tea	2.3 +/- 0.5	2.1 +/- 0.7	0.10
Milk as a drink	0.6 +/- 0.8	0.5 +/- 0.6	0.38
Whole egg	0.2 +/- 0.1	0.2 +/- 0.2	0.44
Egg in cooking	0.2 +/- 0.2	0.1 +/- 0.1	0.30

Table 7. Continued. Average daily intake[1] of foods/food groupings for the intervention group prior to (n=29) and following (n=29) combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	Pre-intervention Mean +/- SD	Post-intervention Mean +/- SD	p-value
Beef	0.2 +/- 0.2	0.2 +/- 0.1	0.74
Beef liver	0.04 +/- 0.1	0.09 +/- 0.1	0.19
Chicken	0.04 +/- 0.07	0.02 +/- 0.03	0.19
Chicken liver	0.02 +/- 0.07	0.02 +/- 0.02	0.78
Goat	0.01 +/- 0.03	0.003 +/- 0.01	0.12
Goat liver	0.004 +/- 0.03	0.002 +/- 0.01	0.55
Rabbit	0.01 +/- 0.02	0.003 +/- 0.01	0.40
Pork	0.02 +/- 0.03	0.03 +/- 0.07	0.51
Sweets	0.3 +/- 0.5	0.3 +/- 0.5	0.94
Sugar added to tea	1.5 +/- 1.2	1.3 +/- 1.1	0.49

[1] Average daily intakes calculated by adding frequencies as follows:
0.0 = never, $\leq$ 0.05 = 1-3/monthly
0.14 = 1/week, 0.36 = 2-4/week, 0.79 =5-6/week
1.0=1/day, 2.5 = 2-3/day, 4.5 = 4-5/day, 6 = 6+/day

The pre-intervention frequency of food use among women in the intervention group who had received a partial (horticulture training and the provision of seeds only) versus full horticulture intervention (with water tanks and drip irrigation) is shown in Table 8. There were no statistically significant differences between women who received the partial or full intervention.

Table 8. Comparison of the proportion of intervention group consuming foods/food groupings[1] daily, weekly or less than weekly, according to partial (n=7) and full (n=18) horticultural intervention[2] prior to the peer-led nutrition education intervention (May 2017).

Food/Food Groupings	Partial horticultural intervention[3] %			Full horticultural intervention[3] %			p-value
	Daily	Weekly	Less Than Weekly	Daily	Weekly	Less Than Weekly	
Dark green vegetables	28.6	71.4	0.0	33.3	66.7	0.0	1.00
Pumpkin, carrots, squash	0.0	71.4	28.6	11.1	77.8	11.1	0.58
Orange-fleshed sweet potatoes	0.0	42.9	57.1	0.0	38.9	61.1	1.00
Tomatoes	42.9	28.6	28.6	55.6	27.8	16.7	0.84
Irish potatoes, white sweet potatoes, cassava	42.9	28.6	28.6	33.3	44.4	22.2	0.74
Papaya, mango, guava	0.0	57.1	42.9	5.6	27.8	66.7	0.54
Bananas	42.9	28.6	28.6	16.7	55.6	27.8	0.32
Milk added to tea	100.0	0.0	0.0	100.0	0.0	0.0	1.00
Milk as a drink	14.3	57.1	28.6	38.9	33.3	27.8	0.47
Whole egg	0.0	71.4	28.6	0.0	38.9	61.1	0.31
Egg in cooking	0.0	42.9	57.1	0.0	38.9	61.1	1.00
Beef	0.0	28.5	71.4	0.0	50.0	50.0	0.60
Beef liver	0.0	0.0	100.0	0.0	16.7	83.3	0.64
Pork	0.0	14.3	85.7	0.0	0.0	100.0	0.62
Sweets	0.0	28.6	71.4	5.6	50.0	44.4	0.56

Table 8. Comparison of the proportion of intervention group consuming foods/food groupings[1] daily, weekly or less than weekly, according to partial (n=7) and full (n=18) horticultural intervention[2] prior to the peer-led nutrition education intervention (May 2017).

Food/Food Groupings	Partial horticultural intervention[3] %			Full horticultural intervention[3] %			p-value
	Daily	Weekly	Less Than Weekly	Daily	Weekly	Less Than Weekly	
Sugar added to tea	57.1	14.3	28.6	66.7	16.7	16.7	0.82

[1]Chicken, chicken liver, goat, goat liver and rabbit were consumed less than weekly by more than 90% of women in intervention group; therefore, these foods were excluded from the table.
[2]Partial = horticultural training & provision of seeds; Full= with water tanks and drip irrigation.
[3]Four women either used central garden or researchers were unable to observe their kitchen gardens.

Table 9 shows the average daily intake of foods and food grouping servings for the intervention group with partial and full horticultural intervention prior to the nutrition intervention. Of the 21 foods or food groupings assessed, only the ADI consumption of rabbit, sweets and milk added to tea approached significance, with higher ADI of these among those receiving the full horticultural intervention. This group also had modestly higher ADI of dark green vegetables, pumpkin, carrots, squash, tomatoes, milk, beef, chicken and goat. All other ADI food consumption differences were not statistically significant.

Table 9. Average daily intake[1] of foods/food groupings reported by the intervention group according to partial (n=7) and full (n=18) horticultural intervention[2], prior to combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	Partial horticultural intervention[3] Mean +/- SD	Full horticultural intervention[3] Mean +/- SD	p-value
Dark green vegetables	0.9 +/- 1.1	1.1 +/- 1.0	0.72
Pumpkin, carrots, squash	0.3 +/- 0.3	0.5 +/- 0.7	0.33
Orange-fleshed sweet potatoes	0.1 +/- 0.2	0.1 +/- 0.2	1.00
Tomatoes	1.2 +/- 1.2	1.3 +/- 1.1	0.87
Irish potatoes, white sweet potatoes, cassava	1.2 +/- 1.2	1.02 +/- 1.1	0.74
Papaya, mango, guava	0.2 +/- 0.2	0.1 +/- 0.2	0.45
Bananas	1.0 +/- 1.1	0.4 +/- 0.6	0.25
Milk added to tea	1.9 +/- 0.8	2.5 -/+ 0.0	0.08
Milk as a drink	0.3 +/- 0.3	0.6 +/- 0.8	0.17
Whole egg	0.2 +/- 0.1	0.1 +/- 0.1	0.31
Egg in cooking	0.2 +/- 0.2	0.1 +/- 0.2	0.59
Beef	0.07 +/- 0.1	0.1 +/- 0.1	0.17
Beef liver	0.01 +/- 0.02	0.05 +/- 0.09	0.18
Chicken	0.04 +/- 0.02	0.05 +/- 0.08	0.81
Chicken liver	0.01 +/- 0.02	0.03 +/- 0.08	0.53
Goat	0.007 +/- 0.02	0.01 +/- 0.04	0.67
Goat liver	0.0	0.008 +/- 0.03	0.33

Table 9. Continued. Average daily intake[1] of foods/food groupings reported by the intervention group according to partial (n=7) and full (n=18) horticultural intervention[2], prior to combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	Partial horticultural intervention[3] Mean +/- SD	Full horticultural intervention[3] Mean +/- SD	p-value
Rabbit	0.0	0.008 +/- 0.02	0.08
Pork	0.03 +/- 0.05	0.01 +/- 0.02	0.47
Sweets	0.09 +/- 0.1	0.4 +/- 0.6	0.09
Sugar added to tea	1.5 +/- 1.3	1.6 +/- 1.1	0.77

[1]Average daily intakes calculated by adding frequencies as follows:
0.0 = never, ≤ 0.05 = 1-3/monthly
0.14 = 1/week, 0.36 = 2-4/week, 0.79 =5-6/week
1.0=1/day, 2.5 = 2-3/day, 4.5 = 4-5/day, 6 = 6+/day
[2]Partial = horticultural training & provision of seeds; Full= with water tanks and drip irrigation.
[3]Four women either used central garden or researchers were unable to observe their kitchen gardens.

Table 10 shows the proportion of the foods and food groupings consumed, by the intervention group according to partial and full horticultural intervention, after the combined horticultural and peer-led nutrition education intervention. There were no statistically significant differences in food use following the nutrition intervention regardless of whether the women had the full or partial horticultural intervention.

Table 10. Comparison of the proportion of intervention group consuming food/food groupings[1] daily, weekly or less than weekly, according to partial (n=7) and full (n=18) horticultural intervention[2], after peer-led nutrition education intervention (June 2017).[2]

Food/Food Groupings[3]	**Partial horticultural intervention[3] %**			**Full horticultural intervention[3] %**			**p-value**
	Daily	**Weekly**	**Less Than Weekly**	**Daily**	**Weekly**	**Less Than Weekly**	
Dark green vegetables	28.6	71.4	0.0	27.8	66.7	5.6	1.00
Pumpkin, carrots, squash	14.3	42.9	42.9	5.6	77.8	16.7	0.25
Orange-fleshed sweet potatoes	0.0	14.3	85.7	0.0	33.3	66.7	0.65
Tomatoes	28.6	42.9	28.6	61.1	33.3	5.6	0.20
Irish potatoes, white sweet potatoes, cassava	14.3	85.7	0.0	44.4	38.9	16.7	0.11
Papaya, mango, guava	0.0	28.6	71.4	5.6	27.8	66.7	1.00
Bananas	28.6	57.1	14.3	5.6	66.7	27.8	0.28
Milk added to tea	100.0	0.0	0.0	100.0	0.0	0.0	1.00
Milk as a drink	14.3	71.4	14.3	27.8	44.4	27.8	0.60
Whole egg	0.0	57.1	42.9	0.0	50.0	50.0	1.00
Egg in cooking	0.0	28.6	71.4	0.0	27.8	72.2	1.00
Beef	0.0	42.9	57.1	0.0	66.7	33.3	0.52
Beef liver	0.0	14.3	85.7	0.0	22.2	77.8	1.00
Pork	0.0	0.0	100.0	0.0	5.6	94.4	1.00
Sweets	0.0	57.1	42.9	22.2	44.4	33.3	0.60

Table 10. Comparison of the proportion of intervention group consuming food/food groupings[1] daily, weekly or less than weekly, according to partial (n=7) and full (n=18) horticultural intervention[2], after peer-led nutrition education intervention (June 2017).[2]

Food/Food Groupings[3]	**Partial horticultural intervention[3] %**			**Full horticultural intervention[3] %**			**p-value**
Sugar added to tea	57.1	28.6	14.3	61.1	16.7	22.2	0.84

[1]No women reported consuming chicken, chicken liver, goat, goat liver or rabbit on a daily or weekly basis; these foods were excluded from the table.
[2]Partial = horticultural training & provision of seeds; Full= with water tanks and drip irrigation.
[3]Four women either used central garden or researchers were unable to observe their kitchen gardens.

The average daily intake of foods and food grouping servings for the intervention group following the nutrition intervention is shown in Table 11. Results indicated that, although the average daily intakes for most foods/food groupings were not significantly different, the consumption of rabbit was significantly higher among those with the full horticultural intervention (p=0.04) compared to those who received the partial horticultural intervention only, although intakes were very low. Average daily intakes of pumpkin, carrot and squash were two times higher among those with the full horticultural intervention, although the difference was not significant. Similarly, the average intakes of milk added to tea and beef liver were higher among the members with the full horticultural intervention; however, the differences were not statistically significant.

Table 11. Average daily intake[1] of foods/food groupings reported by the intervention group according to partial (n=7) and full (n=18) horticultural intervention[2], following combined horticultural and peer-led nutrition education intervention.

Food/Food Groupings	Partial horticultural intervention[3] Mean +/- SD	Full horticultural intervention[3] Mean +/- SD	p-value
Dark green vegetables	1.1 +/- 1.1	1.3 +/- 1.1	0.61
Pumpkin, carrots, squash	0.3 +/- 0.2	0.7 +/- 0.9	0.14
Orange-fleshed sweet potatoes	0.1 +/- 0.2	0.1 +/- 0.2	0.78
Tomatoes	1.2 +/- 1.2	1.4 +/- 1.1	0.74
Irish potatoes, white sweet potatoes, cassava	1.5 +/- 1.2	1.1 +/- 1.1	0.38
Papaya, mango, guava	0.2 +/- 0.2	0.1 +/- 0.2	0.64
Bananas	0.9 +/- 1.0	0.5 +/-0.6	0.21
Milk added to tea	2.0 +/- 0.8	2.5 +/- 0.0	0.08
Milk as a drink	0.6 +/- 0.8	0.7 +/- 0.8	0.66
Whole egg	0.2 +/- 0.1	0.1 +/- 0.1	0.76
Egg in cooking	0.2 +/- 0.2	0.2 +/- 0.1	0.92
Beef	0.1 +/- 0.1	0.2 +/- 0.2	0.18
Beef liver	0.01 +/- 0.02	0.07 +/- 0.1	0.06
Chicken	0.03 +/- 0.03	0.05 +/- 0.08	0.44
Chicken liver	0.01 +/- 0.02	0.03 +/- 0.09	0.41
Goat	0.02 +/- 0.03	0.01 +/- 0.04	0.68
Goat liver	0.0	0.008 +/- 0.03	0.33

Table 11 Continued. Average daily intake[1] of foods/food groupings reported by the intervention group with partial (n=7) and full (n=18) horticultural intervention[2], following the combined horticultural and peer-led nutrition education intervention.[2]

Food/Food Groupings	Partial horticultural intervention[3] Mean +/- SD	Full horticultural intervention[3] Mean +/- SD	p-value
Rabbit	0.0	0.01 +/- 0.02	**0.04**
Pork	0.03 +/- 0.05	0.01 +/- 0.02	0.49
Sweets	0.2 +/- 0.3	0.3 +/- 0.3	0.48
Sugar added to tea	1.4 +/- 1.3	1.6 +/- 1.1	0.75

[1]Average daily intakes calculated by adding frequencies as follows:
0.0 = never, ≤ 0.05 = 1-3/monthly
0.14 = 1/week, 0.36 = 2-4/week, 0.79 =5-6/week
1.0=1/day, 2.5 = 2-3/day, 4.5 = 4-5/day, 6 = 6+/day
[2]Partial = horticultural training & provision of seeds; Full= with water tanks and drip irrigation.
[3]Four women either used central garden or researchers were unable to observe their kitchen gardens

The associations between food use and demographic characteristics for both the intervention and comparison groups shown in Table 12. Only the statistically significant differences are shown in Table 12; the full results are found in Appendix E.

There were a greater number of statistically significant associations between demographic characteristics and frequency of food use in the intervention group. For example, more women in the intervention group who were married and whose husbands were over 50 years of age reported consumption of tomatoes and Irish or white sweet potatoes/cassava on a daily basis. More women in the intervention group who had completed a higher level of education reported consumption of pumpkin, carrots, squash, orange-fleshed sweet potato and tomatoes on a daily and weekly basis. A greater number of those who owned one acre or less of land and had attained no more than a primary

education reported consumption of bananas daily. Those with husbands under than age of 50 years old reported more consumption of sugar in tea on a daily basis. More women from the intervention group who owned two goats or less reported weekly consumption of orange-fleshed sweet potato and higher consumption of sugar in tea. More women in the intervention group whose husbands had a higher level of education reported consumption of orange-fleshed sweet potato on a weekly basis. More intervention group members who reported that their husbands were businessmen also reported daily consumption of tomatoes, followed by farmers and those with skilled jobs. More women in the intervention group who owned less than four exotic cattle reported consumption of sweets on a daily basis.

Among women in the comparison group, more of those who owned a bank account and whose husbands attained secondary education reported consumption of papaya, mango and guava on a daily and weekly basis. More women who did not own a bank account reported higher weekly consumption of sweets. For the comparison group, more women whose husbands are businessmen reported ‘daily’ consumption of sugar in tea compared to farmers or casual labourers who reported ‘less than weekly’ consumption of sugar in tea. More women from the comparison group who owned two or more exotic cattle reported daily consumption of sugar in their tea.

There were no other significant associations between demographic characteristics and food use in either the intervention and comparison groups.

Table 12. Association between food use[1] and demographics in the intervention (n=29) and comparison (n=19) groups.[2]

		Intervention	**Comparison**
Food/ Food groupings	**Demographics**	**p-value**	**p-value**
Pumpkin, carrots, squash	Mother's Education	**0.004**	0.31
Orange-fleshed sweet potato	Mother's Education	**0.05**	0.78
	Husband's Education	**0.03**	1.00
	Number of goats owned	**0.04**	0.16
Tomatoes	Marital Status	**0.006**	0.71
	Mother's Education	**0.05**	1.00
	Husband's Education	**0.005**	0.51
	Husbands Age	**0.003**	0.83
	Husband's occupation	**0.03**	0.84
Irish or white sweet potatoes, cassava	Marital Status	**0.01**	0.72
	Husband's Education	**0.001**	0.89
	Husbands Age	**0.02**	0.19
	Husband's occupation	**0.02**	0.96
Papaya, mango, guava	Husband's Education	0.22	**0.04**
	Bank account ownership	1.00	**0.01**
Bananas	Mother's Education	**0.03**	1.00
	Acres Owned	**0.05**	1.00
Milk as a drink	Agricultural Land	**0.02**	1.00
	Acres Owned	**0.05**	1.00
Sweets	Bank account ownership	0.07	**0.05**
	Number of exotic cattle owned	**0.05**	0.50
Sugar in tea	Husbands age	**0.05**	0.51
	Husbands occupation	0.54	**0.008**
	Number of exotic cattle owned	0.73	**0.007**

[1]Foods consumed infrequently such as eggs and beef were excluded from the table.

[2]Only statistically significant comparisons are displayed on the table.

5. DISCUSSION

5.1 Food Use Assessed

This study was conducted with the intention of capturing food use differences between members of a women's self-help group receiving a combined horticulture and peer-led nutrition education intervention and a comparison group. It was also completed to identify any differences in food use between those receiving a full versus a partial horticulture intervention.

The main finding from this study was the difference in consumption of orange-fleshed sweet potato (OFSP) between the two groups (intervention and comparison). Prior to and following the nutrition education intervention, more women within the intervention group consumed more OFSP on a weekly basis relative to the comparison group. These results are consistent with previous studies where combinations of both horticultural and nutrition education interventions increased fruit and vegetable production (Darnton-Hill, 2014; Helen Keller International, 2001). This higher OFSP consumption, and therefore β-carotene consumption, should also result in an increase in their vitamin A intakes. If women continue to consume these β-carotene rich foods on a regular and long-term basis, it would contribute to reduced micronutrient malnutrition (vitamin A) (Bhattacharjee, 2007; McDermott et al., 2013).

From this study, the higher frequency of OFSP consumption among the intervention group suggests that the combined intervention was effective since the horticulture element introduced OSP to the area and one of the nutrition messages encouraged the women to increase their consumption of OFSP and other β-carotene containing vegetables such as carrots or pumpkin and provided opportunities for them to taste these vegetables in traditional meals, like *mukimo*, *githeri* and *chapati*. Studies in

other sub-Saharan African countries have similar findings where the implementation of a combined nutrition education intervention and horticultural support resulted in increased consumption of β-carotene containing orange-fleshed sweet potatoes and micronutrient intakes (Low et al. 2007 & 2017; Yeudall et al., 2001).

Sweet potatoes are the fifth most important food crop in developing countries, and a staple crop for many areas of sub-Saharan Africa. This is why their cultivation is being used to improve incomes and food security in poverty-stricken rural areas (Kapinga et al., 2007). With that said, the majority of farmers in Eastern Africa grow and consume the white-fleshed or purple-fleshed sweet potato, both of which are lower in β-carotene relative to the orange-fleshed variety. Low levels of vitamin A knowledge were observed in a 2013 Ethiopian study (Busse, 2017) where 63% of mothers were knowledgeable about vitamin-A functions, but only 8% identified OFSP as a source, with just 1% consuming OFSP within the previous seven days (Busse, 2017). This suggests that education is needed in order to clearly identify OFSP as an important source of β-carotene and that the vitamin is important to prevent blindness and infections. As well, nutrition education is needed to provide appropriate strategies to incorporate this crop in daily foods as a means of changing eating habits. Furthermore, there was an interesting pattern within the results of this study, where a higher proportion of the comparison group consumed the Irish potatoes/white sweet potatoes/cassava food group more often. Since starchy tubers are staples within the Kenyan diet (Mohajan, 2014, Oniango, 2003), it appears the intervention group was substituting the healthier orange-fleshed sweet potatoes for the traditional white starchy tubers as a result of the combined intervention. Groups working in Eastern Africa, such as Farmers Helping Farmers in Kenya

(http://www.farmershelpingfarmers.ca/), have been emphasizing and encouraging farmers to grow and consume orange-fleshed sweet potatoes and other orange-fleshed vegetables (Gamble et al., 2013), with the goal to increase β–carotene consumption, addressing the vitamin A deficiency that is widespread in Kenya (Low et al, 1997; Kapinga et al., 2007).

Within the intervention group, there were no significant differences in the usual food use prior to and following the intervention, which could be due to multiple factors. In terms of OFSP, there may have been an unchanged availability of the orange-fleshed sweet potatoes as they had been planted close to the time of the pre-test during a planting season and can take three to four months to mature; these were therefore not ready to harvest by the time of the post-test. Secondly, the intervention group was previously exposed to this specific vitamin A nutrition message as part of the 2016 pilot study, and although there was a significant increase in OFSP consumption prior to and following the 2016 pilot study (Muthee, 2018), this repetition of the nutrition message may be a reminder to maintain OFSP at the current level, rather than a driver to increase consumption.

Aside from OFSP, milk, beef and rabbit, there were no other significant differences in food use among the intervention group or between the intervention and comparison group. Consistent with other reports of typical food consumption patterns in Kenya (Oniang'o, 2003; Mohajan, 2014), the foods most often consumed by women in both groups included tomatoes, Irish potatoes, green leafy vegetables and both milk and sugar added to tea. It is unlikely that foods such as green leafy vegetables would increase in consumption since they were consumed frequently prior to the study. Further, the short

time period of five weeks may not have allowed the women sufficient time to implement more of the nutrition messages. Finally, although rainwater tanks and drip irrigation were provided to the women with the full horticultural intervention to help them to cope with erratic and insufficient rainfall, this provides protection for kitchen gardens only. The lack of rainfall during the time of study could still negatively impact the kitchen gardens of women with the partial horticultural intervention as well as all women's field crops, such as maize and beans, that rely on rainfall only..

Findings from this study are consistent with findings from another component of our larger study (Muthee, 2018) which found that post-intervention, more of the intervention group reported consumed vitamin-A containing green vegetables (kale, spinach, swiss chard and pumpkin leaves), dried peas and beans, vitamin-C containing fruits and other fruits and vegetables relative to the comparison group. Similarly, following the nutrition education intervention, the intervention group had a significantly higher diet diversity score, with higher consumption of vitamin-A green vegetables and vitamin-C vegetables (red and green bell or chilli peppers, tomatoes and zucchini). Muthee suggests that the increased diet diversity reflected the messages emphasized within the nutrition education intervention. For example, to increase non-heme iron absorption for meals prepared with beans, it was encouraged in the nutrition message to add vitamin-C vegetables such as bell or chilli peppers to their traditional meals such as *githeri* or *mukimo*. However, the women's dietary intakes in Muthee's study were collected over a single 24-hour period, providing more specific short term food use data compared to the FFQ in the present research, which provides estimates of usual intake (over 30 days). While this may explain why the present findings differed from that of

Muthee (2018), FFQ can measure the impact of the combined intervention on women's usual food intake over a longer period (Shim et al., 2014), and recognize foods consumed less often that still contribute to women's overall nutritional status and health.

The majority of women in both groups were around 50 years of age, married, the household owned their home and agriculture land and women had completed primary education or none at all. Results suggest that women in the comparison group have modestly higher socio-economic status in that more women owned exotic cattle and chickens and reported owning a bank account. Although it might be expected that the higher socio-economic status could positively influence diet diversity, this was not observed in the present study. Rather, women in the intervention group had more diverse diets, suggesting that the combined intervention had a significant and positive impact on the variety of foods consumed.

In both the comparison and intervention groups, married women with higher education levels and those with husbands with higher education levels reported more frequent consumption of nutrient-dense foods such as pumpkin, carrots, squash, orange-fleshed sweet potatoes and tomatoes than those who did not share these characteristics. As well, women whose husbands were businessmen reported more frequent consumption of tomatoes, Irish potatoes, white sweet potatoes and cassava, possibly reflecting a higher household income which can impact food purchases and consumption (Walton, 2012). This suggests that nutrition education can accompany increased income to positively effect good nutritional choices, such as the consumption of orange-fleshed sweet potato or carrots, rather than the traditional starchy staples. In addition, those with some knowledge and education on food use and nutrition will be more conscious of their purchases,

influencing what they and their family consume. Basic education along with the promotion of home gardens has been described as a positive factor in improving nutrition and health status (Ecker et al., 2010). Although the comparison group owned more exotic (dairy breed) cows, they consumed milk less frequently than the intervention group. Although this group was able to produce more milk, it is likely that they are choosing to sell it, rather than consume more of it. This apparently contradictory relationship between dairy cattle ownership and milk consumption of milk was also observed by our research team in a previous study of women farmers in a nearby region in Kenya. Walton et al (2012) found that families benefitted from selling the milk they produce as it contributed to the household's income and therefore to the purchase of household goods, school fees, and foods, such as more caloric-dense staples such as maize and cassava (Walton, 2012). The path from milk production to consumption is thus not a linear one (Walton, 2012) which further reinforces the importance of nutrition sensitive agriculture in order to achieve optimal health outcomes.

The more frequent beef consumption in the comparison group was likely a reflection of their modestly higher socioeconomic status (based on higher exotic dairy cattle and bank account ownership). This is consistent a previously reported link between higher animal flesh-food consumption and higher income of women (Oniang'o, 2003; European Commission, 2015). Encouraging the consumption of animal protein sources was not included as part of the intervention because of the economic challenges of purchasing animal products. Nonetheless, consumption of animal flesh foods (including beef, chicken, rabbit and liver, among others) was assessed to verify that consumption was indeed low for this population. To understand why this difference in beef

consumption was reported, we can look at the demographics of the comparison group relative to the intervention group. Analysis showed that more of these women owned exotic (dairy) cattle and, as discussed above, the sale of milk contributed to their household income. In addition, a higher proportion of this group owned a bank account. All of these factors reflect a more financially secure comparison group. It thus makes sense why a higher proportion of the comparison group, who appear to have a greater expendable income, reported consuming more beef, due to the known positive relationship between income and consumption of animal protein sources. Meat is more expensive than vegetables and starchy tubers, making this nutritious source of protein, iron, and B-vitamins a challenge to purchase. Similarly, a higher proportion of women who reported owning agricultural land and animals (chickens, goats, exotic and local cattle) consumed milk, bananas, sweets and sugar in tea. These agricultural assets are important to maintain and increase a family's income and food purchasing ability (Covarrubias, 2012). The significant differences in food use according to the demographic factors reaffirms the notion that income strongly influences and dictates what an individual and their family consume (Olielo, 2013, Taljic et al., 2016, Musyoka et al., 2006; Walton 2012). Further, the household food insecurity assessment from another component of our larger study (Muthee, 2018) supports the probable differences in socio-economic status between these two groups. Muthee's results showed that households in the intervention group were significantly more likely to be food insecure relative to the comparison group ($p=0.01$): more (62%) women in the intervention group were severely food insecure relative to the comparison group (26%).

As explained previously, beef consumption was higher among the comparison group members yet, unexpectedly, the intervention group's average intake of rabbit was higher than the comparison group. However, the latter was a rarely eaten food in both groups, consumed only on a monthly basis. It is therefore unlikely that there is a connection between the horticultural support or nutrition education and the consumption of rabbit. However, a paper presented at the 2010 International Symposium on Food and Nutrition Security by the FAO indicated that even infrequent or low consumption of meat or animal source foods can contribute to improved nutrition and health of rural communities (Neumann et al., 2014). The paper also described the success that could come from encouraging rabbit consumption to address nutritional deficiencies. This is an area which should be explored in future projects.

Although this study suggests a positive effect of the combined horticultural and peer-led nutrition education intervention on orange-fleshed sweet potato consumption by the intervention group, the FFQ tool did not reflect all promoted foods from the nutrition messages. It is therefore not possible to assess the potential impact of the intervention on women's usual food consumption. In some instances, the foods were unintentionally excluded from the FFQ list, such as bell peppers and oranges (related to the vitamin C consumption); the instrument may be modified for future studies. Also, recommendations to use whole grain maize, soak maize and beans, use the 1:1 maize to bean ratio, add at least two nutritious grains when preparing the breakfast porridge *uji* and avoid drinking chai one hour prior to and after meals were not assessed by the FFQ; these behaviours were assessed separately via questionnaire as part of the larger study. Lastly, and possibly related to the 2016 pilot nutrition education and horticultural intervention, some foods

emphasized in the nutrition messages were already being consumed regularly by the women in 2017, such as green leafy vegetables or tomatoes. This made it unlikely that consumption would increase significantly after the intervention.

5.2 Horticulture Intervention

As expected, a higher proportion of the intervention group had drip irrigation and healthy-looking garden plants and many women had planted orange-fleshed sweet potatoes.

Women who had the full horticultural intervention had higher average daily intakes for 14 and 13 of the 21 foods/foods groupings prior to and following the intervention, respectively. The consumption of sweets and milk added to tea was higher for those women receiving the full intervention, with differences approaching significance. This may be due to the drip irrigation contributing to the success of the women's kitchen gardens, and enabling them to grow, consume and sell more, improving their household income and allowing them to purchase sweets and milk more often (Olielo, 2013, Taljic et al., 2016, Musyoka et al., 2006). This relationship is consistent with the goals set out by Farmers Helping Farmers for the horticultural intervention: to increase household food consumption of the vegetables grown in the gardens, increase household income and increase the overall community food supply (http://www.farmershelpingfarmers.ca/).

The members of the intervention group with the full horticultural intervention did have higher ADI intakes of rabbit, milk added to tea and beef liver relative to those with the partial intervention, with the latter two food groupings approaching significance. These results again suggest the positive effect of drip irrigation and rainwater tanks on

food consumption. As a result of the full horticulture intervention and the ability to sell excess produce, women would be more likely to have the economic means to purchase beef liver, milk and small animals such as rabbits. The higher intake of beef liver is important to take note of, as it is rich in heme iron (Dietitians of Canada, 2016) and is being consumed by women in an area where iron deficiency is prevalent (FAO, 2010). This consumption is unique, as researchers were informed anecdotally that traditionally, the organ meat is only consumed by the husbands. One might assume that the full horticultural intervention is enabling the women to purchase this excellent source of heme iron. While this is a positive outcome of the intervention, it may not be feasible to recommend that every woman to begin purchasing beef liver, as this food is not easily accessed economically or culturally. Perhaps it would be beneficial to promote raising other animals, such as rabbit, which have high reproduction rates. A study from Zambia (Zhang A, 2016), explored animal sources of food as a method of combatting micronutrient inadequacies. They concluded that supplementation with small amounts of milk and meat dramatically improves the supply of deficient nutrients, iron included, and decreases their likelihood of being deficient.

5.3 Strengths and Limitations

A major strength of this study was the peer-led nutrition education element of the intervention, as it is widely used, and has the capability to increase the credibility and effectiveness of the messages presented (USAID, 2010). This approach may also have contributed to women feeling emotionally empowered. A study done in conjunction with the larger project and with the same intervention group (Shileche, 2018), found that women in the intervention group felt more emotionally empowered in the long term. This

is important, since women's empowerment, along with basic education and the promotion of home gardens, has been described as a positive factor in improving nutrition and health status (Ecker et al., 2010).

The design of the study included both pre and post-tests completed for the intervention group, with a pre-test only being completed with the comparison group. This made it difficult to assess the extent of changes in food use over the five week intervention among women in the intervention group relative to changes in the comparison group. Food availability in the comparison group could have been affected by a lack of rainfall since none had drip irrigation or water tanks. It also may have been beneficial to have completed the 'Growing Condition Checklist' during the post-test, to assess if there were any major differences in the growing conditions and the harvest from the women's gardens.

This study had a high participant response rate even though it required a significant amount of time and patience from the women in the intervention group, with each woman being asked to complete two home interviews of approximately 1.5 hours each. A number of women also participated in focus group discussions as well, as part of another component of the larger study. In spite of these demands, all women participated in both interviews. The high participation rate likely reflects the long-standing partnership with Farmers Helping Farmers, which means the women recognized this study as being connected to tangible benefits that they had received, including the enhanced gardens and horticulture support. Secondly, it is important to note that this study was piloted in 2016 such that 2017 was the second year that the women's group and elected *Champs*

participated in the intervention. As a result, women in the intervention group were already familiar with the process and the instruments and were highly engaged in the intervention.

In spite of the high participation rate, there are limitations associated with the small sample size. With only having 29 intervention members and 20 comparison members, statistical power could have been reduced. Similarly, the study had limited power to detect significant differences between the intervention group with and without the full horticulture intervention.

Food intakes and diet diversity were assessed in the parallel study (Muthee, 2018) using a 24-hour recall, which may be more sensitive to differences in food intakes over a short-term period. The food frequency questionnaire (FFQ) instrument chosen for this study had both its strengths and limitations. To begin, it is recommended that FFQ be developed specifically for the target population being assessed (Shim et al., 2014; Cardoso et al., 2010). For this study, the food list used was based on dietary recalls of women in the same area, to reflect their usual dietary intakes (Gamble et al, 2013). This FFQ tool required respondents to rely on the memory of food consumption within the previous four weeks, which may have led to under or over reporting and inaccurate results (Cardoso et al., 2010). Social desirability bias may also have been a factor, as intervention group members recognized this study as being connected to tangible benefits that they had received, and may have answered to support the success of the intervention (Herbert et al., 1995). As mentioned, although the FFQ is a tool that is useful in describing patterns of dietary consumption, there were select nutrition messages taught during the intervention which may not be reflected by this tool. Specifically, the adherence to the nutrition message of avoiding tea consumption one hour before and after a meal cannot be

assessed using a FFQ, because it is not meal based dietary assessment method. As well, since portion sizes were not included in the FFQ, the message concerning using a 1:1 maize to bean ratio was not reflected. In other instances, the foods were simply not included on the FFQ list, such as bell peppers and oranges (related to the vitamin C consumption) or the additional two grains recommended for *uji*. The soaking of maize and beans, could not be addressed by the FFQ, as this message focused on practices, rather than consumption. Lastly, some foods emphasized were already used regularly, such as green leafy vegetables to increase iron and vitamin A intake or the tomatoes which represented the vitamin C rich foods. This made it unlikely that the consumption would increase significantly after the intervention.

Since the combined intervention involved a horticultural element, it was important to assess the growing conditions in each group during the study. Results from the growing condition checklist support the conclusion that the drip irrigation helped to mitigate the effects of inadequate rainfall during the study. However, the women with the partial horticultural intervention may have also been negatively impacted in terms of both their harvest yield and purchasing and food consumption options. It is also important to note that the consumption of some foods will vary throughout the year, depending on their seasonality, regardless of whether drip irrigation is present or not.

The strong partnership with FHF and the contributions of FHF staff were significant strengths of this study. FHF staff's extensive knowledge of horticulture, the local crops, the women's unique situations, the community and their fluency in the native dialect was paramount to the completion of this research. Likewise, the knowledge and expertise of local translators who were familiar with not only the local dialect but the

whole study was a strength.. However, there is a possibility that there were errors in the results due to the translation and interpretation required between the interviewers and respondents. Respondents may have altered their answers to appear more needy or more secure, which is possible for women from both intervention and comparison groups. Furthermore, skewed results may have arisen due to there being two different translators who could have asked or interpreted questions and/or responses differently (Lee, Sulaiman-Hill & Thompson, 2014). To reduce the error from differences in translation and interpretation, the translators were trained and FHF staff were present for initial interviews to assist translators with correct terminology. As well, graduate students on the larger project who were familiar with the questionnaires and spoke Swahili and had some familiarity with the local language of Kimeru, were present during the home interviews.

Finally, and most certainly not least, the participation of two Kenyan graduate students who were registered dietitians completing their graduate work was a strength of the study. Their great depth of nutrition knowledge, expertise on the Kenyan culture and their ability to connect and create a great rapport with the women participants, helping them feel comfortable, were key to the success of this study.

5.4 Future Research

There are a number of recommendations and suggestions that stem from this study concerning future research. To begin, the FFQ may be re-evaluated with community members to identify if any commonly consumed foods should be added to the list, or if others should be removed. To better examine full effects of the combined intervention, consumption of oranges, bell peppers and zucchini should be assessed in order to assess the impact of the nutrition message about consuming vitamin C rich foods

to increase iron absorption. However, any extension of the food list needs to be done cautiously, so that foods are relevant to the target population while avoiding a long food list which would place an excessive burden on respondents.

The peer led nutrition education component of the present study focused on increasing the consumption of promoted vegetables and fruit from the women's kitchen gardens. However, nutrition messages that encourage consumption of any animal food source at all, such as beef, eggs or rabbit should be considered. Rabbit production may also be an avenue to investigate in future projects.

Although it is outside the scope of this honours project, a multivariate analysis should be conducted to better understand the association between food use and demographic factors.

6. CONCLUSIONS

These study results provide insight into the usual food use of women living in Naari and the

impact a combined horticultural and peer-led nutrition education intervention may have.

Objective 1: To assess differences in the frequency of food use and average daily food intakes between members of a women's self-help group receiving a horticulture and peer-led nutrition education intervention and a comparison group not receiving the intervention.

A higher proportion of women who received a combined nutrition education and horticultural intervention consumed orange fleshed sweet potatoes (OFSP) on a weekly basis relative to the comparison group. This was consistent with one of the main nutrition messages taught both in 2016 and 2017 and the introduction of OFSP as part of the horticulture intervention. These findings suggest that the combined intervention supports the women in growing, harvesting and consuming vegetables that they have learned are nutritionally superior to the traditional Irish or white/purple sweet potatoes. The intervention group also reported a higher average daily intake of rabbit prior to the nutrition intervention, and due to the higher harvest yield, the women may able to invest in raising or purchasing small animals for consumption. The finding that more comparison group women consumed beef, which is one of the most expensive foods on the list, is consistent with past evidence that food consumption is directly influenced by socio-economic status which includes productive agricultural assets.

Objective 2: To assess differences in the frequency of food use and average daily food intakes of women in the intervention group prior to and following the intervention.

There were no significant differences in either the frequency of use or average daily intakes among the intervention group members, both prior to and following the nutrition intervention. The lack of differences in food use may be due to the positive impact of a pilot intervention the year prior to the study on usual food use and the short time period separating the pre and post-test.

Objective 3: To assess differences in the frequency of food use and average daily food intakes between members of a women's self-help group with and without drip irrigation prior to and following the intervention.

This study found few differences in the frequency of food use prior to or following the nutrition education intervention for the intervention group members, according to the presence of drip irrigation. The consumption of milk added to tea and beef liver was higher for those with drip irrigation, with differences approaching significance. However, after the nutrition intervention, those with the drip irrigation reported a significantly higher average daily intake of rabbit. Both these findings are suggestive of increased income so that women could purchase such items. Since the drip irrigation is provided to the members based on need, this horticultural support has enabled the more vulnerable women to maintain food use comparable to other members of their group.

Objective 4: To assess differences in frequency of food use between members of a women's self-help group receiving a horticultural and peer-led nutrition education

intervention and comparison group, according to demographic factors such as age, education, occupation, livestock and land ownership.

This study revealed that demographic characteristics such as age, education, marital status and livestock ownership influenced food consumption in both the intervention and comparison groups. Higher education levels were associated with more frequent consumption of nutrient-dense foods such as pumpkin, carrots, squash, orange-fleshed sweet potatoes and tomatoes. The higher exotic livestock (dairy cattle) ownership in the comparison group reflected higher income levels which was associated with more frequent beef consumption. This was an important relationship to understand because regardless of the amount of nutrition knowledge and education a woman and their family may have, a decreased ability to successfully produce or ability to buy the foods which are promoted, will impede nutritional and health improvements.

Therefore, the approach used by FHF, which supports sustainable agricultural development with a strong focus on women, will increase farming yields and livelihoods that will, in turn, improve food consumption and overall health. In order to understand the relationship between the combined intervention, demographic characteristics and usual food use, multivariable analysis should be conducted.

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APPENDICES

Appendix A: Combined Nutrition Messages and Cooking Tips

Champs Family Nutrition and Cooking Tips 2017

Githeri Messages:

Make Super Star Githeri! Making githeri this way will make you and your family healthier and give more energy.

1. Use **mpempe (whole grain) maize** to obtain more nutrients like B vitamins and fibre. Muthekore maize is not as nutritious. Whole grains are an excellent source of B-vitamins. They are beneficial for growth and energy.

2. Use **equal amounts** of maize and beans to get more protein for strength. Always maintain the 1 to 1 ratio for a healthy pot! Beans are body building foods.

   Soak maize and beans overnight before cooking. Drain water to remove the substances that cause stomach problems. Use enough water so that you can discard some soaking water and get rid of those substances. Do not use the soaking water as it could cause stomach problems. Use it for your crops. Cover with fresh water and proceed to cook. Soaked maize and beans will cook more quickly (2-3 hours).

   Soaking:

   - ✓ reduces the cooking time
   - ✓ reduces use of fuel
   - ✓ improves the digestibility
   - ✓ improves the nutritional quality of the food

3. **Add at least two vegetables** in addition to tomatoes and onions. The more the better for a healthy pot! Naari vegetables are delicious!

   - o Use one green and one orange vegetable in your githeri as often as you can: daily is best.

- Greens give you iron and vitamin A which are important for energy, strength, good eyesight and to prevent illness. Green leafy vegetables such as kales, spinach, swiss chard or cowpea leaves are rich in nutrients such as iron, folate, and vitamin A. These nutrients are very important for growing children and women.

- Orange vegetables (orange-fleshed sweet potatoes, carrots, pumpkin, butternut) are a rich source of vitamin A which is important for good eyesight and to prevent illness.

4. Add vegetables **on the top** near the end of cooking time to protect vitamins.

5. When eating githeri, **add vitamin C rich foods** to your meal to protect iron found in beans and cereals. Iron in food is needed for energy and strength.
   - Tomatoes, pili pili ho ho, paw paw and oranges are good sources of Vitamin C.

Mukimo Messages:

Make Super Mukimo: preparing mukimo this way will make you and your family healthier and stronger.

1. Use mpempe maize
2. Use equal amounts of maize and beans as is recommended when preparing githeri
3. Soak and cook the maize and beans the same as is recommended when preparing githeri.
4. Double the amount of greens such as kales, spinach, swiss chard, stinging nettle (thaa) or cowpea leaves. These are rich in nutrients such as iron, folate, and vitamin A which are important for energy, strength, good eyesight and to prevent illness.

5. Add pumpkin or butternut squash to the Irish potatoes and mash. Pumpkin is high in vitamin A good for eyesight and to prevent illness.
6. When eating mukimo, add vitamin C rich foods to your meal to protect iron found in beans and cereals. Iron in food is needed for energy and strength.

   - Tomatoes, pili pili ho ho, paw paw and oranges are good sources of Vitamin C.

Uji Messages:

Make Super Uji: preparing uji this way will make you and your family healthier and stronger.

1. Use **mpempe (whole grain) maize** to obtain more nutrients like B vitamins and fibre. Flour from muthikore maize is not as nutritious.

2. Add at least two grain ingredients for more energy and strength.
    - Mix mpempe maize +
        - finger millet or
        - amaranth or
        - sorghum

3. Add other nutritious ingredients to maize flour:
    - dried orange flesh sweet potato or
    - terere seeds or
    - dried arrowroot or
    - dried cassava or
    - dried yams

4. Take the ingredients to a posho mill to be ground into flour
OR grate orange-fleshed sweet potatoes, carrots or pumpkin and cook with the uji.

5. Add milk for added nutrition. This provides calcium for strong bones and teeth.

6. Avoid adding sugar and salt for a healthier uji.

7. Add eggs to increase protein

8. Add vegetable oil to increase energy.

Chapati Messages

When you make chapatis, make them healthier!

- Add orange-fleshed sweet potatoes, carrots and/or pumpkin
    - Peel and boil so that it is very soft. Mash and add it first
    - Grate raw carrots and then mix with flour
    - Add 1 or 2 eggs to add protein for strength and to make them extra soft
- Add oil rather than solid fat. Oils with added vitamins like Golden Fry are more nutritious.
- Try to minimize the amount of oil used.

Tea (Chai) messages:

- Drink tea one hour before or one hour after meals. Avoid tea at meals to protect iron.
    - Substances in tea leaves make it difficult for your body to use the iron from foods
    - Tea can still be enjoyed, but it is best to consume it before or after meals to prevent its interference with iron in your meal.
    - Replace tea at meals with hot milk or water.

De-worming messages:

- Ensure that your child takes a dewormer once in every six months.
    - Worms compete with your body for the nutrients in the food you eat and they make you sick.
    - Even if you give enough food to your children or grandchildren, worms can steal the energy and nutrients from the food. Eliminate these good for nothing parasites!

- To protect against worms:
    - Have your child take a de-worming medicine once in every six months. Keep record of the last time your child took the pill least you forget.
    - Have your children wear shoes at all times except when sleeping.
    - Everyone should wash their hands with soap and water after using the latrine and before preparing or eating food.

Appendix B: Introduction Script for Home Interviews

Thank you for allowing us to come today.

We are students from the University of Prince Edward Island in Canada. We are working with Farmers Helping Farmers which, as you may know, is using drip irrigation, kitchen gardens and supports for growing crops to improve the nutrition and health of families in Naari.

We are conducting this interview as part of a large research project Farmers Helping Farmers (FHF), University of Prince Edward Island (UPEI), Kenyatta University, University of Nairobi, and Naari Dairy Co-operative Society. The goal of this research project is improve nutrition, food security, and livelihoods of farmers in Naari.

The information we collect will help us to understand if the nutrition projects are helping women and their families in Naari.

We would like to ask you some questions about the food you eat, the cell phone you use, and your household. The survey will take a little over an hour.

You do not have to participate in the survey, but we hope that you will answer the questions since your views are very important.

We assure you that this survey is anonymous, meaning that there should be no way to connect your responses with you. All of your answers are confidential and will not be shared with anyone other than the researchers.

You are free to withdraw from the study whenever you want and there will be no negative consequences if you do. If you have any questions about the study, feel free to ask us at any time (we have our mobiles on the consent form we will be asking you to sign). If you have any concerns about the ethical conduct of this study, also feel free to contact the UPEI Research Ethics Board at (902) 620-5104, or by email reb@upei.ca.

Your assistance and cooperation is highly appreciated. You will receive one litre of cooking oil as a token of appreciation for participating in the study.

We have a consent form for you to sign.

Consent form for Survey Participants

We invite you to participate in this research. Your signature or thumbprint on this consent form means:

- You have been informed about the research and you understand its details.
- You understand that participating in this research study is voluntary.
- You understand that you can withdraw from the study at any time and there will be no consequences.
- You understand that you can ask any questions, at any time, about the research study.
- You understand that there are minimal risks and benefits associated with the study.
- You understand that the answers you provide will be kept confidential.
- You understand that you can keep one copy of the signed or thumb printed consent form if you so wish.
- You understand that if you have any concerns about the ethical conduct of this study, you are feel free to contact the UPEI Research Ethics Board at (902) 620-5104, or by email reb@upei.ca.

……

……..……..

Signature or thumbprint of participant **Date**

Researcher who obtained consent: I have explained this study to the best of my ability. I have invited questions and given answers to the participant. Therefore, I believe that the participant understands what is involved in being part of the research study.

…… ……..……..……..…….

Signature of Researcher **Date**

Research contacts:

Sarah W. Muthee - 0728 917 017 or smuthee@upei.ca
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jtaylor@upei.ca

<u>Appendix C:</u> UPEI/Farmers Helping Farmers/ QE II Scholars: Food Frequency Questionnaire (FFQ)

Name _____ ID _____

I. Food Use

We are interested in the foods that you have eaten over the past month. I will read a list of foods and ask you how often you eat them.

Food Item / Number of times	Last month		Each Week			Each Day			
	0	1-3	1	2-4	5-6	1	2-3	4-5	6+
1.Leafy green vegetables (kale, spinach, pumpkin leaves, cow pea, sweet potato, other dark green leaves)									
2.Pumpkin, carrot or squash									
3.Orange-fleshed sweet potato									
4.Tomatoes									
5.Irish potatoes, white sweet potatoes, cassava									
6.Pawpaw, mango, guava									
7.Bananas									
8.Milk (in your tea)									
9.Milk as a drink									
10. Egg (whole egg e.g. Fried or boiled)									
11.Egg in cooking (e.g. Pancake)									
12.Beef (flesh)									
13.Beef liver/organ meat									
14.Chicken meat									
15.Chicken liver/organ meats									
16.Goat meat									
17.Goat liver/organ meats									

Food Item	Last month		Each Week			Each Day			
Number of times									
18.Rabbit	0	1-3	1	2-4	5-6	1	2-3	4-5	6+
19.Pork									
20.Sweets (candy, sugar cane, chocolate, cakes, pastries, soda, mandazi (fresh donut)									
21.Sugar in tea									

Appendix D: Demographic Questionnaire 2017

Finally, we have a few short questions on your household.

55. Does your household own this structure (house, flat, shack), do you pay rent, or do you live here without paying rent? ***(Nyomba iu mbukaraga na njaa yaku, gokomborete, iyaku kana ukaraga kuu utirite?)***	Owns ***(Niyaku).....>...1*** Pays rent/lease ***(Niyagukombora)....2*** No rent with consent of owner..... 3 ***(Ukaraga wei ni mwene)*** No rent, squatting…… 4
56. Does your household own the land on which the structure (house, flat, shack) sits? ***(Munda juu wakite ni jwa njaa yaku?)***	Owns ***(Niyaku).....>...1*** Pays rent/lease ***(Niyagukombora)....2*** No rent with consent of owner..... 3 ***(Ukaraga wei ni mwene)*** No rent, squatting…… 4
57. Does any member of this household own any agricultural land? ***(Kuri muntu wa njaa yaku urina munda jwa kurima?)***	Yes..... 1 No 2
58. How many acres or hectares of agricultural land do members of this household own? ***(Antu ba njaa yaku barina munda nyung'ana?)***	Acres.....1 Hectares.....2 Plot size (SQ FT)..... 3 Don't know… 9
59. Does this household own any livestock, herds, other farm animals, or poultry? ***(Njaa yaku irina nyomoo cia ndithia kana nguku?)***	Yes..... 1 No 2
60. Do you own any of these animals? ***(Ni nyomoo iriku urina cio?)***	YES NO ***(Namba)*** a) Local cattle..... 1 2 ***(Ng'ombe cia kimeru)*** _____ b) Exoctic/grade cattle..... 1 2 ***(Ng'ombe cia kinandi)*** _____

	c) Horses/Donkeys/Camels..... 1 2 ***(Mbarasi/Ntigiri/Nkamira*** _____ d) Goats ..... 1 2 ***(Mburi)*** _____ e) Sheep…….. 1 2 ***(Ng'ondu)*** _____ f) Chickens.....1 2 ***(Nguku)*** _____
62. Do you own a bank account? ***(Urina account ya banki)***	YES.....1 NO 2
63. DETAILS OF THE MOTHER ***(Mantu ja Mwekuru)***	Age ***(Miaka)*** Marital status…….. ***(Niuguri)*** Level of education……..highest level completed Specify highest level (standard/form) completed ***(Kithomo wakinyirie naa?)*** _____
64. DETAILS OF THE HUSBAND/ partner (if applicable) ***(Mantu ja Mukuru)***	Age…***(Miaka)***…… …… Occupation ……..you categorize as you prefer (***Ngugi)*** Level of education. ***(Kithomo)*** Primary.....1 Post-primary/vocational.....2 Secondary/'A'Level.....3

	College(Middle level)..... 4 University 5

Thank you for completing this questionnaire!
(Ibwega nigutucokeria biuria)

Appendix E: Growing Conditions Checklist

Name: _____ Study ID number: _____

Now I will ask you a few questions about your shamba.

When did you last have a good harvest of maize and beans?

When you grow more vegetables than your family needs, what do you usually do with the excess? (check two most common)

□ Share with extended family
□ Share with neighbours (for free)
□ Sell to neighbours
□ Sell at local market
□ Other _____

Do you expect to have a good harvest this growing season? □ Yes □ No

Are you using drip irrigation in your kitchen garden? □ Yes □ No

Observation Checklist for Student to Complete:

Current adequate rainfall for crops	□ Yes □ No
Water in tank.	□ Yes □ No
Drip irrigation in use	□ Yes □ No
Plants healthy in kitchen garden	□ Yes □ No
Orange sweet potatoes in garden	□ Yes □ No
House style (circle):	Brick or wood
Roof on main house (circle):	Tile or corrugated metal

Appendix F: Complete results of usual food use by varying demographics for intervention and comparison group.

Table 13. The usual food use the intervention group by varying demographics. Only statistically significant comparisons are displayed on table.

Food/ Food groupings	**Demographics**	**Intervention group %**			**p-value**
Pumpkin, carrots, squash	**Mother's Education**	*Daily*	*Weekly*	*Less Than*	**0.004**
	Secondary/college/university/ adult education	30.8	69.2	0.0	
	None/primary	0.0	62.5	37.5	
Orange-fleshed sweet potato	**Mother's Education**	*Daily*	*Weekly*	*Less Than*	**0.02**
	Secondary/college/university/ adult education	0.0	61.5	38.5	
	None/primary	0.0	18.8	81.3	
	Husband's Education	*Daily*	*Weekly*	*Less Than*	**0.03**
	Secondary/college/university/ adult education	0.0	83.3	16.7	
	None/primary	0.0	33.3	66.7	
	Not Applicable	0.0	12.5	87.5	
	Number of goat owned	*Daily*	*Weekly*	*Less Than*	**0.04**
	More than 2	0.0	0.0	100.0	
	Less than or equal to 2	0.0	80.0	20.0	
	None	0.0	35.0	65.0	
Tomatoes	**Marital Status**	*Daily*	*Weekly*	*Less Than*	**0.006**
	Married	71.4	19.1	9.5	
	Single/widowed/divorced	12.5	37.5	50.0	
	Mother's Education	*Daily*	*Weekly*	*Less Than*	**0.05**
	Secondary/college/university/ adult education	69.2	30.77	0.0	
	None/primary	43.8	18.8	37.5	
	Husband's Education	*Daily*	*Weekly*	*Less Than*	**0.005**
	Secondary/college/university/ adult education	50.0	50.0	0.0	
	None/primary	80.0	6.7	13.3	
	Not Applicable	12.5	37.5	50.0	

Table 13 Continued. The usual food use the intervention group by varying demographics. Only statistically significant comparisons are displayed on table.					
Food/ Food groupings	**Demographics**	**Intervention group %**			**p-value**
Tomatoes	**Husbands Age**	*Daily*	*Weekly*	*Less Than*	**0.003**
	50 or older	85.7	14.3	0.0	
	Younger than 50	42.9	28.6	28.6	
	Not applicable	12.5	37.5	50.0	
	Husband's occupation	*Daily*	*Weekly*	*Less Than*	**0.03**
	Farmer/casual labourer	66.7	22.2	11.1	
	Businessman	87.5	0.0	12.5	
	Skilled jobs (teacher/pastor/driver)	50.0	50.0	0.0	
	Not Applicable	12.5	37.5	50.0	
Irish or white sweet potatoes, cassava	**Marital Status**	*Daily*	*Weekly*	*Less Than*	**0.01**
	Married	52.4	38.1	9.5	
	Single/widowed/divorced	0.0	50.0	50.0	
	Husband's Education	*Daily*	*Weekly*	*Less Than*	**0.001**
	Secondary/college/university/ adult education	16.7	83.3	0.0	
	None/primary	66.7	20.0	13.3	
	Not Applicable	0.0	50.0	50.0	
	Husbands Age	*Daily*	*Weekly*	*Less Than*	**0.02**
	50 or older	57.1	28.6	14.3	
	Younger than 50	42.9	57.1	0.0	
	Not applicable	0.0	50.0	50.0	
	Husband's occupation	*Daily*	*Weekly*	*Less Than*	**0.02**
	Farmer/casual labourer	44.4	44.4	11.1	
	Businessman	75.0	12.5	12.5	
	Skilled jobs (teacher/pastor/driver)	25.0	75.0	0.0	
	Not Applicable	0.0	50.0	50.0	
Bananas	**Mother's Education**	*Daily*	*Weekly*	*Less Than*	**0.03**
	Secondary/college/university/ adult education	15.4	76.9	7.7	
	None/primary	37.5	25.0	37.5	

Table 13 Continued. The usual food use the intervention group by varying demographics. Only statistically significant comparisons are displayed on table.

Food/ Food groupings	Demographics	Intervention group %			p-value
	Acres Owned	*Daily*	*Weekly*	*Less Than*	**0.05**
	>1 acre	0.0	75.0	25.0	
	≤ 1 acre	38.9	44.4	16.7	
	Unknown	33.3	0.0	66.7	
Milk as a drink	**Agricultural Land**	*Daily*	*Weekly*	*Less Than*	**0.02**
	Owners	38.5	42.3	19.2	
	Rent or no rent consent	0.0	0.0	100.0	
	Acres Owned	*Daily*	*Weekly*	*Less Than*	**0.05**
	>1 acre	50.0	50.0	0.0	
	≤ 1 acre	33.3	38.9	27.8	
	Unknown	0.0	0.0	100.0	
Whole eggs	**Number of goat owned**	*Daily*	*Weekly*	*Less Than*	**0.05**
	More than 2	0.0	50.0	50.0	
	Less than or equal to 2	0.0	100.0	0.0	
	None	0.0	40.0	60.0	
Eggs in cooking	**Number of local cattle owned**	*Daily*	*Weekly*	*Less Than*	**0.05**
	4 or more	0.0	66.7	33.3	
	Less than 4	0.0	80.0	20.0	
	None	0.0	28.6	71.4	
Beef	**Number of chickens owned**	*Daily*	*Weekly*	*Less Than*	**0.002**
	More than 5	0.0	80.0	20.0	
	Less than 5	8.3	16.7	75.0	
	None	0.0	0.0	100.0	
Beef Liver	**Husband's occupation**	*Daily*	*Weekly*	*Less Than*	**0.06**
	Farmer/casual labourer	0.0	0.0	100.0	
	Businessman	0.0	37.5	62.5	
	Skilled jobs (teacher/pastor/driver)	0.0	25.0	75.0	
	Not Applicable	0.0	0.0	100.0	

Table 13 Continued. The usual food use the intervention group by varying demographics. Only statistically significant comparisons are displayed on table.					
Food/ Food groupings	**Demographics**	**Intervention group %**			**p-value**
Sweets	**Number of exotic cattle owned**	*Daily*	*Weekly*	*Less Than*	**0.05**
	4 or more	9.1	87.5	12.5	
	Less than 4	20.0	20.0	60.0	
	None	0	36.4	54.6	
Sugar in tea	**Husbands Age**	*Daily*	*Weekly*	*Less Than*	**0.05**
	50 or older	42.9	14.3	42.9	
	Younger than 50	100.0	0.0	0.0	
	Not applicable	50.0	37.5	12.5	
	Number of goat owned	*Daily*	*Weekly*	*Less Than*	**0.06**
	Less than or equal to 2	88.9	11.1	0.0	
	None	45.0	20.0	35.0	

Table 14. The usual food use of the comparison group (n=19) by varying demographics. Only statistically significant comparisons are displayed on table.					
Food/ Food groupings	**Demographics**	**Comparison %**			**p-value**
Papaya, Mango, Guava	**Bank account**	*Daily*	*Weekly*	*Less Than*	**0.02**
	Own account	7.1	78.6	14.3	
	No Account	0.0	20.0	80.0	
	Husband's Education	*Daily*	*Weekly*	*Less Than*	**0.04**
	Secondary/college/university/ adult education	0.0	87.5	12.5	
	None/primary	0.0	20.0	80.0	
	Not Applicable	16.7	66.7	16.7	
Beef	**Goat**	*Daily*	*Weekly*	*Less Than*	**0.009**
	Owns	14.3	42.9	42.9	
	Doesn't own	0.0	100.0	0.0	
Beef	**Number of goats owned**	*Daily*	*Weekly*	*Less Than*	**0.01**
	More than 2	33.3	33.3	33.3	
	Less than or equal to 2	0.0	50.0	50.0	
	None	0.0	100.0	0.0	
	Sheep	*Daily*	*Weekly*	*Less Than*	**0.02**
	Owns	0.0	50.0	50.0	
	Doesn't own	7.7	92.3	0.0	
	Number of sheep owned	*Daily*	*Weekly*	*Less Than*	**0.04**
	More than 2	0.0	66.7	33.3	
	Less than or equal to 2	0.0	33.3	66.7	
	None	7.7	92.3	0.0	
Sweets	**Bank account**	*Daily*	*Weekly*	*Less Than*	**0.05**
	Own account	7.1	35.7	57.1	
	No Account	0.0	100.0	0.0	
Sugar in tea	**Number of exotic cattle owned**	*Daily*	*Weekly*	*Less Than*	**0.007**
	More than 2	90.0	0.0	10.0	
	Less than or equal to 2	22.2	11.1	66.7	
	Husband's occupation	*Daily*	*Weekly*	*Less Than*	**0.008**
	Farmer/casual labourer	12.5	12.5	75.0	
	Businessman	100.0	0.0	0.0	
	Skilled jobs (teacher/pastor/driver)	66.7	0.0	33.3	
	Not Applicable	100.0	0.0	0.0	