Effects of a Combined Horticulture and Peer-led Nutrition Education Intervention on Food Security, Diet Diversity and Knowledge, Attitudes, and Practices of Women Farmers Belonging to Women's Self-help Groups in Rural Eastern Kenya

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Sarah Wangeci Muthee

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Name of Author: Sarah Wangeci Muthee

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Examiners':

_____Dr. Rebecca Reed-Jones (Graduate Studies Committee, Chair)

_____Dr. Kim Critchley (External examiner)

_____Dr. Jennifer Taylor (Co-supervisor)

_____Dr. Colleen Walton (Co-supervisor)

_____Dr. Carolyn Peach Brown (Supervisory Committee Member)

_____Dr. Irene Awuor Ogada (Supervisory Committee Member)

Date:

ABSTRACT

Research in developing countries suggests that horticulture interventions are an effective means of enhancing the diversity of diets and food security, particularly when they are combined with nutrition education and when women are the focus. However, there is little evidence of the effectiveness of such interventions in developing countries such as Kenya, where micronutrient deficiencies and food insecurity remain a significant problem, particularly among the rural farm women.

This research used a pre-post quasi experimental design to assess the effects of a combined horticulture and peer-led nutrition education intervention on food security, diet diversity and nutrition knowledge, attitudes and practices among farmers in Kenya. The horticulture intervention was provided through the research partner Farmers Helping Farmers, with some women receiving enhanced kitchen gardens and some receiving horticultural support only. The nutrition education intervention used a peer-led approach to teach women how to incorporate the nutritious crops from the enhanced gardens into their staple dishes. The objectives were (i) to identify and/or develop methods to assess household food security, diet diversity and nutrition knowledge and practices and to use these methods to pilot the intervention and assess its impact on these outcomes; (ii) to assess the impact of the full intervention on household food security, diet diversity, nutrition knowledge, attitudes and practices; (iii) to compare household food security among women in the intervention group with and without enhanced kitchen gardens. Two manuscripts served these objectives using data from a pilot intervention (May 2016) and actual implementation of the combined intervention (May-July 2017). The first manuscript identified and validated methods to assess household food insecurity and diet diversity; a tailored questionnaire to assess nutrition knowledge and practices was also developed. The impact of the pilot intervention was assessed following a peer led education and cooking session using in home interviews. Results indicated that households in the intervention group were more food insecure ($p=0.01$) but had higher diet diversity ($p=0.02$) relative to the comparison group. Knowledge scores related to iron ($p=0.03$) were significantly higher in the intervention than the comparison group.

The second manuscript includes results from the 2017 intervention. Post-intervention, nutrition knowledge scores related to iron, vitamin A and protein were higher in the intervention group ($p=0.01$; $p=0.05$; $p=0.01$) as were attitudes towards vitamin A messages ($p=0.02$). Practices relating to iron (($p=0.01$), vitamin A ($p=0.04$) and protein ($p=0.04$) were also significantly high in the intervention group. Households in the intervention group were more food insecure relative to the comparison group. No significant differences existed in household food security between women with and without enhanced kitchen gardens.

This dissertation identified that the combined horticulture and peer-led intervention had a positive effect on diet diversity, nutrition knowledge, attitudes and practices of the women.

This work will inform the development of current and future interventions that aim to improve these outcomes. Future research is needed to investigate the long term effects of this combined intervention on food security, diet diversity and nutrition knowledge, attitudes and practices as well as nutrition status.

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Project Partners

Two Naari Area Women's Groups

Naari Dairy Farmers Cooperative Society

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1.0 Chapter One: Introduction

Many countries around the world continue to struggle with high levels of food insecurity. A household is considered to be food insecure when its members lack the means to access sufficient quantities of safe and nutritious food to be healthy and achieve their full potential in life (Food and Agriculture Organization [FAO], International Fund for Agricultural Development [IFAD], United Nations Children's Fund [UNICEF], World Food Programme [WFP], World Health Organization [WHO], 2017). Recent statistics suggest that about 689 million people (one in nine people) in the world are food insecure, with 307 million of those living in Sub-Saharan Africa (FAO et al., 2017). A consequence of food insecurity is inadequate food intake. In addition to inadequate intake of calories and protein, consumption of a diet low in diversity can result in deficiencies of micronutrients (vitamins and minerals) (Black et al., 2008; FAO et al., 2017). The prevalence of micronutrient deficiencies (MND) has increased concurrently with the increasing food insecurity (Talukder et al., 2014; FAO et al., 2017). Over the past two decades, Sub-Saharan Africa (SSA) has had the highest level of the world's poor and food insecure population, with more than one in four people being food insecure (Fanzo, 2012; FAO, 2015). In Kenya, a country located in SSA, more than four million people are estimated to be food insecure, with the food crisis being expected to worsen as a result of crop failure and climate change (WFP, 2016).

Food insecurity is attributed to many factors such as extreme poverty, unemployment, periods of prolonged drought, water scarcity, flooding, post-harvest losses, food price inflation, soil infertility, civil conflict, inter-communal rivalry and poor food production technologies (FAO, 2010; FAO, 2016; WFP, 2016). Furthermore,

food insecurity is exacerbated by gender inequalities in agriculture where women farmers have limited access to education, land, and credit which reduces their agricultural yields compared to their male counterparts (Doss, 2011; FAO, 2010; Njuki, Parkins, & Kaler, 2016; Peterman, Quisumbing, Behrman, & Nkonya, 2011; Peterman, Behrman, & Quisumbing, 2011).

The diversity of food consumed also provides insight into the magnitude of a household's food insecurity status and diet quality (Hoddinott & Yohannes, 2002; Ruel, 2003; WFP, 2016). Diet diversity (DD) assesses the number of different food groups consumed by a person or group of people over a given period of time (Arimond et al., 2011; Gibson & Ferguson, 2008; Ruel, 2003). The diversity of an individual's diet reflects their economic ability to access a varied diet (Thorne-Lyman et al., 2010) or their level of nutritional knowledge (McLeod, Campbell, & Hesketh, 2011; WFP, 2016). A recent national survey found that about 12 percent of households in Kenya were consuming poor diets that lacked essential vitamins and minerals such as vitamin A and iron (WFP, 2016). In fact, household's that were experiencing food shortages were less likely to consume iron rich foods compared to the food secure households. Furthermore, rural households were more prone to food shortages (39 %) compared to urban households (23%), which reflects low consumption of heme iron rich foods and vitamin A rich fruits and vegetables, thereby increasing the risk of developing MND (WFP, 2016).

MND have acute and irreversible effects on the health status of an individual (Black et al., 2008; Grantham-McGregor et al., 2000; Gwatkin et al., 2007; Maluccio et al., 2005; Matorell et al., 2010; UNICEF, 2011). Significant evidence links MND to

childhood cognitive and physical underdevelopment (Grantham-McGregor et al., 2000; Maluccio et al., 2005) reduced resistance to disease, increased risk of developing lifestyle diseases later in life (Fall, 2009) and reduced school performance (Matorell et al., 2010). These negative impacts limit a country's social and economic growth (Fanzo et al., 2011; Gwatkin et al., 2007; UNICEF, 2011). In the long term, food insecurity and low DD contribute to a cycle of poverty and low productivity, reducing social and economic development. Despite the impressive reduction in the number of Kenyans suffering from MND since the 2009 population census (Kenya Demographic Health Survey [KDHS], 2014), the prevalence of MND remains high particularly among women and children (UNICEF, 2011). Up to 43 percent of women of reproductive age and 60 percent of children under the age of five are at risk of iron deficiency anemia (UNICEF, 2011). As a result, MND remain the leading cause of illness and death in Kenya (Ronsmans, Collin, & Filippi, 2008; UNICEF, 2008). Clearly, much remains to be done in order to alleviate MND and food insecurity in Kenya. There is a need for more ambitious and concerted approaches to address food insecurity and MND (Haselow, Stormer, & Pries, 2016).

Several strategies have been explored globally and locally to reduce the devastating effects of food insecurity and low DD. These strategies include food aid, vitamin and mineral supplementation, food fortification, bio-fortification and efforts to increase food production (KDHS, 2014; UNICEF, 2011). However, these approaches have had limited success due to limited geographic coverage and acceptability, donor dependency and lack of affordability (Allen, 2003; Bailey, West, & Black, 2015; Berti, Faber, & Smuts, 2014; Underwood, 2004; Yeudall, Gibson, Cullinan, & Mtimuni,

2005). Nevertheless, scholars suggest that food security and DD are achievable through long term and culturally appropriate agricultural production and dietary modification strategies that target the root causes of food insecurity rather than its symptoms (Berti et al., 2014; Gibson, 2014; Hagenimana, Oyunga, Low, Njoroge, & Gichuki, 1999).

Food-based interventions are one such strategy that integrates agriculture with basic health care services that promote appropriate dietary behaviours through female nutrition education empowerment programs (Berti et al., 2014; Darnton-Hill, 2014). This combined approach has been proven effective in improving food insecurity, low DD, MND as well as nutritional knowledge, attitudes and practices of the targeted groups (Gibson, 2014; Hagenimana, Oyunga, Low, Njoroge, & Gichuki, 1999; Low et al., 2007; McDermott, Aït-Aïssa, Morel, & Rapando, 2013; Schreinemachers, Patalagsa, & Uddin, 2016; Yeudall, Gibson, Cullinan, & Mtimuni, 2005). Food based interventions are easily adaptable at the community level and require little or no external donor support, therefore enabling communities to be more self-reliant through capacity building (Yeudall et al., 2005). Even in food insecure settings, nutrition education has positively impacted the DD and KAP of people in developing countries (David, Kimiywe, Waudo, & Orodho, 2008; Gebremedhin et al., 2017; Lassi, Das, Zahid, Imdad, & Bhutta, 2013).

A number of different avenues of communicating nutrition messages have been explored, including use of face to face or individual counseling, use of single and multiple tailored educational materials as well as use of automated methods such as computers, among others (Brug, Oenema, & Campbell, 2003; Gans et al., 2009; McNulty, 2013). While the effectiveness of these methods has been well researched in

developed countries, less is known about methods that are effective with less educated and economically disempowered populations in developing countries (Brug et al., 2003; Gans et al., 2009). The peer-led nutrition education approach, where members of the target group are trained to deliver educational sessions to their peers, has emerged over the years and has demonstrated great potential in targeting such vulnerable populations (Prez-Escamilla, Hromi-Fiedler, Vega-Lpez, Bermdez-Milln, & Segura-Prez, 2008). However, the impact of this approach on food security, DD and nutrition knowledge, attitudes and practices remains unclear, particularly in developing countries, such as Kenya, where it has not been extensively utilized.

Although much literature exists on food insecurity in Kenya, there is limited knowledge of the impact of a combined horticulture and peer-led nutrition education intervention on addressing this problem. Very few studies in Kenya have documented the impact of this integrated approach, particularly when resources are channelled through women's self-help groups (WG) using the peer-led approach (Gamble, Smith, & Wallwin, 2013; Hagenimana et al., 1999). Farmers Helping Farmers, a non-profit organization based in Prince Edward Island, Canada, has been working with Kenyan WG to provide essential agricultural inputs to build enhanced kitchen gardens, including drip irrigation, water tanks to capture rain water, quality seeds, and to provide horticultural training. Beginning in 2010, nutrition education programming using a peer-led approach was added to complement the horticulture intervention in the Meru region. Although Gamble et al. (2012) found a significant improvement in the DD and food security status of rural women who were members of WG over a two year period with this intervention, knowledge, attitudes and practices were not assessed. This study will

be the first to assess the impact of a combined horticulture and peer-led nutrition education intervention on food security, DD and nutrition knowledge, attitudes and practices of women farmers in Kenya.

1.1 Aim of the Study

This study aims to assess the effects of a combined horticulture and peer-led nutrition intervention on food security, diet diversity and knowledge, attitudes and practices of women farmers belonging to a women's group in Meru, Kenya.

1.2 Specific Objectives

i. To identify and/or develop methods to assess outcomes of a combined horticulture and peer-led nutrition education intervention, including household food security, diet diversity and nutrition knowledge and practices and to use these methods to pilot the intervention and assess its impact on these outcomes;

ii. To compare household food security, diet diversity, nutrition knowledge, attitudes and practices between an intervention group receiving an enhanced combined peer-led nutrition education and horticulture intervention and a comparison group not receiving the intervention;

iii. To compare household food security among women in the intervention group with and without enhanced kitchen gardens.

1.3 Hypotheses of the Study

Following the implementation of a combined peer-led nutrition education and horticulture intervention, there will be:

i. Higher levels of household food security, diet diversity and nutrition knowledge, attitudes and practices among women in the intervention group compared to pre-intervention levels.

ii. Higher levels of household food security, diet diversity and nutrition knowledge, attitudes and practices among women in the intervention group relative to the comparison group.

2.0 Chapter Two: Literature Review

This review will discuss the issues of food insecurity, low diet diversity and micronutrient deficiencies in developing countries, as well as the strategies to address these issues.

2.1 Food Insecurity

Food insecurity has been a major global concern since the 1974 World Food Conference, which was held at a time when the world was facing massive food shortages (World Food Summit [WFS], 1996). Since then, the terms food insecurity and food security have been widely used to describe whether an individual, household or population has access to a sufficient quantity and quality of food (Coates, Swindale, & Bilinsky, 2007). The World Food Summit Plan of Action reaffirmed this definition by stating that "food security exists when all people at all times have physical, social and economic access to sufficient, safe, and nutritious food in order to be able to maintain a healthy and active life" (WFS, 1996). This definition clearly highlights the key elements of food security which include food availability, accessibility, stability and utilization (FAO, 2015).

Food availability includes the quantity, quality and seasonality of food which are affected by domestic production, local markets and imports. *Food accessibility* refers to the ability of a household to physically and economically acquire sufficient, safe and preferred foods continuously. The ability of a household to access food is heavily dependent on a household's purchasing power: a household with a higher income is more likely to be food secure than a household with a lower income. The *stability* element of food security refers to a household's ability to acquire a variety of preferred

foods all year without social, financial or political disruptions (Coates et al., 2007; WFP, 2016; WFS, 1996). However, even where food access and availability are stable, there may still be instances of food insecurity due to poor food utilization. *Food utilization* refers to the ability of a household to implement appropriate nutritional practices and basic nutritional knowledge of food storage, processing, preparation and distribution to the household members (Coates et al., 2007; FAO, 2016; WFP, 2016; WFS, 1996). As well, good sanitation, safe drinking water and good health status are necessary to achieve adequate food utilization (WFS, 1996; FAO, 2016). All of these elements of food security must be present in order for a household's food security to be achieved.

A critical analysis of the four main elements of food security demonstrates that the concept of food security is complex and is directly or indirectly affected by multiple factors. Specifically, the primary causes of food insecurity in developing countries may range from poverty, natural disasters, urbanization, social and gender inequalities, poor access to agricultural technologies, civil war, environmental degradation, rapid population growth, poor health status, low-levels of education and cultural insensitivities (FAO, 2010; FAO, 2016; Njuki et al., 2016).

2.2 Food Insecurity in Kenya

Kenya is located in Eastern SSA, with an estimated population of 44 million people (WFP, 2016). The country's economy is heavily dependent upon agriculture, which is a key contributor to rural development, poverty reduction and in generation of income and livelihoods for rural families (KDHS, 2014). About 80 percent of Kenyan land, specifically the northern and eastern regions, is classified as arid or semi-arid, and

is, therefore, unsuitable for rain fed agriculture (Monitoring African food and Agricultural Policies [MAFAP], 2013; WFP, 2016).

In recent years, Kenya has enjoyed a robust economic growth that has led to its classification as a lower middle income country (Kenya National Bureau of Statistics [KNBS], 2016; World Bank, 2015). The country's Gross Domestic Product (GDP) grew by 5.6 percent in 2015 with agriculture contributing to 30 percent of the total GDP (KNBS, 2016).

Despite the country's tremendous economic growth (KNBS, 2016; World Bank, 2015), four million Kenyans were classified as severely food insecure in 2016 and were in dire need of food aid; these numbers are expected to rapidly increase as a result of climate change and seasonal crop failure (WFP, 2016). Notably, in 2016, one in three households in Kenya experienced reduced food access, with rural households being more likely to experience food shortages than urban households, 36 and 23 percent respectively (WFP, 2016). In particular, Kenya's Meru County had 1.4 million people who were food insecure in 2011(Government of Kenya [GOK], 2011). Also, the prevalence of wasted, stunted, and underweight children was reported to be on the rise (GOK, 2013; KDHS, 2014). In 2015, Meru County experienced a severe food shortage with some areas projected to be heading towards a food crisis due to failed rains and consequent crop failure (KFSSG & CSG, 2015). According to the 2017 Kenya Food Security Steering Group (KFSSG) report, Naari, this study's area of interest, was in need of strategies to mitigate food insecurity and low DD (KFSSG & CSG, 2017). About 35 percent of the households in Naari were reported to be experiencing short term food instability, reduced food intake, reduced diet diversity and increased risk of acute

malnutrition (KFSSG & CSG, 2017). Other reports by the Kenyan government have also raised similar concerns over the increased prevalence of MND in this area (KFSSG & CSG, 2015). As a result, the Meru County government has recognized that, in order to minimize the detrimental effects of food insecurity and poor DD, combined agriculture and nutrition interventions that are culturally acceptable and sustainable need to be implemented at the household level (KFSSG & CSG, 2015, 2017).

The increasing food insecurity in rural Kenya, particularly in the Naari area, is chiefly attributed to poverty, gender inequalities, failed rains and drought, post-harvest losses, food price inflation and under-utilization of irrigation (MAFAP, 2013; WFP, 2016). For instance, only six to eight percent of the Kenyan's fertile land is under irrigation. The majority (80%) of smallholder famers who contribute about 75 percent of the country's food basket lack access to irrigation because of the expense associated with it (MAFAP, 2013; WFP, 2016). This lack of irrigation makes smallholder farmers highly vulnerable to climate change and seasonal food shortages (Keller, 2013). Smallholder farmers are peasant farmers who cultivate on average 0.2 to 0.3 hectares of land, on which they mainly grow subsistence crops and depend heavily on family labour for food production (Hickey, & Curtis, 2012).

In rural Kenya, women smallholder farmers tend to bear the burden of cultivating family land while still performing their primary role, that of feeding their families (Njuguna, Brownhill, Kihoro, Muhammad, & Hickey, 2014). Despite their enormous contribution in agriculture, women have lower productivity than men because of limited access to critical farm inputs such as education, quality seeds, technology and credit which lowers their productivity. This has a negative impact on the food security of a

household (FAO, 2010; Njuki et al., 2016; Peterman et al., 2011). While it is unclear how gender equity in agriculture might be achieved, evidence has shown that food insecurity is unlikely to be resolved without closing the existing gender gap in agriculture (FAO, 2010; Quisumbing, Brown, Feldstein, Haddad, & Pea, 1995). In fact, the Food and Agriculture Organization has stated that women's access to these crucial production resources, as well as formal education, are important potential solutions to the problems of food insecurity and MND and could positively impact a nation's economic growth (FAO, 2010).

2.3 Assessing Diet Quality

A number of different methods are used to examine the diet quality of a household or population in both developed and developing countries. Before diet quality can be assessed, methods are used to assess dietary intake, the most common of which are meal based methods, such as the 24 hour recall and food records, or list based methods such as food frequency questionnaires (Gibson & Ferguson, 2008; Shim, Oh, & Kim, 2014). The 24 hour recall captures the foods or food groups consumed by an individual over a given 24 hour reference period; food records require individuals to record everything they eat and drink over a specified period of days (Gibson & Ferguson, 2008; Shim et al., 2014). Food frequency questionnaires attempt to capture usual food intake by asking individuals to report how often they eat a list of foods, which often contain food items that are sources of nutrients of interest (Shim et al., 2014)

Data generated from these dietary assessment methods are then interpreted using either dietary reference intakes (to assess the adequacy of nutrient intakes) (Barr,

Murphy, & Poos, 2002) and/or diet quality indexes (Kim, Haines, Siega-Riz, & Popkin, 2003; Shim et al., 2014). Due to lack of resources, there are significant challenges conducting dietary surveys in developing countries; it has thus become increasingly common to use simple indexes of diet quality such as the Diet Quality Index International (DQI-I) and diet diversity assessments. These are urgently needed in order to identify key issues such as a lack of animal source foods, or fruits and vegetables, and to identify groups at risk of nutritional inadequacies (Arimond et al., 2011). The DQI-I tool, which was developed to allow cross cultural comparisons, is based on four standard indicators namely adequacy, variety, moderation and balance (Kim et al., 2003). The adequacy of a diet determines whether an individual is able to consume sufficient amounts of essential nutrients from a variety of foods in order to maintain good health and nutrition status; variety focuses on the range of foods consumed within and across food groups as well as variety within protein sources; moderation assesses whether foods and nutrients are over or underutilized and balance examines the composition and the proportion that each food group contributes in a diet (Kim et al., 2003). Scores for each standard indicator are created and summed across all components. A method that has been shown to be a strong predictor of micronutrient adequacy in resource poor regions of the world is the 'food group diversity indicator' method, commonly referred to diet diversity (Arimond et al., 2011). Diet diversity assesses the variety of foods consumed and is assessed by counting the number of unique food groups within and across food groups (Arimond, Wiesmann et al., 2011) and is "widely recognized as being a key dimension of diet quality" (Arimond et al., 2011). In its simplest form, it includes six food group indicators (starchy staples, legumes and nuts, dairy, animal

source foods, vitamin A-rich fruits and vegetables and other fruits and vegetables). Other versions include nine, 13 and 21 groupings. According to Arimond et al. (2011), the 21 group index had the strongest correlation with micronutrient adequacy in several countries compared to those with fewer food groupings.

2.4 Diet Quality in Developing Countries

In developing countries, food consumed is often limited to a starchy diet due to food insecurity and low purchasing power (FAO, 2015). For example, the majority of individuals in developing countries, Kenya included, rely heavily on staple foods which are typically plant-based and high in starch (Neumann et al., 2003; Yeudall et al., 2005). These foods include cereals, grains, legumes, potatoes, and cassava (Black et al., 2008a; FAO, IFAD, & WFP, 2014; Walingo, 2009; WFP, 2016). According to a recent survey, the diet of Kenyan people is characterized by a high intake of starch such as maize, millet, sorghum or rice (WFP, 2016). The survey reported that one in three Kenyan households ate no food rich in heme iron (i.e. sourced from animal products) seven days prior the survey, with this prevalence doubling in some arid and semi-arid zones. Again, low income and female led households consumed a less diversified diet compared to the rich and male headed households (WFP, 2016). This finding is consistent with Neumann et al. (2003) who documented that low diet diversity in Kenyan households often results in low intakes of foods such as vegetables, fruits, milk or dairy products, eggs and meat, which are a rich source of essential vitamins and minerals. Even with adequate or excess intakes of energy from starchy diets, monotonous diets put women and children at a greater risk of developing multiple micronutrient deficiencies (Allen, 2003; Black et al., 2008a; Moursi et al., 2008; Neumann et al., 2003; Victora et al., 2008).

2.5 Micronutrient Malnutrition

Globally, about two billion people are deficient in essential micronutrients (UNICEF-WHO-The World Bank, 2012), with about a third of Sub-Saharan Africa's population experiencing its effects (UNICEF, 2011). Malnutrition results from insufficient food intake and is often a consequence of food insecurity. In most cases, malnutrition is caused by inadequate intake of energy, protein and essential micronutrients and can be as a result of poor DD (Black et al., 2008b; UNICEF, 2011; UNICEF-WHO-The World Bank, 2012). Unlike other forms of malnutrition (e.g. calorie and protein deficiencies) that are rapidly manifested physically, micronutrient deficiencies (MND) take a long time to become evident; therefore, they can easily go unnoticed (Meenakshi et al., 2010; UNICEF, 2011; UNICEF-WHO-The World Bank, 2012). In particular, vitamin A, iron, zinc and iodine are major public health concerns globally and in Kenya (GOK, 1999; KDHS, 2014).

Despite the significant strides made by the Kenyan government in supplementation and food fortification initiatives (KDHS, 2014; UNICEF, 2011), the prevalence of these MND remain high. About 60 percent of children under the age of five years and 43 percent of women of reproductive age are at risk of developing iron deficiency anemia (UNICEF, 2011). In addition, 70 percent of children under the age of six months suffer from vitamin A related deficiency. Goitre rates (due to lack of iodine) are estimated at 10 percent (UNICEF, 2011). These deficiencies have long term consequences, especially for women as they are more likely to experience miscarriages, still births, reduced energy to work and even death (UNICEF, 2011). Moreover, as a result of the deficiencies, infants and children are more likely to be become blind,

stunted (attain low-height for age) or have mental and/or physical disabilities (Black et al., 2008b; GOK, 1999; UNICEF, 2011). Therefore, if no long term measures are put in place to address the root causes of this problem, these deficiencies will lead to a vicious cycle of poor nutritional status that will affect many generations in terms of health and economic development (Prasad & Kochhar, 2015).

2.6 Strategies to Address Food Insecurity and Micronutrient Malnutrition

The subsequent sections will discuss different strategies that have been explored in the quest to alleviate food insecurity and micronutrient deficiencies in developing countries. These include conventional approaches, emergency food aid, nutrition education interventions, and integrated food-based strategies. However, it is important to first understand the context within which these strategies are implemented including the role of women in agriculture in developing countries and women's self-help groups.

2.6.1 Role of Women in Agriculture in Developing Countries

Globally, female farmers are important contributors to agricultural labour, comprising about 43 percent of the workforce in developed and developing countries (Doss, 2011; Njuki et al., 2016). In Eastern and Southern Asia and SSA, women comprise almost 50 percent of the agricultural labour force and earn lower pay compared to their male counterparts (Doss, 2011; FAO, 2010). In spite of the significant contribution by women smallholder farmers to agricultural productivity, women face many challenges that reduce their ability to produce more food (FAO, 2010). Women perform the bulk of daily and unpaid household work compared to men (Doss, 2011; FAO, 2010), including kitchen gardening, cultivating cash crops on their family farms, collecting fuel and water, processing and preparing food, distributing food to household

members and tending to livestock (Doss, 2011; IFPRI, 2009; Njuki et al., 2016; Quisumbing et al., 1995). Women are also limited by gender inequalities in terms of land area, poor agricultural technologies, poor access to credit, low access to land ownership, cultural constraints and poor access to information and training (FAO, 2010; IFPRI, 2009; Njuki et al., 2016; Peterman et al., 2011; Quisumbing et al., 1995). These factors significantly impact women's ability to increase their agricultural yields, therefore increasing the levels of poverty and food insecurity for poor and vulnerable rural households.

Significant evidence links gender inequalities to rural food insecurity, particularly in SSA (IFPRI, 2009). A comparison of the 2009 Global Hunger Index with the 2008 Global Gender Gap Index illustrated that food insecurity was more prevalent in countries with larger gender gaps, where women were less educated and had less access to education and appropriate health care services compared to men (IFPRI, 2009). Research suggests that food insecurity can be reduced by improving women's status especially through implementation of programs that aim to improve women's capacity, agricultural yields, nutrition knowledge, attitudes and practices and income earning abilities (FAO et al., 2014; IFPRI, 2009; Smith, 2003). According to the Food and Agriculture Organization, if women in the developing world had equal access to production inputs as men, their yield would increase by 2.5 to 4 percent; this would in turn reduce the number of hungry people in the world by 100 to 150 million people (FAO et al., 2014). Therefore, for greater food security to be realized gender equity is needed in agriculture. This translates into equal access to vital agricultural inputs such as training, quality seeds and modern agricultural technologies.

2.6.2 Women Self-help Groups in Developing Countries

According to Oino, Auya and Luvega (2014), Self-Help Groups (SHGs) are voluntary, small group structures that are established for mutual aid and the accomplishment of defined goals. They argue that the initiators and members of such groups perceive that their needs cannot be met by or through existing institutions. Again, they emphasize that SHGs create a platform for social interactions of members who are expected to be personally responsible for running the group. Members of SHGs are engaged in a variety of well-defined activities including education, health, social, economic and political empowerment (Oino, Auya, & Luvega, 2014). For these reasons, women's self-help groups have become an important means of improving societal problems, most importantly, food insecurity and low socio-economic status of women and their families (Canadian Feed the Children [CFTC], 2016; Oino et al., 2014; Quisumbing et al., 1995; World Vegetable Center [WVC], 2016). Women in SHGs often engage in initiatives such as crop production, food processing and preparation, tending livestock, working for wages on farms, collecting fuel and water as well as trade and marketing (CFTC, 2016; Oino et al., 2014).

Different studies have examined the role of SHGs in improving food insecurity and socio-economic status of the women in the developing world. In rural Bangladesh, Kumar and Quisumbing (2010) assessed the long-term effects of group-based and individual dissemination of agricultural technologies. They found that women's wealth increased relative to men's when technologies were channeled through existing women's groups rather than through individuals. As well, there was a significant improvement in the nutritional status of women and children, which affirms the potential that can be harnessed through use of existing or formal women's groups to solve complex societal

problems (CFTC, 2016; Kumar & Quisumbing, 2010; Oino et al., 2014; WVC, 2016). Through their collective action, members of SHGs enjoy a wide range of benefits which include raised standards of living, improved nutritional status and socio-economic and political empowerment (Carinne Brody et al., 2015; Kumar & Quisumbing, 2010; Oino et al., 2014).

In Kenya, the SHG concept began in rural areas primarily as a women's initiative with the clear objectives of social and economic empowerment. The initial purpose was to save and lend money (*"merry-go-round"* activities) (Oino et al., 2014). The *"merry-go-round"* involved a series of activities where each member of the SHG contributed a predefined amount of money. In each round of contribution, money was given to a different member of the group as a donation to enable them to address a personal or family concern. Members of the SHGs also participated in micro-credit activities which enabled members to borrow cash and repay it with minimal interest. With time, SHGs became more diversified and moved on to other activities such as the purchase of iron roofing sheets and water tanks and the construction of latrines. Additionally, the SHGs provided the single most important forum for education among women at the community level including a platform for the dissemination of gender-specific training and support in areas of agriculture, health, education, and microenterprise (Mutugi, 2006; Oino et al., 2014).

2.6.3 Conventional Approaches to Alleviate Micronutrient Malnutrition and Food Insecurity

A number of conventional approaches have been used to address malnutrition and food insecurity in the developing world. These include food aid, increasing household food production, supplementation and fortification, and nutrition education.

Food aid is defined as the provision of food to vulnerable populations by individuals, aid agencies or governments (Coates et al., 2007). Food aid is viewed as a crucial but temporary solution that offers immediate relief in times of food emergencies to food insecure populations (Del Ninno, Dorosh, & Subbarao, 2007). This approach has been adapted by many governments and donor agencies across the globe in times of natural disasters. Food aid has been termed effective in addressing short term food shortages. However, in the long term, food aid alone may create a sense of dependency because it relies heavily on donor support, thereby limiting a community's future resilience to food shocks. Food aid is also unsustainable, very expensive, has poor geographical coverage and does not offer a participatory approach of solving the underlying causes of food insecurity. Although this approach may be a quick fix solution for reducing effects caused by acute food shortages, it is not the most appropriate solution to mitigate household food insecurity in the long run (Del Ninno et al., 2007; Smith & Subbarao, 2003).

Apart from food aid, supplementation, food fortification and bio-fortification are used globally and locally to mitigate food insecurity (Berti et al., 2014; KDHS, 2014). Such approaches target vitamin and mineral deficiencies which are a consequence of food insecurity. These approaches have been found to be ineffective in alleviating under nutrition or micronutrient deficiencies due to a number of factors (Allen, 2003; Bailey, West, & Black, 2015; Berti, Faber, & Smuts, 2014; Hagenimana et al., 1999; Imhoff-Kunsch, Flores, Dary, & Martorell, 2007; Yeudall et al., 2005). For example, in rural resource-poor settings, supplementation and fortification may have limited benefits and low sustainability because of inaccessibility, low acceptability and compliance, lack of

affordability and high dependency on external donor support (Berti et al., 2014; Gibson & Ferguson, 1998; Underwood, 2004; Yeudall et al., 2005). In addition, these strategies do not address the root causes of undernourishment because they are only used as short term measures to supplement diets that are low in essential micronutrients (Bailey et al., 2015; Berti et al., 2014; Gibson & Ferguson, 1998). Also, in resource-poor settings, households may have limited access to fortified food or supplements due to limited purchasing power. This was demonstrated by a study conducted in Guatemala which showed that consumption of fortified flour was higher among economically empowered families than among poor households with limited purchasing power (Imhoff-Kunsch, Flores, Dary, & Martorell, 2007). This indicates the need to explore other approaches that specifically target the root causes of food insecurity at the community level.

Another conventional approach used to address food insecurity at the household level is increasing food production through home gardening (Wiggins & Keats, 2013). Odebode (2006) defines home gardening as farming system where a variety of crops are grown on a relatively small piece of the family land close to the main house. Home gardening is one food-based strategy that has been successful in improving micronutrient status, particularly Vitamin A status, of vulnerable populations living in resource-poor settings (Arimond, Hawkes et al., 2011; Gibson, 2011). Other benefits of home gardening include increased food production, crop diversification and diet diversification (Guite, Ghosh, & Brahmachari, 2014; Hagenimana et al., 1999; McDermott et al., 2013; Schreinemachers et al., 2016; Thompson & Amoroso, 2014; WVC, 2016; Yeudall et al., 2005). This approach ensures that food is produced locally,

thereby lowering prices of staple foods, which, in turn, allows families to purchase a variety of nutritious foods (Wiggins & Keats, 2013).

Although staple food availability and access is considered vital to achieving food security, researchers argue that having the means to access, utilize and sustain a diversified diet remains critical to achieving and maintaining good health and nutritional status (Negin, Remans, Karuti, & Fanzo, 2009). Chastre, Duffield, Kindness, LeJeune, and Taylor (2007) indicated that increasing food production alone is an ineffective approach, especially for populations with limited purchasing power, since accessing diverse diets may not be a priority for a household when income is insufficient. Another limitation of home gardening interventions is that they take time to become self-sustaining and yield results (FAO, 2010). Provision of essential agricultural inputs such as drip irrigation, water tanks, quality seeds, horticultural training and nutrition education is considered vital especially when bridging the gender gap in agriculture (FAO, 2010). However, very few agricultural interventions have consistently supplied the participants with these essential inputs due to limited resources (FAO, 2010; Thompson & Amoroso, 2014). For example, a study by Schreinemachers et al. (2016) promoted the cultivation and consumption of nutrient rich vegetables such as orange sweet potatoes, spinach and amaranth in Bangladesh. Women participants were only provided with quality seeds and agricultural training; organizers assumed they would be able to address the other production constraints such as water supplies and pest control. The study found the home gardening intervention did not have any effect on availability of vegetables especially in the dry season because of water shortage.

Finally, nutrition education programming has been used in developing countries with the aim of improving knowledge and attitudes and ultimately dietary intake and nutritional status (David et al., 2008; Gebremedhin et al., 2017; Lassi et al., 2013; McNulty, 2013). Nutrition education refers to a set of predefined educational strategies that aim to empower individuals to freely make informed choices about the food they eat and other dietary and nutrition related habits that influence their health and nutrition status (Contento, 2011). Education strategies vary and can be focused on target persons, groups or even key policy makers (Contento, 2011). Nutrition education programs are usually purposively developed based on the identified nutritional needs of a population and the cultural context (Macías & Glasauer, 2014).

In Kenya, nutrition education has received very little attention, despite the essential role it can play in preventing and alleviating micronutrient deficiencies (David et al., 2008). Different approaches can be utilized in the execution of nutrition education programs. One-on-one counseling is the most common method of nutrition education used by health workers or community health volunteers in the developing countries (McNulty, 2013). However, there is a widespread shortage of professionals with the knowledge and skills for implementing nutrition education interventions, particularly in Africa (McNulty, 2013). Strong evidence shows that there is a need to build the national professional capacity in both nutrition education and agricultural programs that aim to improve the food security status of individuals or society as a whole (Herforth, Nicolo, Veillerette, & Dufour, 2016). Although one-on-one nutrition counseling has a wide range of benefits, it is limited to a few people who seek the service.

Peer-led nutrition education is another approach that has gained momentum over the years. The peer-led education approach focuses initially on training a person or persons who, in turn, train other individuals or peers in their home, agency, group or community (Suhrheinrich, 2011). Benefits of this approach include improved nutrition-related behavior and dietary intake (Luccia, Kunkel, & Cason, 2003; Prez-Escamilla et al., 2008), improved nutrition knowledge and retention among participants, improved food selection and preparation practices (Arnold & Sobal, 2000; Brink & Sobal, 1994) and improved household food security and lowered food expenditures (Burney & Haughton, 2002; Dollahite, Olson, & Scott-Pierce, 2003). Further, peer-led programs are more likely to be cost effective and sustainable compared to non-peer led or conventional interventions (Arnold & Sobal, 2000; Brink & Sobal, 1994; Stock et al., 2007; Suhrheinrich, 2011).

2.6.4 Integrated Food-based Strategies

A food-based strategy is an integrated approach that promotes homestead food production, nutrition education, crop diversification and, to some extent, home based food fortification (Darnton-Hill, 2014). This approach has provided multiple benefits which include improved food security, diet diversity, crop diversification, dietary habits, income and nutritional status of populations living in poor rural settings where critical inputs for food production are scarce (Gibson, 2014; Guite et al., 2014; Hagenimana et al., 1999; Low et al., 2007; McDermott et al., 2013; Schreinemachers et al., 2016; Thompson & Amoroso, 2014; World Bank, 2007; WVC, 2016; Yeudall et al., 2005). Food-based strategies have yielded better results when women smallholder farmers are targeted. This is because rural women are limited by cultural norms, water scarcity, lack of education, credit and modern agricultural technologies in producing a sufficient

quantity and diverse variety foods (FAO, 2010; IFPRI, 2009; Njuki et al., 2016; Peterman et al., 2016). These benefits of food-based interventions, therefore, help communities build resilience to seasonal food shortages all year round (Yeudall et al., 2005). Integrated agricultural/horticultural food-based strategies such as home gardening with a nutrition education component have also been associated with an increase in the production and consumption of nutritious fruits and vegetables (Arimond et al., 2011; Gibson, 2011; World Bank, 2007).

Food-based interventions are most likely to be successful in improving household food security and diet diversity when they involve the community, target women from resource-poor settings and integrate a nutrition education component which aids in the improvement of nutritional knowledge, attitudes and practices of individuals (Hagenimana et al., 1999; Talukder et al., 2014). A number of studies suggest that, while home gardening has been shown to increase household food production and access to a diversified diet, nutrition education plays an equally critical role in increasing individual capacity to make informed food choices and adapting positive dietary behaviour (Faber & Benade, 2003; Hagenimana et al., 1999; Ruel & Levin, 2000; Talukder et al., 2001). For example, in areas such as Bangladesh, Cambodia, Nepal and the Philippines, food-based strategies have enabled households to cope with food shocks such as seasonal food shortages, thereby reducing the need for households to adopt harmful coping strategies in order to survive (Darnton-Hill, 2014). Examples of these harmful coping strategies include reducing the quantity of food consumed, skipping meals, replacing nutritious foods with staple foods, selling household and agricultural assets and borrowing cash in order to purchase food (Kiess, Moench-Pfanner, & Bloem, 2001). A

study conducted in rural South Africa found that integrating home-gardening with nutrition education was an effective approach of mitigating vitamin A deficiency in children living in low socio-economic status (Faber & Benade, 2003). Mothers were encouraged to set-up home gardens and to cultivate yellow/orange fruits and vegetables, rich in beta-carotene such as pawpaw, butternut, and carrot and orange fleshed sweet potatoes. Findings from the study indicated a decrease in the prevalence of Vitamin A deficiency from 58 percent to 34 percent after the implementation of the integrated intervention (Faber & Benade, 2003). An integrated nutrition and horticulture intervention in Meru County, Kenya found significant improvements in the DD and household food security status of rural women members of women's groups from 2011-2013 (Gamble et al., 2013).

2.6.5 Farmers Helping Farmers Development Partners and Program in Naari, Meru County

Farmers Helping Farmers (FHF) is a non-profit organization based in Prince Edward Island, Canada. The organization has been working with smallholder farmers and WG in Kenya for over thirty five years and in partnership with University of Prince Edward Island (UPEI) since 2004. In 2015, FHF and UPEI formed a new partnership with the Naari Dairy Cooperative Society (ND) in Eastern Kenya. The project goal was to reduce food insecurity and micronutrient deficiency in women farmers and their families. This project provided training to increase dairy cow milk production, a horticulture intervention to increase vegetable production (including horticultural training and critical infrastructure for enhanced kitchen gardens: water tanks, drip irrigation and vegetable seeds) and nutrition education to enhance nutrition knowledge, attitudes and practices. The peer-led nutrition education was combined with the

horticulture intervention and emphasized incorporating crops from the enhanced kitchen garden into typical foods of the Naari women. The combined nutrition and horticulture intervention was targeted to women belonging to a women's self-help group.

2.7 Research Gap

Research has shown that there is a strong potential to improve food security, diet diversity and nutritional knowledge, attitudes and practices of women and children provided that critical agricultural inputs such as water, seeds, horticultural support are channelled through WG rather than individuals (Contento, 2011; Gamble et al., 2013; Guite et al., 2014; Kumar & Quisumbing, 2010). However, most of the studies reviewed randomly selected and assigned women participants into either an intervention or control group in order to implement the food-based interventions (Guite et al., 2014; Low et al., 2007; WVC, 2016) and did not work with existing or formal women's self-help groups. Further, very few horticulture interventions provided the participants with the essential food production inputs throughout the interventions.

The reviewed literature also shows that very few studies have used a registered dietitian to facilitate nutrition education sessions or train peer educators (Gamble et al., 2013; Walton, Van Leeuwen, Yeudall, & Taylor, 2012). The majority of studies reviewed used non-professionals such as extension officers (Hagenimana et al., 1999), training instructors (Fanzo et al., 2011), nutrition agents (Low et al., 2007) and community health workers (Prez-Escamilla et al., 2008) to teach nutrition education messages. Unlike dietitians and food scientists, these agents have very little or no formal training in human nutrition, health or food science (Hagenimana et al., 1999). Furthermore, despite the vulnerability of both women and children to food insecurity

and micronutrient deficiencies in the developing world, Kenya included (FAO et al., 2017; UNICEF, 2011), evidence showed that most food security interventions primarily targeted children (Yeudall et al., 2005), men only or both men and women (Bijlmakers & Islam, 2007; Fanzo et al., 2011; Hagenimana et al., 1999; Low et al., 2007; WVC, 2016).

In Kenya, very few studies of combined horticulture and nutrition education interventions have examined multiple important outcomes such as food security, diet diversity and nutrition knowledge, attitudes and practices. The latter are important, since examining nutrition knowledge and attitudes will help provide possible explanation for the outcomes of the intervention. This study aimed to fill these knowledge gaps by implementing a peer led nutrition education intervention combined with the horticulture intervention and conducting a comprehensive evaluation of impacts on food security and diet diversity and nutrition related knowledge, attitudes and practices among farm women in Naari, Kenya.

3.0 Chapter Three: Assessing the Impact of a Combined Horticulture and Peer-led Nutrition Education Intervention on Household Food Security, Diet Diversity and Nutrition Knowledge and Practices of Women Farmers in Self-help Groups in Kenya: A Pilot Study

3.1 Introduction

In spite of improvements in some countries, the number of food insecure people continues to rise in regions such as Sub-Saharan Africa (SSA), South-East Asia and West Asia (FAO et al., 2017). In fact, Sub-Saharan Africa is home to the most food insecure population, with an estimated 307 million people being in dire need of food assistance (FAO et al., 2017). The increasing food insecurity levels in the world have been attributed to multiple complex causes such as civil unrest, climate change, prolonged drought, flooding and post-harvest losses (FAO, 2016; FAO et al., 2017). Furthermore, lack of access to vital agricultural inputs by women in the developing countries have been associated with reduced food production and subsequently increased levels of food insecurity at the household and national levels (Doss, 2011; FAO, 2010; Njuki et al., 2016; Quisumbing et al., 1995).

The increasing food insecurity in the world has been accompanied by a concurrent increase in the prevalence of micronutrient deficiencies (MND) (FAO et al., 2017) with an estimated 815 million people suffering from MND (FAO et al., 2017). In SSA, a third of its population is experiencing the devastating effects of MND (UNICEF, 2011). MND are a consequence of poor diet diversity, a key indicator of a household's food insecurity status (Hoddinott & Yohannes, 2002; Ruel, 2003; WFP, 2016). In developing countries, such as Kenya, low quality monotonous diets that are high in energy and low in essential micronutrients are common, increasing the risks of a household developing MND (Black et al., 2008; Neumann et al., 2003; Walingo, 2009;

Yeudall et al., 2005). In children, micronutrient deficiencies such vitamin A and iron have been associated with irreversible effects such as loss of sight, poor cognitive and physical development, reduced resistance to infections throughout the life cycle and infant mortality (Black et al., 2008; Fall, 2009; Grantham-McGregor, Walker, & Chang, 2000; Maluccio et al., 2005; UNICEF, 2011). In women of reproductive age, vitamin A and iron deficiencies have been linked to devastating consequences such as miscarriages, maternal death, reduced productivity and a cycle of poverty (Black et al., 2008; FAO et al., 2017; Gwatkin et al., 2007; UNICEF, 2011).

Recently, Kenya, a country located in Eastern SSA, has been reported to be on the verge of a food crisis as a result of failed short and long season rains and seasonal flooding (MAFAP, 2013; WFP, 2016). The country's food production has decreased because of its high dependency on rain-fed agriculture (WFP, 2016). The result is that more than four million Kenyans are estimated to be food insecure and at risk of micronutrient deficiencies (WFP, 2016). With the exception of iodine, levels of micronutrient deficiencies, such as iron and vitamin A, have not improved in decades, particularly among young children and women of reproductive age (GOK, 199; UNICEF, 2011). As many as 43% of women of reproductive age and 60% of children under the age of five are at risk of iron deficiency anemia (UNICEF, 2011).

In Kenya, supplementation and food fortification interventions have been frequently used in the fight against micronutrient deficiencies (KDHS, 2014; UNICEF, 2011). Although these are important public health strategies whose aim is to reduce the MND burden (UNICEF, 2011), these short term interventions have not addressed the root cause of MND which is often food insecurity (Bailey et al., 2015; Berti et al., 2014;

Gibson & Ferguson, 1998; FAO et al., 2017; Talukder et al., 2014). In rural and resource-poor settings, these interventions have proven to be unsustainable and have had low acceptability and compliance (Berti et al., 2014; Gibson & Ferguson, 1998; Imhoff-Kunsch et al., 2007; Underwood, 2004; Yeudall et al., 2005).

Efforts to increase staple food production have also been explored as another means of improving a household's food insecurity (Spielman & Pandya-Lorch, 2009; Wiggins & Keats, 2013). A large body of evidence show that food availability alone does not guarantee good nutrition and health status (Negin et al., 2009). This is because increasing food production yields do not solve problems relating to food access and utilization which are equally important factors when mitigating food insecurity and its consequences (Negin et al., 2009). Therefore, interventions that focus only on increasing a household's food production have over time been shown to be ineffective (Gillespie & Kadiyala, 2012; Masset, 2011; Negin et al., 2009).

Food-based interventions have been shown to be effective, not only in introducing new nutrient rich and drought resistant crops in poor communities, but also in diversifying local diets (Darnton-Hill, 2014; Hagenimana et al., 1999; Low et al., 2007; McDermott, Aït-Aïssa, Morel, & Rapando, 2013; Talukder et al., 2014; Yeudall et al., 2005). These interventions are characterized by an integrated approach that promotes homestead food production, nutrition education, crop diversification and, to some extent, home based food fortification (Darnton-Hill, 2014). Lessons learned from past interventions indicate that they were more effective when women were targeted and when nutrition education is combined with gardening interventions (Darnton-Hill, 2014; Hagenimana et al., 1999; Low et al., 2007; McDermott et al., 2013; Yeudall et al.,

2005). Despite their easy adaptability, sustainability and cost effectiveness, these combined agriculture and nutrition education interventions have gained little recognition and therefore their impact on diet diversity and food security is not well known (Darnton-Hill, 2014), particularly in Kenya.

Further, although some interventions (Arimond et al., 2011; Gamble et al., 2013; Gibson, 2011; Talukder et al., 2014; Yeudall et al., 2005) have assessed changes in food practices such as consumption of animal flesh, vitamin A rich crops, whole grain maize and soaking of whole grain maize, few studies (Yeudall et al., 2005) have examined whether there were accompanying changes in nutrition related knowledge. This is important in understanding why changes in practices, diet diversity or food security may have occurred. For example, we previously implemented a combined agriculture and nutrition education intervention with Kenyan women farmers in partnership with Farmers Helping Farmers, a non-profit organization based in Prince Edward Island, Canada. While we found positive changes in diet diversity and food security (Gamble et al, 2013), we did not assess changes in nutrition knowledge, which made it more challenging to attribute these changes to the intervention. Since it has been demonstrated that intervention specific knowledge measures are important (Wardle, Parmenter, & Waller, 2000), there is a need to develop methods which are directly relevant to the messages communicated through the intervention. This will be accomplished by the present study, which is part of a larger four year study in Naari, Kenya, which aims to improve food security, diet quality and dairy production among rural Kenyan women through a food based and dairy intervention.

Study objectives were 1) to identify and/or develop methods to assess outcomes of interest for a combined horticultural and peer led nutrition education intervention (household food security, diet diversity and nutrition knowledge and practices) and 2) to use these methods to pilot the intervention and assess its impact on these outcomes among two groups of Kenyan women farmers.

3.2 Materials and Methods

3.2.1 Study Site

Naari community is located in Meru County, North Eastern Kenya. The County's population was projected to be at 1.6 million people by 2017 (GOK, 2013). The local people's livelihood is heavily dependent on agriculture, cash crops and livestock farming. Naari area is characterized by high dependency on rain-fed agriculture and unpredictable dry seasons which are associated with high household food insecurity, low diet diversity and high levels of child acute malnutrition (GOK, 2013; KFSSG & CSG, 2015; SRA, 2017).

Figure 1. Map of the Study Area

Source: National Geospatial-Intelligence Agency, Bethesda, MD, USA, March 2, 2018

3.2.2 Background on the Intervention Group

In 2015, Farmers Helping Farmers (FHF) partnered with the Naari Dairy Cooperative Society to develop and deliver multiple projects in horticulture and dairy farming, with the aim of strengthening the livelihoods of small holder farmers. One project within this larger initiative was to partner with a registered women's self-help group and to establish enhanced kitchen gardens (horticulture intervention). The goal of this project was to increase the availability of nutrient dense vegetables for the household and in the community and to enhance consumption of these vegetables in efforts to improve diet diversity. The Naari dairy Board of Directors was requested by FHF to conduct an inventory and screen all the registered women's self-help groups in the Naari area in order to identify a women's self-help group for a horticultural intervention, an enhanced kitchen garden project. For a women's group to qualify and form a partnership with FHF, the group had to be a formal/existing women's self-help group, had to be registered with the government, ideally have at least 35 members, have a well-defined organizational structure, be actively involved with the community and have year round access to water. After screening, the one women's self-help group (intervention group) was selected to receive the horticulture intervention by FHF.

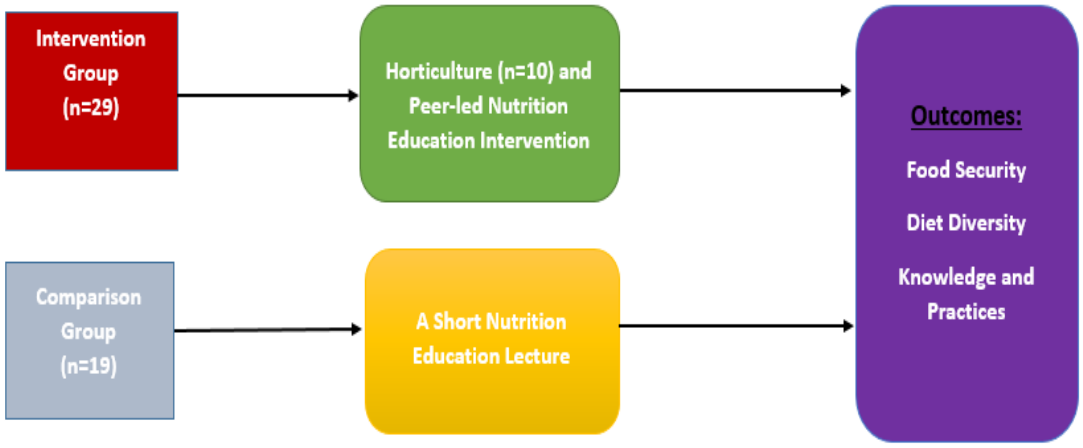
The women's group that comprised the intervention group was formed and registered with Kenya's Ministry of Gender, Children and Social Development as a Self-help group in 2012. In 2015, the group had 30 active members. Like other self-help group formed in Kenya, the women's group was initially formed as a "merry-go-round"; the main purpose of this activity is to help members save and lend money as a means of improving their socio-economic status (Oino et al., 2014). Later on, the group evolved

and started engaging in farming activities as a means to help its members cope with food insecurity. This was done by leasing half an acre of land on which the women mainly planted maize. The group also owned a greenhouse which is located at a church compound where most members were congregants. The women mainly grew local vegetables in the greenhouse for sale to its members and the larger community. As of 2015, only one woman in the group was practicing gardening at home as the majority of women came from very poor homesteads (Farmers Helping Farmers, personal communication, March 19, 2018).

3.2.3 Combined Horticulture and Peer-led Nutrition Education Intervention

A quasi-experimental design was used to assess the effect of a combined horticulture and nutrition education intervention on food security, diet diversity and nutrition knowledge and practices of Kenyan women farmers (Figure 2). The intervention group received a combined horticulture intervention and a peer led nutrition education intervention. Participants in the comparison group consisted of women farmers in the area who were not members of the same women's group. They received a single nutrition education lecture with no food preparation, peer led education, food tasting or provision of nutrition education materials. Approval to conduct the study was obtained from UPEI Research Ethics Board, FHF and Naari Dairy prior to conducting the study. Informed consent was also acquired from each participant. The two components of the intervention are described below.

Figure 2. Quasi-experimental Design



Horticulture Intervention initiated in 2015

Peer-led Nutrition Education Intervention implemented in May 2016

3.2.3.1 Horticulture Component

In 2015, Farmers Helping Farmers (FHF) a non-profit organization based in Prince Edward Island, Canada partnered with the Naari Dairy to implement a horticulture intervention. This intervention introduced the cultivation of nutritious crops rich in vitamin A (β-carotene), C and iron, particularly orange/yellow, red and dark green vegetables and fruits with the objective of improving diet diversity and reducing micronutrient malnutrition in households and in the community. Crops introduced to the intervention group included orange fleshed sweet potatoes (OFSP), carrots, squash, tomatoes, kale, amaranth and cabbage, all of which are excellent sources of vitamins and minerals (e.g. vitamin A and vitamin C). In the first phase of the horticulture intervention (early 2016), all members of intervention group were trained in gardening, compost preparation, soil management and pest control by a Farmers Helping Farmer's horticulturalist. At this time, ten women were provided with enhanced kitchen gardens. These gardens included the provision and installation of a water storage tank, drip irrigation lines, quality vegetable seeds and orange sweet potato cuttings. Horticulture training and support was provided to these ten women to assist in the setting up and management of their enhanced kitchen gardens. The remaining women received these additional horticulture supports over the next two years (described in Chapter 4).

3.2.3.2 Peer-led Nutrition Education Component

A peer-led nutrition education intervention was developed to complement the horticulture component of the food based intervention. The goals of this intervention were to incorporate the new crops into the local staple meals, increase the nutrition knowledge of the benefits of the new crops, as well as create awareness of why these dietary modifications were necessary based on known MND in Kenya (GOK, 1999;

UNICEF, 2011). The FHF/UPEI team had developed key 'messages' for a previous food based intervention which was implemented in a nearby community from 2011-2013 (Gamble et al., 2013). These included 1) the use of *mpempe* maize (whole grain) which is a rich source of B vitamins and fibre, 2) soaking maize and beans overnight before cooking in order to reduce the level of anti-nutritional factors such as phytates, 3) adding more green vegetables to food and adding them closer to the serving time to protect vitamins, 4) adding orange vegetables to local recipes, 5) adding vitamin C rich foods to meals in order to improve the bioavailability of the iron that is found in beans and cereals and 6) avoiding *chai* (tea) one hour before and after meals in order to improve the bioavailability of iron and 7) adding nutritious cereals to *uji* (porridge) for more vitamins, minerals, protein and fibre. In order to obtain feedback on the messages and the delivery of the intervention, we conducted a focus group discussion with six of the women who had participated in the earlier intervention (Gamble et al., 2013). The women indicated that the messages were culturally relevant, easy to understand and incorporate into their day to day cooking practices. The foods prepared as part of their intervention were viewed as good tasting and nutritious. We therefore decided to use the same messages for the present intervention with some modification of wording to ensure they coincided with Kenyan dietary guidance. For example, message 7 was modified to specify that 'at least two' grains be added to *uji* for 'energy and strength'. They also suggested that, rather than providing the messages and cooking tips in a binder, they would prefer laminated pages which would be more portable. These changes were incorporated into the nutrition education component of the intervention.

For the nutrition education component of the 2016 intervention, six women from the intervention group were nominated and trained as champions or 'champs'; they were strong women leaders who were successful farmers and proficient cooks. The champs were supported by UPEI faculty members, the author and two undergraduate nutrition students to plan and host two peer-led workshops where they taught the above seven key nutrition messages. Both workshops were held in Kimeru, the native language and each champ was provided with a laminated copy of the messages and cooking tips which they used as a reference while teaching. The nutrition team first met with the executive of the women's group and explained the project, the rationale and the goals. Once identified, the champs were invited to the two workshops, where the champs and women's group members collectively prepared commonly consumed foods using the nutrition messages and cooking tips to modify the recipes or techniques of food preparation. The aim of these participatory cooking sessions was to help the women learn practical ways of incorporating the enhanced kitchen garden crops into their typical foods. The nutrition team first explained the seven key nutrition messages and the rationale behind the messages to the champs. The nutrition messages promoted the use and consumption of orange/yellow, red and green vegetables and fruits which are a rich source of micronutrients, appropriate food preparation and cooking methods in order to preserve the nutritional value of meals and to improve the nutrition knowledge and practices (KP) of the women. The champs then estimated the food needs and costs for the two workshops and assigned responsibilities such as shopping for ingredients, soaking of dry maize and beans the night prior to the workshop and collecting firewood for cooking. The goal of this session was to help the champs enhance their budgeting

skills and acquire essential organizational skills to help them plan future peer-led nutrition education interventions.

Following the training and planning sessions, the champs facilitated two peer-led nutrition education workshops with the remaining women in the women's group. The seven key nutrition messages were divided between two workshops to ensure that they were not too long (Figure 3). The two peer-led workshops were held at a local church compound, which was a central location for all the members of the women's group. In both workshops, the champs began teaching their peers (other members of the women's group) nutritional messages after all the cooking was completed. The foods prepared were consistent with the key messages taught in each workshop. The most commonly consumed local foods were prepared in order to demonstrate to the intervention group how to incorporate the messages into their daily routine. These foods included *mukimo*, which consisted of mashed boiled Irish potatoes, whole maize (*mpempe*), beans and pumpkin leaves. The second food prepared was *githeri* (a stew mixture of *mpempe* maize and beans) which was made using oil, onions, tomatoes, carrots and kale. Others included *uji* (porridge), *chapati* (a round flat unleavened bread made with wheat flour, salt and water and cooked on a traditional griddle) and beef stew, which included beef, carrots and other vegetables. In addition, the nutrition team provided a fruit salad (with pawpaw, pineapple and bananas) for dessert. Orange fleshed sweet potatoes were added to both *uji and chapatis*. In contrast, the comparison group received a single nutrition education lecture with no cooking demonstrations, no food tasting or provision of nutrition education materials.

Figure 3. Schedule of the Peer-led Nutrition Education Workshops

Time	Activity
8 am	Arrival of champs at the local church
10 am	Arrival of other members of women's self-help group
11 am	Peer-led nutrition education begins
12 pm	Questions session
12:30 pm	Serving the food samples
1:30 pm	Cleaning up and end of the workshop

3.3 Sampling Procedure

As noted above, the intervention group (n=30) was preselected by ND and FHF in the fall 2015 to receive a horticultural intervention based on demonstrated need for the intervention, having a well-defined organizational structure and year round access to water. On the other hand, the comparison group participants (n=20) were randomly chosen from a list of dairy farmers provided by the ND. These women lived across the Naari area and had received dairy training from FHF and the University of Prince Edward Island (UPEI) as a part of an ongoing four year project.

3.4 Assessment of Intervention Outcomes

3.4.1 Household Food Insecurity Assessment

The Household Food Insecurity Access Scale (HFIAS) was developed by the United States Agency for International Development-funded Food and Nutrition Technical Assistance II project (FANTA) in collaboration with other partners. This validated tool was used to assess the household food security status of the women (Coates, Swindale, & Bilisky, 2007). The HFIAS questionnaire (Appendix F) contained a set of eighteen questions, nine 'occurrence' (used to assess whether a household experienced the condition in the question) and 'frequency-of-occurrence' questions (used to assess how often the identified condition occurred) (Coates et al., 2007). The 'occurrence' and 'frequency-of-occurrence questions were asked retrospectively in order to capture the participant's household food insecurity levels in the past thirty days from the day the survey was conducted. Furthermore, the 'occurrence' questions elicited responses in order to identify the extent to which the women experienced the three universal domains

of food insecurity which include ‘anxiety (worry or stressed over food), reduced food quality and quantity’ (Coates et al., 2007).

3.4.2 Diet Diversity Questionnaire

Diet diversity (DD) was determined using the standardized ‘multiple-pass’ 24hour recall method (Arimond et al., 2011). The ‘multiple-pass’ approach was used in order to capture all foods and beverages consumed by each participant in the past 24 hours prior the survey. In the first pass, the participants were asked to give a list of all the foods and beverages they had consumed in the past 24 hours. In the second pass, the interviewer reviewed each of the foods and beverages listed, with participants being asked to identify all the ingredients used in preparing those foods. Participants were also asked to give a detailed description of the food preparation method (s) for all the foods and drinks they reported to have consumed. Finally, women were asked to report the total yield and the number of people served for any recipes, so that we could ascertain that the 15g minimum consumption of a food group had been met (Arimond et al., 2011).

3.4.3 Knowledge and Practices Questionnaire

A structured nutrition knowledge and practices questionnaire was developed by the research team to assess the impact of the intervention on nutrition related knowledge and practices of the participants over the course of a four year larger study (Appendix H). Questions were designed to assess knowledge and practices relevant to the nutrition education intervention. The questionnaire included a series of 25 close-ended and open-ended questions that captured participant’s knowledge and practices pertaining to the seven key nutrition messages that were taught during the peer-led nutrition education workshops. For example, participants were asked if they were familiar with the nutrition

messages (e.g. soaking maize and beans before cooking), whether or not they implemented the messages at home (e.g. adding more greens to *githeri*) and whether they remembered the rationale behind each message (e.g. why they soaked maize and beans).

3.5 Data Handling and Statistical Analysis

For household food insecurity 'occurrence' questions, a score of '1' or '0' was given, where '1' indicated presence and '0' indicated absence of any household food insecurity conditions. For all 'frequency-of occurrence' questions, a continuous score of either 1 (rarely), 2 ("sometimes") or 3 ("often") was coded depending on how often the condition occurred (Coates et al., 2007).

For diet diversity, all foods were classified into one of 21 food groupings (Arimond et al, 2011). Participants were given a score of one for each unique food grouping consumed in the 24 hour assessment period; all those not consumed were given a score of zero. The total of number of different food groups consumed each day was then summed for each participant.

All survey data were coded and entered manually into a Microsoft Excel sheet (Microsoft Office, Microsoft Corp. 2013) and then doubled checked for accuracy by the research team. Data were imported into Statistical Analysis System software (SAS, Version 9.2) and examined for normality using the Shapiro-Wilk test (Shapiro & Wilk, 1965). For normally distributed data, independent sample t-tests were used to compare the means between the intervention and the comparison group. For non-normally distributed data, non-parametric tests (Wilcoxon Signed Rank Test) were used (Wilcoxon, 1945). Independent sample t-test was used to compute the means while

Pearson Chi-square or Fisher's exact test were used to assess differences in proportions (Fisher, 1922; Pearson, 1990). Due to small numbers in some cells, continuity adjusted chi-square values were used to report all outcomes and a probability of $p \leq 0.05$ were regarded as significant.

3.3 Results

3.3.1 Household Food Insecurity

The intervention group had significantly higher levels of household food insecurity within a month of the peer-led nutrition education intervention relative to the comparison group (2.5±1.2, 2.2±1.3, respectively, p=0.01; independent sample t-test). While it appears that more women in the comparison group than intervention group were classified as food 'secure' and fewer were classified as 'moderately' food insecure, differences were not significant (Table 3.1). The majority of women in the intervention group were classified as either 'moderately' or 'severely' food insecure, suggesting that more women in the intervention group experienced some form of food insecurity (Table 3.1).

Although no significant differences were found with respect to the proportion of women who experienced one or more household food insecurity related-domains (Table 3.2), more women in the intervention than the comparison group reported having experienced food related anxiety as well as a reduction in the quality and quantity of food consumed in the past 30 days.

Table 3.1. Proportion of women experiencing the four levels of household food insecurity between the intervention and comparisons group in 2016

Food Insecurity Level	Intervention group (n=29) % (n)	Comparison group (n=19) % (n)	p value[1]
Secure	27.6 (8)	42.1 (8)	0.40
Mildly Insecure	17.2 (5)	21.1 (4)	
Moderately Insecure	31.0 (9)	10.5 (2)	
Severely Insecure	24.1 (7)	26.3 (5)	

[1]Pearson Chi-square or Fisher's exact test

Table 3.2. Proportion of women between the intervention group and comparison group experiencing household food insecurity domains in 2016

HFIAS* Related Domains	Intervention group (n=29) % (n)	Comparison group (n=19) % (n)	p value[1]
Anxiety	44.8 (13)	26.3 (5)	0.32
Reduced Quality of Food	65.5 (19)	57.9 (11)	0.81
Reduced Quantity Food	55.2 (16)	36.8 (7)	0.34

*HFIAS= Household Food Insecurity Access Scale.
[1]Pearson Chi-square or Fisher's exact test

No significant differences were found between the intervention and the comparison group in regard to their responses to each food insecurity 'frequency-of-occurrence' questions (Appendix A). Nevertheless, some general differences were observed between the two groups even if they were not significant. For instance, more women in the intervention than comparison group answered yes to question one (worry your household would not have enough food), question three (have to eat a limited variety of foods), question four (have to eat food you really did not want to eat) and question six (have to eat fewer meals in a day). In contrast, relatively more women in the comparison group indicated that they 'never' worried that their household would not have enough food and never had to eat a smaller meal than they felt was necessary.

3.3.2 Comparison of Diet Diversity

Significantly more women in the intervention than comparison group consumed a more diverse diet, with an average of 7.5±1.5 different food groups being consumed in the previous twenty-four hours (Table 3.3).

Table 3.3. Mean and range of food groups consumed between the intervention and comparison group in 2016

Food groups consumed	Intervention group (n=29)	Comparison group (n=19)	p value[1]
Mean (SD)	7.5±1.5	6.5±1.1	0.02
Range	5-11	5-9	

[1]Independent sample t-test

Differences were found between the intervention and the comparison group in the percentage of women who consumed foods the day before the interview (Table 3.4). Significantly more women in the intervention group consumed vitamin A green vegetables, dry beans and peas and vitamin A yellow/orange vegetables in the 24 hours prior to the survey.

The most frequently consumed food groups by women in both the intervention and the comparison group were grains and fluid milk (primarily in tea). Foods that were not consumed by both groups included poultry, cheese, large fish, small fish, nuts and seeds, organ meat and other meats (data not shown).

Table 3.4. Proportion of women in the intervention and comparison group who consumed the 21 food groups in 2016

Commonly consumed food groups	Intervention group (n=29) %	Comparison group (n=19) %	p value[1]
1. Grains (Maize)	96.6	100	1.00
2. Milk/yogurt	96.6	100	1.00
3. vitamin A green veg.	96.6	52.6	0.01
4. Other vegetables	93.1	89.5	1.00
5. Dry beans and peas	89.7	63.2	0.04
6. Vit-C fruits	79.3	68.4	0.50
7. Other starchy staples	72.4	68.4	1.00
8. Vit-A yellow/orange veg.	51.7	21.1	0.04
9. Large animal meat	37.9	36.8	1.00
10. Vit-C vegetables	20.7	31.6	0.50
11. Egg	10.3	10.5	1.00
12. Soybeans	6.9	0	0.51
13. Other fruits	0	5.3	0.40
14. Vit-A fruits	0	5.3	0.40

[1]Pearson Chi-square or Fisher's exact test

3.3.3 Nutrition related Knowledge and Practices

The mean iron knowledge scores were significantly higher in the intervention (0.4±0.4) than the comparison group (0.2±0.3; p=0.3; independent sample t-test). However, no differences were found in the vitamin A knowledge scores between the two groups. With respect to individual knowledge questions, a significant difference existed, with a higher proportion of women in the intervention group than the comparison group giving one correct answer about why they had to soak dry beans in water before cooking (Table 3.5). Although no significant differences were found in the other knowledge questions, more women in the intervention than the comparison group had one or more correct answers for each knowledge question asked.

Table 3.5. Proportion of women in the intervention and comparison groups who gave at least one correct answer for each knowledge question in 2016

Knowledge questions		Intervention group (n=29) % (n)	Comparison group (n=19) % (n)	p value[1]
Why soak maize in water before cooking?	1 correct	73.3 (11)	33.3 (1)	0.50
	>1 correct	26.7 (4)	66.7 (2)	
Why soak dry beans in water before cooking?	1 correct	42.9 (12)	10.5 (2)	0.03
	>1 correct	14.3 (4)	10.5 (2)	
Why use *mpempe* maize?	1 correct	100 (29)	100 (19)	-
Are you familiar with practice of soaking dry maize and beans in water before cooking?	Incorrect	100 (29)	100 (19)	-
Why should greens be added at this time?	Incorrect	79.3 (23)	94.7 (18)	0.29
	1 correct	20.7 (6)	5.3 (1)	
Why eat fruits with or shortly after meals?	Incorrect	72.4 (21)	79.0 (15)	0.86
	1 correct	27.6 (8)	21.1 (4)	

[1]Pearson Chi-square or Fisher's exact test

With respect to practices, a higher proportion of women in the intervention group than comparison group implemented more than one recommended iron related food practices, although differences were not statistically significant (Table 3.6). The recommended practices to improve iron status of the women included soaking of dry maize and beans overnight before cooking, draining off water used for soaking to reduce anti-nutrients and eating vitamin C containing fruits and vegetables with meals.

Table 3.6. Percentage of women using the promoted food related practices between the intervention and the comparison group in 2016

Practices		Intervention group (n=29) % (n)	Comparison group (n=19) % (n)	p value[1]
Iron practices	<1practice	48.3 (14)	73.7 (14)	0.15
	≥1practice	51.7 (15)	26.3 (5)	

[1]Pearson Chi-square or Fisher's exact test

3.4 Discussion

This pilot study was designed to assess whether an integrated horticulture and peer-led nutrition education intervention would improve household food insecurity, diet diversity and nutrition knowledge and practices of women smallholder farmers belonging to a women's self- help group in the poor community of Naari. To our knowledge, there have been few, if any, studies evaluating the effectiveness of these combined interventions, particularly in Kenya.

3.4.1 Knowledge and Practices

Results of this study indicate that iron related knowledge scores were significantly higher in the intervention than the comparison group one month after the implementation of the peer-led nutrition education intervention. This suggests that there was a short term retention of the recommended iron nutrition knowledge and practices by the intervention group at baseline. Besides that, no differences were found in vitamin A knowledge scores between the two groups.

Our results are comparable with those of a study conducted in rural Malawi which found that the intervention group had significantly higher iron knowledge scores than the control group, (60% versus 8%, respectively) (Yeudall et al., 2005). It is encouraging that significant increases in nutrition knowledge were observed in the present research five weeks after the intervention since the Malawi study had a more lengthy (one year) intervention period.

In contrast to this study's findings, some studies have found differences in vitamin A knowledge scores (Faber & Benade, 2003; Low et al., 2007), although they became evident after a long intervention period. For example, a two year quasi-

experimental study conducted in rural Mozambique found no differences in the overall knowledge score between women in the intervention and control group at the baseline (Low et al., 2007). However, after two years of the intervention, more women in the intervention (8.1) than the control group (4.3) had significantly higher overall knowledge scores based on a 12 point scale (Low et al., 2007). Correspondingly, a pilot study conducted in South Africa reported higher vitamin A knowledge scores among women receiving a growth monitoring (for their children) and gardening intervention, particularly with regards to identifying sources of vitamin A as well as symptoms associated with its deficiency (Faber & Benade, 2003). Due to lack of a health facility in the South African study area, community members offered their homestead once a month to serve as a growth monitoring center for their children. The nine homesteads also served as a demonstration and training points for agricultural activities. Demonstration gardens were set up at these centers where promoted crops (orange fleshed sweet potatoes, butternut, carrots and spinach) were planted. Community members trained as 'nutrition monitors' used these platforms to promote the growth and consumption of the yellow/orange fruits and vegetables. Foods grown in the demonstration gardends were prepared and servered to all women and children attending the clinic. Food served for tasting was meant to familiarize the women and their children with these new crops, show them different ways to cook them and encourage them to participate in gardening activities.

Another longitudinal study conducted in Western Kenya found significantly higher vitamin A knowledge scores ($p=0.04$) among cohort pregnant and lactating women receiving an integrated agriculture, nutrition and health intervention at baseline.

The intervention group showed a significantly greater point increase (p=0.01) in the overall nutrition and health knowledge scores from baseline to nine months postpartum compared to the control group (who received clinic-based nutrition counseling only) (Girard et al., 2017).

With regards to the recommended practices, no significant differences were found between the intervention and the comparison group within a month of the peer-led nutrition education intervention. Nevertheless, results suggest that there was a relatively higher proportion of women in the intervention than the comparison group who used more than one of the iron recommended practices. This is in contrast to a Malawian study which found an increase in use of recommended practices in both groups after a year of the intervention (Yeudall et al., 2005). In any case, lack of differences in the practices scores may suggest that change in dietary behaviour takes time to evolve with differences being more likely to be observed in the medium or long term phases of a project rather than in the short term (Macías & Glasauer, 2014). Generally, it is important to note that food-based interventions that have included a nutrition education component, such as this one, have shown more success in increasing nutrition knowledge and uptake of recommended dietary modification strategies than those singly targeting to increase food production (Darnton-Hill, 2014; Gibson, 2011; Ruel & Levin, 2000; Talukder et al., 2014; World Bank, 2007; Yeudall et al., 2005).

Attitudes towards foods, the affective and cognitive evaluative reaction toward a food or food practice (Trendel & Werle, 2016), have also been identified as predictors of dietary behaviour (Friese, Hofmann, & Wanke, 2008). In order to better understand the

motivations behind women's food selection, it is important that attitudes also be assessed in future interventions.

3.4.2 Food Security

Overall, household food insecurity was significantly higher in the intervention group than in the comparison group, with higher HFIAS scores, with the majority of women in the intervention group being classified as ‘moderately’ food insecure (indicating that majority of women ‘sometimes’ or ‘often’ eat a limited variety of foods, had to ‘rarely’ or ‘sometime’ eat a smaller meal than they felt they needed and eat fewer meals in a day) (Coates et al., 2007). As a result, more women in the intervention group experienced the HFIAS-related domain of anxiety, reduced quality and quantity of food which are indicators of severe food insecurity.

On the other hand, the comparison group had a higher proportion of women who were classified as food secure; with about 74% reporting that they ‘never worried that their households would not have enough food’. The relatively higher percentage of food secure households in the comparison group suggests that women in comparison group were less stressed socio-economically, possibly because they were all members of the Naari Dairy and likely generated income from the sale of milk. However, since demographic data was not formally assessed as part of this study, we cannot draw firm conclusions as to why food insecurity was more prevalent in the intervention group. Nevertheless, the high levels of food insecurity in the intervention group are consistent with the Kenyan and the global trends of food insecurity (FAO et al., 2017). Naari community is reported to be among the most vulnerable areas in Kenya to food insecurity and its devastating consequences, low diet diversity and undernutrition

(KFSSG & CSG, 2017). In the neighbouring Kiirua and Murega area, Gamble et al. (2013) study noted overall high rates of food insecurity and low diet diversity which decreased overtime. These results were, however, attributed to the prevailing drought and crop failure prior to and during the study (Gamble et al., 2013). Nevertheless, different reviews have documented the successes of the horticulture interventions, most importantly, when combined with a nutrition education component and when women are targeted (Darnton-Hill, 2014; Gibson, 2011; Ruel & Levin, 2000; Talukder et al., 2014; World Bank, 2007). Generally, food based interventions that combined horticulture and nutrition education, such as this one, have been linked to increased crop production, diet diversity and improved wellbeing among impoverished populations (World Bank, 2007). For instance, Schreinemachers et al. (2016) found a significant increase in the variety of vegetables and fruits produced and consumed by women in Bangladesh after the implementation of an integrated intervention. However, it is worth noting that the study found no differences in the production of vegetables between the dry and wet season which was mainly attributed to climatic change and water scarcity (Schreinemachers et al., 2016).

Although the findings were opposite of what we expected in regards to differing food insecurity levels between the intervention and comparison groups, large differences existed between the intervention and the comparison group which warrants collection of more data in a subsequent study. For example, not all women in the intervention group were members of the dairy cooperative, owned dairy cattle or sold their milk to the dairy. In contrast, all the respondents in the comparison group were members of the Naari Dairy such that dairy farming was their main source of livelihood. A study in a

nearby area of Kenya found a significant association between household food insecurity and dairy group membership with the prevalence of food insecurity being lower for women who were members of a dairy group compared to non-members (Walton et al., 2012).

3.4.3 Diet Diversity

Mean diet diversity scores were significantly higher in the intervention group than the comparison group, reflecting higher levels of dietary variety and nutritional quality of foods and food groups consumed. The 24-h recall data suggested that vitamin A green and yellow vegetables were the most commonly consumed foods by women in the intervention group, with a consumption rate of 97% and 52%, respectively within a month of the peer-led nutrition education. This is suggestive of a positive impact of the horticulture intervention, with regards to introducing the vitamin A rich vegetables such as orange fleshed sweet potatoes (OFSP), carrots, squash, kale and spinach. This study's findings are comparable with those of a study in rural Mozambique which promoted the cultivation and consumption of vitamin A rich OFSP by young children (Low et al., 2007). OFSP contributed to 35% of vitamin A (β-carotene) consumed by all children in the intervention groups and 90% for those who eat it the previous day (Low et al., 2007). In South Africa, an integrated home gardening and growth monitoring intervention provided a more diverse diet for the intervention group, with as much as 85% of the vitamin A consumed, coming from vitamin A rich green and yellow vegetables and fruits (Faber & Benade, 2003). Although the current study focused on vegetables that were rich in vitamin A (β-carotene), C and iron, other studies have reported increased intake of other nutrient dense foods (not promoted by the intervention) in the

intervention than comparison group (Faber & Benade, 2003). In this study, differences were found in the consumption of dry beans and peas which are a major source of iron and protein for poor populations. The intake of other vegetables, other starchy staples, large animal meat (beef) and soy beans was relatively higher in the intervention than the comparison, thereby suggesting a higher quality diet (Faber & Benade, 2003; Yeudall et al., 2005). It is worth noting that the higher trends in the consumption of large animal meat among women in the comparison group is similar to that of a study conducted in the neighbouring Kiirua and Murega area (Gamble et al., 2013). The higher dietary diversity in the intervention group suggests that the pilot study had a positive impact within one month of the peer-led nutrition education intervention. Although actual food production was not assessed in the current study, it is most likely that the intervention led to an increase in the intervention household's own food production, thereby increasing access to more and a greater variety of vegetables (Darnton-Hill, 2014; Schreinemachers et al., 2016). Consequently, access to a variety of crops as well as increased nutritional knowledge may have influenced dietary practices , which has been reported previously (Darnton-Hill, 2014; Faber & Benade, 2003; Girard et al., 2017; Hagenimana et al., 1999; HKI, 2001; Low et al., 2007; Schreinemachers et al., 2016; World Bank, 2007; Yeudall et al., 2005).

In contrast to other studies that have found differences in the intake of eggs (Hagenimana et al., 1999) as well as vitamin A fruits (Girard et al., 2017), no variations existed for these foods between the intervention and the comparison group for the current study (Gamble et al., 2013). These findings could also reflect a lower socio-economic status of the intervention group relative to the comparison group which is

consistent with why the women's group was selected by FHF to receive the horticulture intervention.

On the other hand, grains, milk, vitamin C vegetables and eggs intake were relatively higher in the comparison group than the intervention group though no significant differences were found. With the exception of other food groups, these results are comparable to those of Walton et al. (2012) who associated higher milk and energy intakes with dairy membership among Kenyan women. Overall, the lack of organ meats, small and large fish, poultry, nuts and seeds and cheese for all 48 women suggest that dietary protein and iron is low in this sample of women. With the exception of nuts and seeds, Gamble et al. (2013) reported the same results. Similarly, a study conducted in Mozambique found that no participant women consumed dairy products and that there was overall low intake of animal flesh foods (Arimond et al., 2011). Flesh foods are sources of heme iron which is better utilized than iron from plant based. As well, the essential nutrient, vitamin B_{12} is only found in animal source of foods. The lack of diversity and animal source of foods are a clear indication of inadequacy of diets in developing countries (Arimond et al., 2011; Yeudall et al., 2005).

Channeling vital food production and nutrition education resources through a formal women's self-help group could also be another reason for the success of the present study in diversifying women's' diets. Other research reviews have also associated similar combined interventions with improved diets, especially when women in resource-poor populations are targeted (Ruel & Levin, 2000; Bushamuka et al; 2005). Kumar and Quisumbing (2010) examined the long-term effects of group-based and individual dissemination of agricultural technologies in rural Bangladesh. Notably,

women's wealth grew more relatively to men's when technologies were channeled through existing women's groups rather than through individuals. Further, a significant improvement in the nutritional status of women and children was also evident therefore affirming the potential that can be harnessed through use of existing women's self-help groups to solve complex societal problems (Kumar & Quisumbing, 2010).

3.5 Strengths and Limitations

The high participant response rate (99%) was one among many strengths of this study, and reflected the high level of engagement among the women in the self-help groups. Although almost all women participated, the small sample size could also have limited the statistical power of this study.

Randomization of groups to each treatment was not possible since FHF had preselected the intervention group to receive the horticulture component of the intervention in 2015, prior to the initiation of the nutrition education component in 2016. This meant that there was no baseline data for household food security, diet diversity and nutrition knowledge and practices of the participants before the horticulture intervention was initiated. However, the quasi-experimental design is often necessary when conducting research in developing countries, where experimental control is more difficult to achieve and it allows for more flexibility, allowing for evaluation of indicators that go beyond the biochemical serum benefits of food-based interventions (Gibson, 2011; Bushamuka et al; 2005; Webb et al; 2007; Darnton-Hill, 2008).

The use of validated tools to assess food security and diet diversity was also a strength of the study. The nutrition knowledge and practices questionnaire was developed by the research team to be used for a similar intervention in 2017 (Chapter 4)

and therefore was not previously validated. Future studies should establish the internal consistency and test re-test reliability of this instrument.

Since all interviews were conducted in English, translation services were used, which can result in difficulties with comprehension and misinterpretation of questions. However, to reduce inconsistencies, the same translator was used to conduct all 48 interviews. The translator was trained by the research team prior to conducting the home interviews and Kenyan employees of FHF attended the early interviews to verify that the translation was accurate and appropriate. In addition, the use of nutrition students and one Kenyan registered dietitian to conduct the interviews was another strength in that they were experienced in conducting 24-hour recalls. Further, the Kenyan dietitian had an excellent understanding of the local dietary habits and food preparation methods.

3.6 Conclusions and Recommendations

Results from this study suggest that food insecurity was a major concern for both the intervention and comparison groups. That food insecurity affected more of the intervention women than those in the comparison group likely reflects higher income from dairy farming in the latter group although this was not assessed as part of this pilot study. It is therefore recommended that socio-demographic information such as age, education level, exotic cattle (dairy cow) ownership, husband's occupation and agricultural land ownership be assessed as these can influence the food security status of these households.

Women in the intervention group had more diverse diets than the comparison group, likely reducing the burden of micronutrient deficiencies of these women smallholder farmers. This finding demonstrates the great potential for this combined

horticulture and peer-led nutrition education intervention to diversify local diets. Notably, the most striking result was the higher consumption of orange yellow/orange vegetables such as orange fleshed sweet potatoes by the intervention group. Given the nature of this combined intervention, it is impossible to conclude that one of the two components of the intervention contributed to the improved diversity. Rather, past research indicates that it is likely that it was not one component, but the combination of both that led to these positive results findings. Specifically, the results reflect both the increased availability of nutritious crops and the peer-led nutrition education provided simple and practical ways of incorporating them into local recipes. (Darnton-Hill, 2014; Hagenimana et al., 1999; Low et al., 2007; Yeudall et al., 2005). While results indicate that a higher proportion of women in the intervention group implemented more than one iron related recommended dietary practices, further research is needed to confirm these findings and assess the impact on other promoted practices such as those pertaining to vitamin A (β- carotene).

This pilot study developed methods to assess knowledge and practices related to the intervention. Since food related attitudes can also impact dietary behaviour, future interventions should also examine the impact on women's food related attitudes. This pilot study will inform the development of future interventions that aim to improve the household food security, diet diversity and nutrition knowledge and practices of populations living in underprivileged settings.

4.0 Chapter Four: A Comparative Analysis on Household Food Security, Diet Diversity, Nutrition Knowledge, Attitudes and Practices of Women Smallholder Farmers Receiving a Combined Peer-led Nutrition Education and Horticulture Intervention in Eastern Kenya

4.1 Introduction

Food insecurity continues to be a major concern globally, particularly in Sub-Saharan Africa the world's most food insecure region (FAO et al., 2017). Chronic food insecurity often results in low diet diversity and micronutrient deficiencies (David et al., 2008; Neumann et al., 2003; Talukder et al., 2014). Evidence shows that two billion people in the world suffer from micronutrient deficiencies due to consuming monotonous diets which are low in essential micronutrients (vitamins and minerals) (McDermot et al., 2013). Diet diversity (DD), the number of different food groups consumed by an individual or group over a given time period (Arimond et al., 2011; Gibson & Ferguson, 2008; Ruel, 2003), has been used to provide insight into the magnitude of food insecurity (Ruel, 2003; Hoddinott & Yohannes, 2002) and micronutrient deficiency (Arimond et al., 2011).

In Kenya, a Sub-Saharan African country, over four million people are food insecure and at risk of developing multiple micronutrient deficiencies (MND) (WFP, 2016). Inadequate intake of vitamin A and iron, the two micronutrients of greatest concern for women and children in Kenya have not improved in decades, particularly among young children and women of reproductive age (GOK, 1999; UNICEF, 2011). The current food crisis, as a result of climate change and recurring crop failures, is expected to worsen food insecurity and low dietary diversity (WFP, 2016). Typically, diets in developing countries, such as Kenya, have low diet diversity consisting mainly

of starchy foods which are energy dense but low in essential micronutrients (Neumann et al., 2003; Walingo, 2009; Yeudall et al., 2005).

A recent survey indicated that one in three Kenyan households did not consume foods rich in heme iron (i.e. iron from animal products), with low income and female-led households consuming less diversified diets compared to the higher income and male headed households (WFP, 2016). These poor quality diets predispose millions of food insecure Kenyans to MND, particularly women and children who have high nutritional needs (Black et al., 2008; Girard et al., 2017; Neumann et al., 2003; Talukder et al., 2014). Research suggests that as many as 43 percent of Kenyan women of reproductive age and 60 percent of children under the age of five are at risk of iron deficiency anemia (UNICEF, 2011). Micronutrient deficiencies remain the leading cause of illness and death in Kenya, particularly among vulnerable populations (UNICEF, 2008), suggesting that much remains to be done in order to alleviate this significant public health issue (Black et al., 2008; Neumann et al., 2003).

Different strategies have been explored in Kenya in order to address micronutrient deficiencies associated with food insecurity. These strategies include supplementation, food fortification and food aid (KDHS, 2014; WFP, 2016). However, these short term strategies have to a large extent failed to alleviate micronutrient deficiencies because they do not address the root causes of MND which are poverty and food insecurity (Bailey et al., 2015; Berti et al., 2014; David et al., 2008; FAO et al., 2017; Gibson & Ferguson, 1998; Talukder et al., 2014). For instance, in rural and poor resource settings, these interventions are not sustainable due to limited geographical

coverage and low acceptability (Berti et al., 2014; Gibson & Ferguson, 1998; Imhoff-Kunsch et al., 2007; Underwood, 2004; Yeudall et al., 2005).

It has been suggested that the high rates of micronutrient deficiencies in Kenya may also be as a result of poor nutrition knowledge and lack of knowledge transfer among Kenyans, most especially the rural poor where micronutrient deficiencies are on the rise (David et al., 2008; Neumann et al., 2003; Perumal et al., 2013; Walingo, 2009). Therefore, the lack of basic nutrition knowledge and appropriate food preparation strategies that improve the bioavailability of essential nutrients have played a major role in exacerbating food insecurity, poor DD and micronutrient deficiencies in the country (David et al., 2008; Walingo, 2009). There is some evidence that nutrition and horticulture interventions such as home gardening with a nutrition education component significantly improve food insecurity and reduce the micronutrient deficiency problem in food insecure populations (Cerqueira & Olson, 1995; Darnton-Hill, 2014; David et al., 2008; Ruel & Levin, 2000; Victora et al., 2008). The success of these integrated interventions is due to their ability to both increase home production of a variety of nutrient rich crops and substantially improve the nutrition knowledge, attitudes and practices of targeted groups through nutrition education (Cerqueira & Olson, 1995; Darnton-Hill, 2014; David et al., 2008; Talukder et al; 2014; Hagenimana et al., 1999; WVC, 2016). However, very few studies have implemented or assessed the efficacy of a combined horticulture and nutrition intervention on nutrition knowledge, attitudes and practices and ultimately food insecurity and MND in Kenya. Farmers Helping Farmers, a non-profit organization based in Prince Edward Island, Canada, has been working with Kenyan women's self-help groups to provide essential agricultural inputs such as drip

irrigation, water tanks, quality seeds, and horticultural training. Beginning in 2010, nutrition education programming using a peer-led approach was added to complement the horticulture intervention in the Meru region. Although Gamble et al. (2012) found a significant improvement in the DD and food security status of rural women members of a self-help group over a two year period, knowledge, attitudes and practices were not assessed. This study will be the first to assess the impact of a combined horticulture and peer-led nutrition education intervention on food security, DD and nutrition knowledge, attitudes and practices of women farmers in Kenya.

4.2 Study Objectives

i. To compare household food security, diet diversity, nutrition knowledge, attitudes and practices between an intervention group receiving an enhanced combined peer-led nutrition education and horticulture intervention and a comparison group not receiving the intervention.

ii. To compare household food security among women in the intervention group with and without enhanced kitchen gardens.

4.3 Materials and Methods

4.3.1 Study Site

Naari community is located in Meru County, Eastern Kenya (see Figure 1). The County's population was projected to be 1.6 million people by 2017 (GOK, 2013). The local people's livelihood is heavily depend on agriculture, cash crop and livestock farming. Naari area is characterized by high dependency on rain-fed agriculture and unpredictable dry seasons which are associated with high household food insecurity, low

diet diversity and high levels of child acute malnutrition (GOK, 2013; KFSSG & CSG, 2015; SRA, 2017).

4.3.2 Background on the Intervention Partners

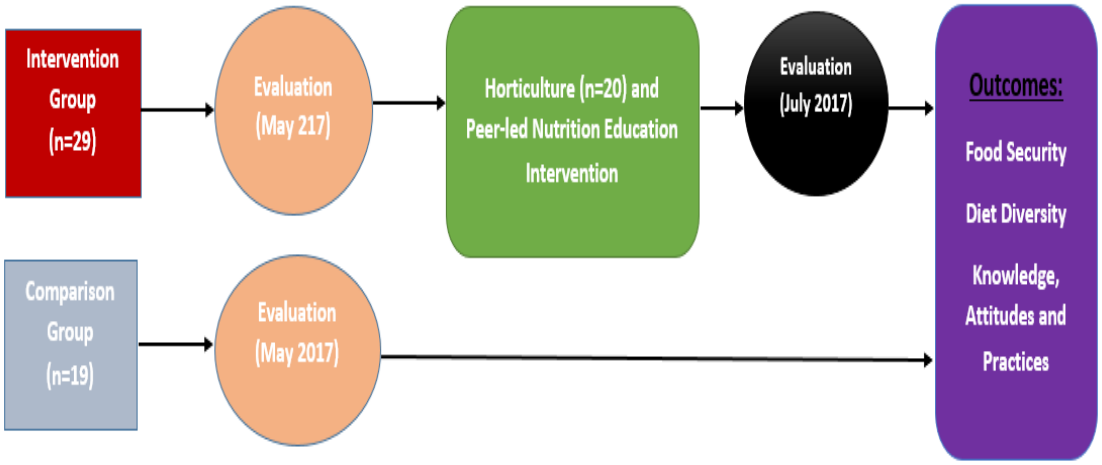
In 2015, Farmers Helping Farmers (FHF) a non-profit organization based in Prince Edward Island, Canada partnered with the Naari Dairy Cooperative Society (ND). This partnership was created to develop and deliver multiple projects in dairy and horticulture farming in order to strengthen the livelihoods of the smallholder farmers. One project within this larger initiative was to partner with a registered women's self-help group and to establish enhanced kitchen gardens (horticulture intervention). The goal of this project was to increase the availability of nutrient dense vegetables for the household and in the community and to enhance consumption of these vegetables in efforts to improve diet diversity. Naari Dairy Board of Directors was requested by FHF to conduct an inventory and screen all the registered women's self-help groups in the Naari area in order to identify a group for the enhanced kitchen garden project. For a women's self-help group to qualify and form partnership with FHF, the group had to be a formal/existing women's group, registered with the government, ideally have at least 35 members, have specific needs, well-defined organizational structures and the members had to have year round access to water. As well, the group had to be actively involved with the community. After screening, one women's self-help group (intervention group) was selected to receive the horticulture intervention. The horticulture intervention was implemented in three stages as described in the section below.

The intervention group was formed and registered with the Ministry of Gender, Children and Social Development as a self-help group in 2012. The women's self-help group started with 45 members; however, as of 2015 the group had only 30 active members. Like other Kenyan self-help groups, the intervention group was initially formed as a *"merry-go-round"* and its main purpose was to help members save and lend money as a means of improving their socio-economic status (Oino et al., 2014). Later on, the grouped evolved and started engaging in farming activities as a means to help its members cope with food insecurity. This was done by leasing half an acre of land on which the women mainly planted *mpempe* (maize). The group also owns a greenhouse which is located at a church compound where most members were congregants. The women mainly grew local vegetables in the greenhouse for sale to its members and the larger community. As of 2015, only one woman in the intervention group was practicing gardening as majority of women came from very poor homesteads (Farmers Helping Farmers, personal communication, March 19, 2018).

4.3.3 Combined Horticulture and Peer-led nutrition Education Intervention

A quasi-experimental pre-post design was used to assess the impact of a combined horticulture and peer-led nutrition education intervention on household food security, DD and nutrition knowledge, attitudes and practices (Figure 4). This design was used because random assignment to the intervention was not possible since the intervention group had been selected earlier by FHF to receive the horticulture component of the combined intervention.

Figure 4. Pre-post Quasi-experimental design



Horticulture Intervention initiated in 2015

Peer-led Nutrition Education Intervention implemented in May 2017

4.3.3.1 Horticulture Component

Once the partnership was established in mid-2015, FHF staff in Kenya initiated the gradual implementation of the horticulture intervention with the intervention group. In early 2016, all members of the intervention group were trained in gardening, compost preparation, soil management and pest control by a Farmers Helping Farmer's horticulturalist. At this time, ten women were provided with enhanced kitchen gardens. These enhanced gardens included the provision and installation of a water storage tank, drip irrigation lines, quality vegetable seeds and orange sweet potato cuttings. Horticulture training and support was provided to these ten women to assist in the setting up and management of their enhanced kitchen gardens. The second phase of this intervention was implemented early in 2017. At this time another ten women from the intervention group received the enhanced kitchen garden materials and services. Consequently, in May 2017, the time of the peer-led nutrition education intervention, 20 out of 30 intervention women had an enhanced kitchen garden. The last phase of the horticulture intervention was planned for January 2018 when the last ten women were to receive the enhanced kitchen gardens.

The horticulture component of this intervention introduced the cultivation of nutritious crops rich in vitamins A and C and iron, with the objective of improving diet diversity and reducing micronutrient malnutrition for the intervention households and in the community. Crops introduced to the intervention group included orange-fleshed sweet potatoes (OFSP), carrots, squash, tomatoes, kale, amaranth and cabbage, all of which are excellent sources of vitamins and minerals (e.g. β-carotene and vitamin C).

4.3.2. Peer-led Nutrition Education Component

A pilot peer-led nutrition education intervention was previously conducted (May 2016) (see chapter 3). At that time, six women from the intervention group were nominated and trained as 'champs' (nutrition peer educators) by the nutrition team. The champs were supported by UPEI faculty members, the author and two undergraduate nutrition students to plan and host two peer-led workshops where they taught seven key nutrition messages (Table 4.1). Both workshops were held in Kimeru, the native language and each champ was provided with a laminated copy of the messages and cooking tips which they used as a reference while teaching. During each workshop, the champs and other members of the self-help group collectively prepared commonly consumed foods using the nutrition messages and cooking tips to modify the recipes or techniques of food preparation. The aim of these participatory cooking sessions was to help the women learn practical ways of incorporating the enhanced kitchen garden crops into their typical foods. Stemming from results of the pilot three new nutrition messages were developed. The first message (adding one orange and one green vegetable in addition to tomatoes and onions) aimed to clarify a misunderstanding that only one vegetable should be added to meals; the second message emphasized the importance of deworming children as a necessary adjunct to improved food intake in order to improve nutritional outcomes; and the third message aimed to increase the protein intake by promoting use of 1:1 ratio of maize to beans.

In May 2017 the same peer-led champs approach was used to reinforce existing messages and further train the champs, and the intervention group women, on three new nutrition messages. The six previously trained champs were invited for a refresher half day training session which was conducted by the nutrition team, two undergraduate

nutrition students and the author. Each champ was provided with a new resource that included the original seven messages and cooking tips and the three new messages. Nutrition messages and cooking tips were developed in English and translated into Kimeru, the local dialect, for this resource. The translator, a member of the women's self-help group, was present during the refresher session to help with the translation since the session was conducted in English.

In May 2017, the champs planned and hosted one peer-led nutrition education workshop where all ten nutrition messages were taught to the members of women's self-help group (Table 4.1). At this time, each member received a printed copy of the nutrition messages and cooking tips translated into Kimeru. Three commonly consumed foods were prepared by the champs and their peers (other members of the intervention group), with assistance from the author and the students. Recipes were adapted based on the 2016 nutrition messages and the foods being renamed as '*super mukimo'*, '*super githeri'* and '*super uji'*. *Super mukimo* was made with *mpempe* maize (whole grain), equal proportions of soaked *mpempe* maze and soaked beans (1:1 ratio), orange sweet potatoes, stinging nettle (wild local greens) and Irish (white) potatoes. In addition to tomatoes and onions, '*super githeri'* was made using a 1:1 ratio of soaked *mpempe* (whole grain) maize to beans, with added carrots and pumpkin leaves. *Super uji* was prepared with finger millet, *mpempe* and grated orange sweet potatoes. As well, fruit salad was prepared to emphasize the importance of accompanying a meal with fruit. The fruit salad was made with locally available fruits, including pineapples, bananas, water melon and pawpaw. All foods were served to the women for tasting after the education session.

Table 4.1. Enhanced nutrition messages used for 2017

Nutrition Messages 2016	Benefit (s)	Rationale	Nutrient Category
Use *mpempe* maize (whole grain).	To increase intake of B-vitamins and fibre.	B-vitamins are essential for helping the body produce energy, formation of red blood cells and for growth and development.	**Other**
Avoid chai (tea) one hour before meals or one hour after meals to protect iron.	Tea is a rich source of tannins (polyphenol compounds).	Tannins inhibit absorption of iron from foods by the body. Iron is essential for energy, blood formation and for growth and development.	**Iron related messages**
Soak maize and beans overnight before cooking. To reduce cooking time, save fuel and improve the digestibility of food.	To reduce anti-nutritional factors (phytates).	Improve nutritional quality of the food by reducing anti-nutritional factors and thereby increase bioavailability of iron and zinc. Iron is essential for energy, blood formation and for growth and development.	**Iron related messages**
Add fruits and vegetables rich in Vitamin C to increase iron. Examples of Vitamin C rich fruits and vegetables include pawpaw, oranges, mangoes, tomatoes, tomatoes, red or green bell and chilli pepper and zucchini.	Vitamin C helps improve the absorption of iron that is found in beans and cereals.	Iron is needed to maintain energy levels and strength. Iron is essential for blood production.	**Iron related messages**

Table 4.1. Enhanced nutrition messages used for 2017 (Continuation)

Nutrition Messages 2016	Benefit (s)	Rationale	Nutrient Category
Add more green leafy vegetables. Add green vegetables close to serving time to protect vitamins and minerals. Examples of green leafy vegetables include cowpea leaves, kale, pumpkin leaves, spinach and Swiss chard.	Green leafy vegetables are rich sources of nutrients such as iron, folate, and vitamin A.	Vitamin A is essential for good eye health and preventing illness. Iron and folate are important for growing children and women. Iron and folate help to maintain the body's energy levels, good mental health, and blood production.	**Vitamin A messages**
Add orange sweet potato, carrots and squash to local foods such as *chapati*, *githeri*, *mukimo* and *uji*.	Orange vegetables are excellent sources of β-carotene (vitamin A).	Vitamin A is important for maintaining good eyesight and preventing illness.	**Vitamin A related messages**
Add at least two nutritious grains to *uji* such as finger millet, millet, sorghum in addition to *mpempe* (whole grain maize) flour.	Grains and cereals are high in vitamins, minerals, protein and fiber. Preparing *uji* with a variety of grains, improves the nutritional quality of *uji* (porridge).	Fibre helps keep the digestive system healthy. Protein is essential for energy, body building and fighting infections.	**Protein related messages**

Table 4.1. Enhanced nutrition messages used for 2017 (Continuation)

Nutrition messages 2017	Benefit (s)	Rationale	Nutrient Category
Use equal amounts of beans and maize (1 to 1 ratio).	Beans are a good source of non-heme iron and protein.	Protein is essential for energy, body building and fighting infections.	**Protein related messages**
Use at least two vegetables, one orange and one green, in addition to tomatoes and onions.	Orange vegetables are excellent sources of β-carotene (vitamin A). Green leafy vegetables are rich sources of nutrients such as iron, folate and Vitamin A.	Vitamin A is important for maintaining good eyesight and preventing illness. Iron and folate are important for growing children and women. Iron and folate helps to maintain the body's energy levels, good mental health, and blood production.	**Iron and vitamin A related messages**
Deworming	Deworming kills intestinal worms which deprive the body of essential vitamins and minerals.	Deworming a child twice a year improves the body's ability to utilize nutrients including Vitamin A and iron.	**Iron and vitamin A related messages**

4.4 Sampling Procedure

As described previously, the intervention group (n=30) was preselected by FHF and their Kenyan partner Naari dairy (ND) in the fall of 2015. The comparison group participants (n=20) were randomly chosen from a list of Naari Dairy group member farmers. Participants in the comparison group consisted of women farmers in the area who were not members of the same women's group. The comparison group women had received dairy training from FHF and the University of Prince Edward Island (UPEI) as a part of an ongoing four year project.

4.5 Assessment of Intervention Outcomes

The socio-demographic questions were adapted from the 2014 Kenya Demographic Health Survey (KDHS) (KDHS, 2014). The household food insecurity access scale (HFIAS) was used to assess the household food security status of the women's households (Coates et al., 2007). This validated questionnaire contained a set eighteen questions, nine 'occurrence' and nine 'frequency-of-occurrence' questions which were asked retrospectively in order to capture the participant's household food insecurity levels in the past thirty days (Appendix F). For the women who answered 'Yes' to the 'occurrence' question (used to assess whether a household experienced the condition in the question), a 'frequency-of occurrence' question ('never, rarely, sometimes and often') was asked next. These data were used to identify the severity of household food insecurity using standard data analysis procedures (Coates et al., 2007).

Diet diversity (DD) was determined using data from the standardized 'multiple-pass' 24-hour recall method(Gibson & Ferguson, 2008). The 'multiple-pass' approach was used in order to capture all foods and beverages consumed by each participant in the

past 24 hours prior the survey. In the first pass, each woman participant was asked to give a list of all the foods and beverages they had consumed in the past 24 hours. In the second pass, the interviewer reviewed each of the food listed, where the respondents were asked to identify all the ingredients used in preparing those foods. The respondents were also asked to give a detailed description of the food preparation method (s) for all the foods and drinks they reported to have consumed (Gibson & Ferguson, 2008). Women were asked to estimate the total amounts of foods added to a recipe (e.g. tomatoes or carrots), so that it could be determined whether the 15g minimum requirement for a food group to be counted as consumed had been met (Arimond et al., 2011). In addition to estimating the amount of each ingredient, the research team also asked the participants to account for the number of people the recipe served as a secondary procedure of ascertaining that at least the 15g minimum requirement was met. After data collection, each food or beverage in the 24-hour recall was then categorized into one of 21 pre-defined groups: grains, other starchy staples, dry beans and peas, soybeans and soy products, nuts and seeds, milk and yogurt, cheese, organ meats, eggs, small fish, large fish and seafood, large animal meat (e.g. beef, pork etc.), bird meat (e.g. poultry), other meat, vitamin A-rich dark green vegetables, vitamin A-rich deep yellow, orange or red vegetables, vitamin A-rich fruits, vitamin C-rich vegetables, vitamin C-rich fruits, all other vegetables and finally, all other fruits (Arimond et al., 2011). Each unique food group that was consumed (at least 15 grams) by a participant was assigned a value of one; those that were not consumed were coded as zero.

The nutrition knowledge, attitudes and practices questionnaire was adapted from the questionnaire piloted in 2016 (Chapter 3). In addition to the 2016 questions, the 2017

questionnaires contained new questions on attitudes for each nutrition message, knowledge and practice's questions on the three new messages and the use of grain in uji (see Table 4.1). The revised questionnaire was designed to assess the level of knowledge on the nutrition messages, the perceived importance of implementing recommended practices, and the degree to which practices were adopted (Appendix I). The tailored questionnaire used a series of close-ended and open-ended questions (64 questions) to capture whether there was short term retention of the recommended nutrition knowledge, attitude and practices based on the ten nutrition messages. For example, participants were asked if they were familiar with the nutrition messages (e.g. are you familiar with the practice of soaking dry maize and beans in water before cooking?), whether or not they implemented the messages at home (e.g. do you soak maize in water before cooking?) and whether they remembered the rationale behind each message (e.g. why do you soak maize in water before cooking?).

4.6 Data Collection

Approval to conduct the study was obtained from UPEI Research Ethics Board, FHF and ND prior to conducting the study. Informed consent was also acquired from each participant.

Primary data for this study was collected through face-face interviews at the women's homes by two undergraduate nutrition students and the first author. A translator was present to translate all the questions and responses from English to Kimeru and vice versa and data were recorded manually. Socio-demographic characteristics were assessed at pre-intervention (May 2017) for both the intervention and the comparison group. Food security, diet diversity and knowledge, attitudes and practices data were

collected in May 2017, prior to, and in July 2017, five weeks after, a peer-led nutrition education for the intervention group. However, these data were only collected once (at pre-intervention) for the comparison group.

4.7 Data Handling and Statistical Analysis

Pearson chi-square or Fisher's exact tests were used to assess differences in proportions (Fisher, 1922; Pearson, 1990).

For household food insecurity 'occurrence' questions, a score of one or zero was given, where one indicated presence and zero indicated absence of the specified household food insecurity conditions. For respondents who answered the 'Frequency-of occurrence' questions, a score ranging from one to three was given depending on how often the condition occurred ('never, rarely, sometimes or often') (Coates et al., 2007). These four 'occurrence' conditions were later grouped into two categories: 'never' occurred versus occurred 'rarely' (which included 'rarely,' 'sometimes' or 'often') to allow for hypothesis testing because of the small sample size. On the other hand, the four levels of household food insecurity ('secure,' mildly insecure,' 'moderately insecure,' and 'severely food insecure') were collapsed into two levels: 'mildly' and 'severely' food insecure. Therefore, levels of food 'secure' and 'mildly' food insecure were combined into a category of 'mildly' food insecure while the levels of 'moderately' and 'severely' food insecure were allotted to the category of 'severely' food insecure to allow for hypothesis testing because of the small sample size.

For diet diversity, all foods were classified into one of 21 food groupings (Arimond et al, 2011). Participants were given a score of one for each unique food grouping consumed in the 24 hour assessment period; all those not consumed were given

a score of zero. The total of number of different food groups consumed each day was then summed for each participant.

All open-ended responses for the knowledge questions were coded and grouped by nutrient of interest. A score of one was assigned to correct responses relating to each message while a zero was given to all incorrect responses. The sum of all correct responses was then calculated for each message. Subsequently, a sum of all correct responses was computed by nutrient of interest group (i.e. vitamin A, iron and protein) and deworming. A knowledge score was then standardized for the four categories by dividing the sum of all correct responses in each nutrient group by the number of questions. Since there was a very high number of positive responses for the knowledge questions, responses were recorded into two categories: 80% or more correct responses and less than 80% correct. The 80% cut-off point was used to capture the women who gave less than 80% and more correct responses for open ended questions with multiple possible correct answers.

To create an attitude score for each nutrient of interest, the sum of all individual responses were divided by the total number of attitude questions in each nutrient category (i.e. vitamin A, iron, protein and deworming) which created the number of people who rated each question as either extremely important, very important, important, not important and not important at all. Given the high number of women who said the messages were ‘extremely’ or ‘very’ important’, responses were recoded into two groups: ‘extremely important’ versus others (‘very important,’ ‘important,’ ‘not important’ and ‘not important at all’).

For the practice score, the sum of all correct responses in each nutrient category was also divided by the number of questions in that category. Responses were then grouped into two main categories: the proportion of women who practiced less than one message versus greater than one. For example, the sum of responses on iron practices score was divided by three i.e. the proportion of women who soaked beans and maize and ate a fruit with meals. The iron score was then collapsed into two main categories: women who implemented all the iron practices and those that used one or less iron related practice.

All survey data were coded and entered manually into a Microsoft Excel sheet (Microsoft Office, Microsoft Corp. 2013) and then doubled checked for accuracy by the research team. Data were imported into Statistical Analysis System software (SAS, Version 9.2) and examined for abnormality using the Shapiro-Wilks test (Shapiro & Wilk, 1965). For normally distributed data, independent sample t-tests were used to compare the means between groups and paired sample t-test was used to compute means within a group. For non-normally distributed data, nonparametric tests (Wilcoxon Signed Rank Test) were used (Wilcoxon, 1945). Continuity adjusted chi-square values were used to report all outcomes and a probability of $p \leq 0.05$ was regarded as significant (Pearson, 1990). Fischer's exact tests were used where cell sizes were less than five and in some instances where the continuity adjusted statistic was not generated by the SAS program (Fisher, 1922).

4.8 Results

4.8.1 Sample Description

Of the 50 women participants, 48 responded to the survey with 29 and 19 in the intervention and the comparison group, respectively. One woman from the intervention group acted as translator and therefore she was excluded from the study. One respondent from the comparison group could not be located.

Fewer women in the intervention group owned more than one acre of agricultural land and had exotic (dairy) cattle compared to the comparison group (Table 4.2). In addition, fewer women in the intervention group owned more than two exotic (dairy) cattle or had more than five chickens. However, more women in the intervention group than comparison group owned four or more local cattle. The comparison group had a marginally higher proportion of women (74%; p=0.08) with bank accounts compared to only 48% in the intervention group. A higher proportion of husbands in the comparison than intervention group had acquired post-primary education, although it was not significant. No other differences were found between the groups.

Table 4.2. Socio demographic characteristics: Pre-intervention (May 2017)

	Intervention group (n=29) %	Comparison group (n=19) %	p value[1]
Women <50 years	48.3	32.6	0.39
Women ≥ 50 years	52.7	68.4	
Married	72.4	73.7	0.67
Single/divorced/widowed	27.6	26.3	
Women's never/primary education	55.2	63.2	0.80
Women's post-secondary education	44.8	36.8	
Owned bank account	48.3	73.7	0.08
Didn't own bank account	51.7	26.3	
Owned home (house)	89.7	89.5	1.00
Didn't own home (house)	10.3	10.5	
Agricultural land ownership	89.7	100	0.40
Didn't own agricultural land	10.3	0.0	
Husband's never/primary education	51.7	26.3	0.16
Husband's post-secondary education	20.7	42.1	
N/A[1]	27.6	31.6***	
Husband's occupation (farmer)	31.0	42.1	0.78
Husband's occupation (businessman)	27.6	26.3	
Husband's occupation (skilled jobs)	13.8	15.8	
N/A[1]	27.6	26.3	
Husband's <50 years	24.1	26.3	0.46
Husband's ≥ 50 years	48.3	31.6	
N/A[1]	27.6	42.1****	
>1 acre of agricultural land	31.0	68.4	0.03*
≤1 acre of agricultural land	58.6	31.6	

Table 4.2. Socio demographic characteristics (continuation)

	Intervention group (n=29) %	**Comparison group (n=19) %**	**p value[1]**
Owned exotic (dairy) cattle	62.1	100	0.01
Didn't own exotic cattle	37.9	0.0	
Owned local cattle	27.6	0.0	0.02
Didn't own local cattle	72.4	100	
Owned ≥5 chicken	51.7	89.5	0.01**
Owned<5 chicken	41.4	5.3	
Owned <4 local cattle	17.2	0.0	0.04
Owned≥4 local cattle	10.3	0.0	
Didn't own local cattle	72.4	100	
Owned ≤2 exotic cattle	34.5	47.4	0.01
Owned>2 exotic cattle	27.6	52.6	
Didn't own exotic cattle	37.9	0	

N/A[1] for divorced/widowed/single women

[1]Pearson Chis-square or Fischer's exact

*Percentage of intervention women who owned agricultural land did not add up to 100% because 10.3% of women did not own the land on which they were cultivating.

**6.9% of women in the intervention group and 5.3% of women in the comparison group did not know the number of chicken they owned.

***Women who were divorced/widowed/single and those who did not know husband's education level.

**** Comparison women who were divorced/widowed/single and those who could not recall husband's age.

4.8.2 Pre-intervention Household Food Security Status between the Intervention and Comparison Group

Prior the intervention, the intervention group had higher mean household food insecurity scores (2.3±1.0; p=0.01) than the comparison group (1.7±1.1; independent sample t-test), indicating a modestly poorer level of food security for the intervention group. A significantly lower proportion of women in the intervention were classified as mildly food insecure compared to the comparison group prior the intervention (Table 4.3). The majority of women in the intervention group were classified as severely food insecure in contrast to the comparison group.

Table 4.3. Proportion of women experiencing mild food insecurity (including secure and mildly insecure households) and severe food insecurity (including moderately and severely food insecure households) between the intervention and comparison groups: Pre-intervention (May 2017)

Food Security Level	Intervention group (n=29) % (n)	Comparison group (n=19) % (n)	p value[1]
Mildly Insecure	37.9 (11)	73.9 (14)	0.03
Severely Insecure	62.1 (18)	26.3 (5)	

[1]Pearson Chi-square or Fisher's exact

Table 4.4. Proportion of women in the intervention and comparison group experiencing household food insecurity domains: Pre-intervention (May 2017)

HFIAS-Related Domains	Intervention group (n=29) % (n)	Comparison group (n=19) % (n)	p value[1]
Anxiety	51.7 (15)	15.8 (3)	0.03
Reduced Quality of Food	69.0 (20)	31.6 (6)	0.02
Reduced Quantity Food	55.2 (16)	21.1 (4)	0.04

NB: HFIAS means household food insecurity access scale.
[1]Pearson Chi-square or Fisher's exact

Pre-intervention, differences existed between the two groups in the proportion of women who experienced one or more household food insecurity related-domains (Table 4.4). Significantly more women in the intervention than the comparison group experienced food related anxiety and a reduction in quality and quantity of food consumed in the past 30 days. Similarly, significant differences were found between the intervention and the comparison with regards to individual responses to each of the food insecurity 'frequency-of-occurrence' questions. Significantly more women in the comparison (84%) than the intervention group (48%) reported that they never worried about their households not having enough food (p=0.03). Likewise, more women in the comparison group reported that they never eat a limited variety of foods 78%; 38%; p=0.02 respectively. All of the women in the intervention group said that they never had to eat a smaller meal than they felt they needed compared with only 79% of comparison group women (p=0.04). No other differences existed in the other food insecurity 'frequency-of-occurrence' questions.

4.8.3 Post-intervention Household Food Insecurity between Intervention and Comparison Group

Five weeks after the nutrition intervention (July 2017), mean household food insecurity scores were significantly higher in the intervention group (2.1±1.0) relative to the comparison group (pre-intervention) (1.7±1.1; p=0.01; independent sample t-test). Differences were found in the proportion of women who were classified as 'mildly' or 'severely' food insecure between the two groups (p=0.04). However, no significant variations existed in the household food insecurity related-domains (anxiety, reduced quality and quantity of food) at post-intervention.

4.8.4 Pre-post Household Food Security in the Intervention Group

Within the intervention group, mean household food insecurity scores were significantly lower following the intervention (2.1±1.0) than prior to the intervention (2.3±1.0; p=0.01; paired sample t-test) meaning the intervention group was more food secure post-intervention. No significant difference was observed in the proportions of women who experienced mild or severe food insecurity prior to and following the intervention. However, there appeared to be fewer women classified as severely food insecure after the intervention (Table 4.5).

Following the intervention, fewer women experienced food-related anxiety in the past 30 days, although this result was only marginally significant (p=0.06) (Table 4.6). There were no other differences with respect to the proportion of women in the intervention group who experienced one or more household food insecurity related-domains pre and post-intervention.

Table 4.5. Proportion of women in the intervention group experiencing mild food insecurity (including secure and mildly insecure households) and severe food insecurity (including moderately and severely food insecure households) (n=29)

Food Security Level	Pre-intervention % (n)	Post-intervention % (n)	p value[1]
Mildly Insecure	37.9 (11)	51.7 (15)	0.43
Severely Insecure	62.1 (18)	48.3 (14)	

[1]Pearson Chi-square or Fisher's exact

Table 4.6. Proportion of women in the intervention group experiencing household food insecurity domains: Pre and post-intervention (n=29)

HFIAS-Related Domains	Pre-intervention	Post-intervention	p value[1]
	% (n)	% (n)	
Anxiety	51.7 (15)	24.1 (7)	0.06
Reduced Quality of Food	69.0 (20)	58.6 (17)	0.60
Reduced Quantity Food	55.2 (16)	37.9 (11)	0.30

[1]Pearson Chi-square or Fisher's exact

No significant differences were found pre and post-intervention in the intervention group's responses to each food insecurity 'frequency-of-occurrence' question. Fewer women (24%) were more anxious that their households would not have enough food following the intervention than prior the intervention (52%; p=0.06). All the women in intervention group reported sufficient quantity of food in the post-intervention period (never had to eat a smaller meal than they felt was necessary, never had no food to eat in the household, never went to sleep at night hungry and never went a whole day and night without food).

4.8.5 Pre-post Household Food insecurity between Women With and Without Enhanced Gardens

Within the intervention group, there were no significant differences in the mean HFIAS score between women who received the enhanced kitchen garden both prior to and following the intervention (data not shown). No differences existed in the HFIAS-related domains based on the presence or absence of enhanced kitchen garden both pre and post-intervention (Table 4.7). Similarly, no differences were found between the two groups on the proportion of women who were classified as either 'mildly' food insecure or 'severely' food insecure at pre and post-intervention (data not shown).

Table 4.7. Proportion of women in the intervention group with and without enhanced kitchen gardens experiencing household food insecurity domains: Pre and post-intervention

	Pre-intervention			Post-intervention		
HFIAS-Related Domains	**No garden**	**With garden**	**p value[1]**	**No garden**	**With garden**	**p value[1]**
	(n=10)	**(n=19)**		**(n=10)**	**(n=19)**	
	% (n)	**% (n)**		**% (n)**	**% (n)**	
Anxiety	57.1 (4)	50.0 (9)	1.00	28.6 (2)	22.2 (4)	1.00
Reduced Quality of Food	57.1 (4)	72.2 (13)	0.80	57.1 (4)	55.6 (10)	0.94
Reduced Quantity Food	42.9(3)	61.1 (11)	0.71	28.6 (2)	38.9 (7)	0.99

[1] Pearson Chi-square or Fisher's exact

4.8.6 Pre-post Diet Diversity Scores between the Intervention and Comparison Group

Prior to the intervention, no differences were found in the number of food groups consumed by the intervention group (6.7±1.0) compared to the comparison group (6.7±1.4; p=0.81; independent sample t-test). Prior to the intervention, there were no significant differences in the number of women in the intervention and comparison groups who reported consuming the food groupings assessed (Table 4.8; 4.8a). However, a higher proportion of women in the intervention group consumed vitamin A containing green vegetables compared to the comparison group. All participants consumed whole grains (*mpempe* maize) and milk within the previous twenty-four hours of the interview.

Following the intervention, the intervention group consumed a more diverse diet, an average of 7.7±1.2 different food groups compared to the comparison group 6.7±1.4 (p=0.01) (pre-intervention). Specifically, significantly more women in the intervention relative to the comparison group consumed vitamin A green vegetables (p=0.02) and vitamin C vegetables (p=0.01) (Table 4.8; 4.8b). Although there were no other significant differences in food use post-intervention, more intervention women consumed dry peas and beans, other starchy staples and other fruits relative to the comparison group. Foods groups that were commonly consumed by both groups at pre and post-intervention included whole grains (*mpempe maize*) and milk. Of the 21 food groups, no women consumed bird meat (poultry), cheese, large fish, small fish, nuts and seeds, organ meat and other meats (data not shown).

Table 4.8. Proportion of women who consumed the 21 food groups in the intervention and comparison group: Pre and post-intervention

	4.8a. Pre-intervention			**4.8b. Post-intervention** (vs. comparison group, pre-intervention)	
Diet diversity food Groups	**Comparison group (n=19)**	**Intervention group (n=29)**	**p value[1]**	**Intervention group (n=29)**	**p value[1]**
	%	**%**		**%**	
1. Grains (*mpempe* maize)	100	100	-	100	-
2. Milk/yogurt	100	100	-	100	-
3. Vit-A green veg.	68.4	89.7	0.14	96.6	0.02
4. Other vegetables	94.7	96.6	1.00	100	0.83
5. Dry beans and peas	79.0	82.8	1.00	93.1	0.32
6. Vit-C fruits	63.2	65.5	1.00	51.7	0.63
7. Other starchy staples	68.4	65.5	1.00	86.2	0.26
8. Vit-A yellow/orange veg.	26.3	20.7	0.91	34.5	0.78
9. Large animal meat	21.1	17.2	1.00	13.8	0.80
10. Vit-C vegetables	26.3	17.2	0.69	75.9	0.01
11. Soybeans	10.5	0.0	0.30	0.0	0.30
12. Other fruits	0.0	10.3	0.40	13.8	0.25
13. Vit-A fruits	10.5	0.0	0.30	0.0	0.30
14. Eggs	0.0	0.0	-	6.9	0.67
Diet Diversity Score	**Mean (SD)**	**Mean (SD)**	**p value[2]**	**Mean (SD)**	**p value[3]**
	6.7 (1.4)	6.7 (1.0)	0.81	7.7(1.2)	0.01

[1]Pearson Chi-square or Fisher's exact test
[2,3]Independent sample t-test.

4.8.7 Pre-post Diet Diversity Scores in the Intervention Group

Within the intervention group, diet diversity was significantly greater post-intervention compared with pre-intervention (p=0.01) (Table 4.9). A significantly higher proportion of women in the intervention group were consuming vitamin C containing vegetables which include red or green bell and chilli peppers, tomatoes and zucchini (p=0.01). Overall, there was a notable improvement in the consumption of food groupings emphasized after the intervention, with about 100% of women consuming other vegetables such as onions and cabbage, 97% consuming vitamin A green vegetables, 93% consuming dry peas and beans, 35% vitamin A yellow vegetables, 14% consuming other fruits and 7% consuming eggs. Whole grains (*mpempe* maize) and milk were consumed by all intervention women at both time periods.

Table 4.9. Mean and range of food groups consumed by the intervention: Pre and post-intervention (n=29)

Food groups consumed	Mean (SD)	Range	p value[1]
Pre-intervention	6.7±1.0	5-9	0.01
Post-intervention	7.7±1.2	6-9	

[1]Paired sample t-test

4.8.8 Pre-intervention Nutrition Knowledge and Scores between the Intervention and Comparison groups

The intervention group had a significantly higher iron-knowledge score (0.8±0.3) than the comparison group (0.4±0.4) prior the intervention (Table 4.10; 4.10a).

Differences between the intervention and comparison group in responses to individual knowledge questions are shown in Table 4.11; 4.11a. A significantly higher proportion of women in the intervention than comparison group were familiar with the practice of soaking dry maize and beans, knew how long one should soak dry maize and beans and knew that the water used for soaking should be discarded before cooking ($p=0.01$). There were also marginally significant differences between the intervention and comparison group with regards to the number of women who had one correct answer for why they had to soak beans before cooking ($p=0.07$) and why they had to eat a fruit with or shortly after meals ($p=0.08$).

Overall, a significantly higher proportion of women in the intervention than comparison group gave more than 80% correct answers for the iron nutrient category prior the intervention ($p=0.01$) (Appendix B). No other differences were noted in the number of correct answers for the other nutrient categories pre-intervention. However, a higher proportion of women in the intervention in compared to the comparison group gave more than 80% correct answers for vitamin A nutrient and nutrient categories as well as deworming, indicating a better knowledge score (Appendix B).

Table 4.10. Mean knowledge score between intervention and comparison group pre and post-intervention (mean score and standard deviation)

	4.11a. Pre-intervention			**4.11b. Post-intervention** (vs. comparison group, pre-intervention)	
Nutrient categories	**Comparison group (n=19) Mean (SD)**	**Intervention group (n=29) Mean (SD)**	**p value[1]**	**Intervention group (n=29) Mean (SD)**	**p value[1]**
Iron score	0.4±0.4	0.8±0.3	0.01	1.0±0.3	0.01
Vitamin- A score	0.4±0.3	0.5±0.2	0.21	0.6±0.3	0.05
Protein score	0.4±0.3	0.6±0.4	0.06	0.9±0.5	0.01
Deworming score	0.7±0.5	0.7±0.5	0.97	0.5±0.3	0.26

[1]Independent sample t-test

4.8.9 Post-intervention Nutrition Knowledge and Scores between the Intervention and Comparison Groups

Following the intervention, the intervention group had significantly higher knowledge score for iron (p=0.01), vitamin A (p=0.05) and protein (p=0.01) relative to the comparison group (Table 4.10; 4.10b). As a result, a significantly greater proportion of women in the intervention group gave at least one correct answer for the individual knowledge questions relative to comparison group (pre-intervention) for nine knowledge questions (Table 4.11; 4.11b).

Overall, at post-intervention, a significantly higher proportion of women in the intervention group relative to the comparison group had more than 80% of the answers correct for the iron nutrient category (Appendix B). Additionally, a marginally higher proportion of women in the intervention group gave more than 80% correct answers for the protein nutrient category (p=0.06). As well, a higher proportion of women in the intervention in respect to the comparison group gave more than 80% correct answers for vitamin A nutrient category, indicating a better knowledge score (Appendix B).

Table 4.11. Proportion of women between intervention and comparison groups who gave correct answers for each knowledge question: Pre and post-intervention

		4.11a. pre-intervention			4.11b. post-intervention (vs. comparison group, pre-intervention)	
Knowledge questions	**Answers**	**Comparison group (n=19) % (n)**	**Intervention group (n=29) % (n)**	**P value[1]**	**Intervention group (n=29) % (n)**	**p value[1]**
Protein						
Why use 1:1 ratio of maize and beans in *githeri*?	Incorrect	89.5 (17)	82. 8 (24)	0.82	48.3 (14)	0.01
	1 correct	10.5 (2)	17.2 (5)		51.7 (15)	
Do you know what *githeri* helps your body with?	1 correct	36.8 (7)	48.3 (14)	0.14	55.2 (16)	0.01
	>1 correct	5.3 (1)	20. 7 (6)		34.5 (10)	
Iron						
Are you familiar with the practice of soaking dry maize and beans before cooking?	Incorrect	100 (19)	6.9 (2)	0.01	0.0 (0)	0.01
	1 correct	0.0 (0)	93.0 (27)		100 (29)	
How long do you soak dry maize and beans?	Incorrect	63.2 (12)	13.8 (4)	0.01	10.3 (3)	0.01
	1 correct	36.8 (7)	86.2 (25)		89.7 (26)	

Table 4.11. Proportion of women between intervention and comparison groups who gave correct answers for each knowledge question: Pre and post-intervention (cont)

		4.11a. pre-intervention			4.11b. post-intervention (vs. comparison group, pre-intervention)	
Knowledge questions	**Answers**	**Comparison group (n=19)**	**Intervention group (n=29)**		**Intervention group (n=29)**	
		% (n)	**% (n)**	**p value[1]**	**% (n)**	**p value[1]**
Why soak maize in water before cooking?	1 correct	77.8 (7)	68.0 (17)	0.90	53.6 (15)	0.37
	>1 correct	22.2 (2)	32.0 (8)		46.4 (13)	
Why soak beans in water before cooking?	1 correct	52.3 (10)	62.1(18)	0.07	55.2 (16)	0.01
	>1 correct	15.8 (3)	31.0 (9)		44.8 (13)	
What do you think should be done with the water used for soaking?	Incorrect	94.7 (18)	55.2 (16)	0.01	24.1 (7)	0.01
	1 correct	5.3 (1)	44.8 (13)		75.9 (22)	
Why eat fruits with or shortly after meals?	Incorrect	89.5 (17)	62.1 (18)	0.08	51.7 (15)	0.02
	1 correct	10.5 (2)	37.9 (11)		48.3 (14)	
Vitamin A						
Why add OFSP to *githeri*?	Incorrect	63.2 (12)	41.4 (12)	0.24	27.6 (8)	0.03

Table 4.11. Proportion of women between intervention and comparison groups who gave correct answers for each knowledge question: Pre and post-intervention (cont)

		4.11a. pre-intervention			4.11b. post-intervention (vs. comparison group, pre-intervention)	
Knowledge questions	**Answers**	**Comparison group (n=19) % (n)**	**Intervention group (n=29) % (n)**	**p value[1]**	**Intervention group (n=29) % (n)**	**p value[1]**
	1 correct	36.8 (7)	58.6 (17)		72.4 (21)	
Why add OFSP to *chapati*?	Incorrect	73.7 (14)	55.2 (16)	0.32	51.7 (15)	0.22
	1 correct	26.3 (5)	44.8 (13)		48.3 (14)	
Why add OFSP to *mukimo*?	Incorrect	68.4 (13)	75.9 (22)	0.81	44.8 (13)	0.20
	1 correct	31.6 (6)	24.1 (7)		55.2 (16)	
Why do you add greens to *githeri*?	Incorrect	26.3 (5)	24.1 (7)	1.00	48.3 (14)	0.22
	1 correct	73.7 (14)	75.9 (22)		51.7 (15)	
When in the cooking process should one add greens to *githeri*?	1 correct	100 (19)	100 (29)	-	100 (29)	-
Why should greens be added at this time?	Incorrect	47.4 (9)	31.0 (9)	0.40	17.2 (5)	0.05
	1 correct	52.6 (10)	69.0 (20)		82.8 (24)	

Table 4.11. Proportion of women between intervention and comparison groups who gave correct answers for each knowledge question: Pre and post-intervention (cont)

		4.11a. pre-intervention			4.11b. post-intervention (vs. comparison group, pre-intervention)	
Knowledge questions	**Answers**	**Comparison group (n=19) % (n)**	**Intervention group (n=29) % (n)**	**p value[1]**	**Intervention group (n=29) % (n)**	**p value[1]**
Deworming						
How often should you deworm children?	Incorrect	31.6 (6)	31.0 (9)	1.00	48.3 (14)	0.40
	1 correct	68.4 (13)	69.0 (20)		51.7 (15)	
Other						
Why do use *mpempe* maize?	1 correct	100 (19)	100 (29)	-	100 (29)	-

4.8.10 Pre-post Nutrition Knowledge and Scores in the Intervention Group

There was a significant improvement post-intervention in the iron and protein-related knowledge scores (Table 4.12). Prior to and following the intervention, no differences existed in the proportion of women in the intervention group who gave more than 80% correct answers in each nutrient category (Appendix C). Nevertheless, a higher proportion of women gave more than 80% correct answers after rather than prior the intervention, with the exception of deworming which had fewer women who gave greater than 80% correct answers.

Table 4.12. Mean knowledge score for intervention group women: Pre-post-intervention (mean score and standard deviation) (n=29)

Nutrient categories	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	p value[1]
Iron score	0.8±0.30	1.0±0.33	0.02
vitamin A score	0.5±0.24	0.6±0.30	0.30
Protein score	0.6±0.44	0.93±0.50	0.01
Deworming	0.7±0.5	0.5±0.32	0.19

[1]Paired sample t-test

4.8.11 Pre-post Attitude Scores between Intervention and Comparison Group

The intervention group had significantly higher vitamin A attitude mean scores prior to the intervention (4.1±0.6; p=0.02) relative to the comparison group (3.7±0.5; independent sample t-test). A similar trend was observed at post-intervention, where the intervention group had significantly higher mean for vitamin A attitude scores relative to the comparison group (p=0.02).

Following the intervention, a significantly higher proportion of women in the intervention relative to the comparison group said it was 'extremely important' to add orange sweet potatoes, carrots or squash to local foods such as *mukimo, githeri uji* and *chapati* (p=0.03) (Table 4.13; 4.13b). A higher number of women in the intervention relative to the comparison group rated all recommended nutrition messages in the iron, vitamin A and deworming messages as 'extremely important' prior to the intervention compared to other categories (very important, important, not very important and not important at all), although differences were not significant (Table 4.13; 4.13a).

Table 4.13. Proportion of women who rated recommended nutrition messages as extremely important versus other categories (very important, important, not very important and not important at all)

		4.13a. Pre-intervention			4.13b. Post-intervention (vs. comparison group, pre-intervention)	
Nutrient categories		**Comparison group (n=19)**	**Intervention group (n=29)**		**Intervention group (n=29)**	
		% (n)	**% (n)**	**p value[1]**	**% (n)**	**p value[1]**
Iron attitude score	Extremely	0.0 (0)	6.9 (2)		0.0 (0)	-
	Other	100 (19)	93.1 (27)	0.67	100 (29)	
Vitamin A attitude score	Extremely	0.0 (0)	20.7 (6)		27.6 (8)	0.03
	Other	100 (19)	79.3 (23)	0.09	72.4 (21)	
Deworming	Extremely	21.1 (4)	34.5 (10)		44.8 (13)	0.17
	Other	79.0 (15)	65.5 (19)	0.50	55.2 (16)	

[1]Pearson Chi-square or Fisher's exact

4.8.12 Pre-post Attitudes Scores in the Intervention Group

No significant differences were found in the mean attitudes scores in the intervention group prior to and following the intervention (Appendix D). Post-intervention, a higher proportion of women in the intervention group indicated that it was 'extremely important' to implement the vitamin A and deworming recommended practices, although it was not significant (Appendix E).

4.8.13 Pre-post Nutrition Practices between the Intervention and Comparison Group

With respect to the mean practices scores prior to the intervention, women in the intervention group had higher scores (1.8±0.4) than comparison women (1.4±0.5) for the recommended iron related food practices. Following the intervention, a significantly higher proportion of women in the intervention, relative to the comparison group, were implementing all iron ($p=0.01$), vitamin A ($p=0.04$) and protein ($p=0.04$) related food practices. No differences were found in the deworming practices score at pre and post-intervention.

At both time periods, a significantly higher proportion of women in the intervention than comparison group were implementing all the iron related recommended practices prior to ($p=0.02$) and after the intervention ($p=0.01$). These practices included soaking of dry maize and beans, eating a vitamin C rich fruit with or shortly after meals or adding more greens to food close to serving time. Furthermore, more intervention than comparison group women were implementing all vitamin A recommended practices (e.g. adding vitamin A green and yellow vegetables to *mukimo, githeri* or *chapati*) following the intervention. A similar trend was observed in the proportion of women using all the recommended protein practices (e.g. using 1:1 ratio of maize and beans).

4.8.14 Pre-post Nutrition practices in the Intervention Group

The mean practices score indicated that there was a significant difference in the iron and protein recommended practices post-intervention (Table 4.14).

Table 4.14. Mean practice score in the intervention group prior to and following the intervention (n=29)

Nutrient categories	Pre-intervention	Post-intervention	
	Mean (SD)	Mean (SD)	p value[1]
Iron practices score	1.8±0.4	2.0±0.0	0.01
Vitamin A practices score	1.5±0.5	1.6±0.5	0.44
Protein practices score	0.3±0.5	0.6±0.5	0.02
Deworming practices score	0.7±0.5	0.6±0.5	0.45

[1]Paired sample t-test

A significantly higher proportion of intervention women implemented all of the iron-related practices at post-intervention (Table 4.15). Also, a significantly higher proportion of women in the intervention added more vitamin A green and yellow vegetables at post-intervention compared to pre-intervention. Although no other significant differences were found, there were modest increases, post-intervention, in the proportion of women that used the other recommended food-related practices. These increases were reflected by the percentage of women who implemented all of the recommended practices in Table 4.15.

Table 4.15. Proportion of women in the intervention group using promoted food related practices: Pre-post intervention (n=29)

Nutrient categories		Pre-intervention	Post-intervention	
		% (n)	% (n)	p value[1]
Iron practices	All practice	75.1 (22)	100 (29)	0.02
	<1practice	24.1 (7)	0.0 (0)	
Vitamin A practices	All practice	51.7 (15)	62.1 (18)	0.60
	<1 practice	48.3 (14)	37.9 (11)	
Protein practices	All practice	31.0 (9)	62.1 (18)	0.04
	<1practice	69.0 (20)	37.9 (11)	
Deworming practices	Deworming	65.5 (19)	55.6 (15)	0.62
	N/A	34.5 (10)	44.4 (12)	

[1]Paired sample t-test

4.9 Discussion

4.9.1 Household Food Security

The lack of differences in household food security scores suggested that food insecurity was a common problem to both groups, although it was more prevalent in the intervention group. A three year comparative study conducted in neighbouring Kiirua and Murega area found a similarly high prevalence of household food insecurity among the women participants (Gamble et al., 2013). In the same way, a recent survey conducted in Kenya found that one in three households experienced a reduction in the quantity and quality of meals consumed (WFP, 2016). Reducing the quality and quantity of food is a common cultural strategy used to cope with short or long term food shortages (Chagomoka et al., 2016; Coates et al., 2007). Although it was hoped that the combined intervention would reduce food insecurity levels, food insecurity is a complex issue which is easily influenced by other confounding factors such as climatic, social and economic factors (Chagomoka et al., 2016; Hassen, Zinab, & Belachew, 2016; Walton et al., 2012).

Prior to the intervention, household food insecurity was significantly more severe in the intervention group than in the comparison group, with higher HFIAS scores among the majority of women who were classified as ‘severely’ food insecure. This likely reflects the higher proportion of women in the comparison group who reported owning dairy (exotic) cattle: all women in the comparison group were members of Naari Dairy and owned dairy cattle, with 53% owning more than two exotic cattle on average compared to 28% in the intervention group. Being part of a dairy group (which provides market access for dairy farmers and is often a cooperative society that is owned and

controlled by farmers who produce milk) in Kenya has been identified as a buffer against food insecurity as members are more likely to have regular income, access to credit and other economic benefits that are inaccessible to non-members (Walton et al., 2012). A similar phenomenon was observed in the current study, with 74% of women in the comparison group having a bank account compared to 48% in the intervention group. These findings are consistent with those of Walton et al. (2012) who found that dairy membership was protective of food insecurity.

Similar to our findings, in Ethiopia, education status of household heads was also found to be an important predictor of food insecurity, with a household being 39% less likely to be food insecure if the household head had acquired formal education (Hassen et al., 2016). In our study a higher proportion of husbands in the comparison than intervention group had post-primary education, which may help explain the household food insecurity differences.

The prevalence of household food insecurity in the intervention group was lower post-intervention, with fewer women in the intervention group being classified as 'severely' food insecure at post-intervention compared to prior the intervention. A similar trend was also observed in the household food insecurity related domains, as a lower proportion of women experienced anxiety, reduced quality and quantity of food following the intervention, although differences were not significant. The post-intervention data collection period (June-July) coincided with the end of the long rains and the start of a harvesting season in Kenya (SRA, 2017). Although the long rains were reported to be below average, soil moisture was sufficient for livestock feed and some food crops. As a result, milk production was expected to increase. As well, it is possible

that the women in the intervention group felt more food secure at the post-intervention time because some crops were ready for harvest (SRA, 2017). This seasonality would help explain why fewer women experienced worry, reduced food quality or quantity at this post-intervention time. Similarly, in rural Tanzania, a longitudinal study found a strong association between seasonal food availability and anxiety and mental health disorders among women smallholder farmers (Hadley & Patil, 2008). The authors reported significantly higher levels of worry and depression during the wet season when food was scarce compared to the dry season when food was available (Hadley & Patil, 2008). In fact, the authors suggested that seasonal anxiety and depression were less likely to occur if households had other means through which they could access food during the food insecure wet seasons. Therefore, future studies should be conducted semi-annually in order to understand how this combined intervention, with drip irrigated kitchen gardens, impacts household food security during the lean versus abundant food supply seasons in the Kenyan context.

4.9.2 Diet Diversity

Prior the intervention, women from the intervention group appeared to have diets that were more diverse than those in the comparison group, although differences in DD scores were not significant. Specifically, their consumption of carrots, amaranth, kale, spinach, cabbage, red onions, spring onions, tomatoes, zucchini, beans, cow peas, lentils, green grams, oranges, guava and pomegranate was higher, reflecting the intervention recommendations to increase the intake of vitamin A green and yellow vegetables, legumes, vitamin C fruits and other fruits. The higher consumption of recommended foods by women in the intervention group suggests that the combined intervention was

effective, with more women in the intervention than in the comparison group not only consuming a variety of vegetables grown in the enhanced kitchen gardens, but also implementing the recommended nutrition practices.

Changes in nutrition knowledge, attitudes and practices have been associated with increased consumption of promoted crops in previous studies (Faber & Benade, 2003; Hagenimana et al., 1999; Talukder et al., 2010). In South Africa, Faber and Benade (2003) reported that 85% of dietary vitamin A came from intake of beta-carotene rich crops such as dark green leafy vegetables which were promoted by the gardening intervention. In turn, the increase in the consumption of such nutritious vegetables and fruits has been shown to have direct impacts on reducing the prevalence of micronutrient deficiencies in the developing countries (Faber & Benade, 2003; Hagenimana et al., 1999; Low et al., 2007; McDermott et al., 2013; Talukder et al., 2010; Yeudall et al., 2005). For instance, in Bangladesh and the Philippines, combined horticulture and nutrition education interventions have resulted in a significant reduction in iron deficiency anemia and vitamin A deficiency, specifically night blindness (Talukder et al., 2010).

In contrast to other studies that have found differences in the intake of eggs (Hagenimana et al., 1999) and vitamin A fruits (Girard et al., 2017), there were no differences in the intake of those foods between the intervention and the comparison group pre or post intervention. These findings suggest the low socio-economic status of the intervention group as indicated by the significantly low ownership of exotic cattle, chickens and acres of agricultural land. It is worth noting that increasing the consumption of eggs was not the focus of the nutrition messages which may also help

explain their consumption. Despite their low socieconomic status and high vulnerability to food insecurity, the intervention group has shown more resilience to food insecurity and poor diet presumably reducing the risks of developing micronutrient deficiencies which may be attributed to the combined intervention.

The intake of grains, milk, other starchy vegetables, vitamin C vegetables, vitamin A yellow vegetables and fruits, soy beans and large animal meat (e.g. beef, pork etc.) were marginally higher in the comparison group than the intervention group although no significant variation was seen pre or post-intervention. With the exception of other food groups, these results are comparable to those of Walton et al. (2012) who associated higher milk and energy intake with dairy membership among Kenyan women. Overall, the lack of intake of organ meats, bird meats (e.g. poultry), small and large fish, nuts and seeds and cheese among all 48 women is noteworthy. With the exception of nuts and seeds, our research group has found similar results in the neighbouring village of Kiirua, Murega and Mukuruweini, where there was low reported intake of animal products (Gamble et al., 2013; Walton et al., 2012). Likewise, a study conducted in Mozambique found that no participant consumed dairy products and that there was overall low intake of heme iron rich foods such as red meat (e.g. organ meat) (Arimond et al., 2011). This is typical of the monotonous diets consumed in some developing countries which are low in animal protein and heme iron (Arimond et al., 2011; Neumann et al., 2003; Yeudall et al., 2005). Given that dairy farming is common in Naari, there may be opportunities to have women increase their milk intake; however, given the cost of animal flesh-foods as sources of protein and iron, it is challenging to see increases in these without improved food security and decreased poverty. Others

have suggested interventions that promote small livestock production (for example rabbits and chickens) may help improved animal flesh food intake (Leroy & Frongillo, 2007; Talukder et al., 2014).

4.9.3 Nutrition Knowledge, Attitudes and Practices

Prior to the peer-led nutrition education intervention the women in the intervention group had a significantly higher awareness of iron-related practices of soaking dry maize and beans. Likewise, a significantly higher number of women in the intervention group were familiar with the practice of soaking dry maize and beans, knew how long one should soak dry maize and beans, and knew what they had to do with the water used for soaking dry maize and beans. This greater knowledge may be attributed to the pilot study in May 2016 that increased this awareness among the intervention group women.

In the 2017 study the intervention group similarly retained the nutrition knowledge over the short (5-week) interval. With the exception of the knowledge of the deworming message, there was a notable improvement in knowledge of the nine key nutrition messages that promoted appropriate food preparation methods and increased consumption of micronutrient rich foods. Significantly more women in the intervention group used a '1:1' ratio of maize to beans when preparing *mukimo* or *githeri*, soaked dry maize and beans before cooking, added OFSP to *githeri* and ate a fruit with or shortly after meals. The consumption of micronutrient rich foods (e.g. OFSP, carrots, squash, tomatoes, kale and amaranth) also improved overtime with increased nutrition knowledge. However, since the comparison group's practices were measured once, we do not know how much they could have changed over the same period. The lack of

improvement in questions pertaining to knowledge of why and when women were to deworm their children over the course of the intervention could be due to that fact that over 50 % women in both groups were 50 years and older and therefore they did not have young children, with only a few taking care of their grandchildren.

At post-intervention, the intervention group reported a higher knowledge score for messages relating to iron, protein and vitamin A in respect to the comparison group. In a Malawian study, similar results were reported after a year-long integrated food-based intervention, where the intervention group had significantly better knowledge and practices of iron, vitamin A and iron sources of food than the control group (Yeudall et al., 2005). Likewise, in South Africa, Faber and Benade's (2003) found that mothers in the experimental group had better knowledge of food sources of vitamin A and could on average highlight at least one consequence of inadequate vitamin A intake than those in the control group. A pre-post experimental study conducted among rural and urban school children in Machakos, Kenya also found an association between better nutrition knowledge and practices with a combined horticulture and nutrition education, nine months after the nutrition education intervention (David et al., 2008). Overall, children in the intervention schools that practiced gardening and received nutrition education had a significantly better knowledge score than those in the control groups at the end of the survey (David et al., 2008). Nevertheless, it is worth noting that the champ's model with the peer-led nutrition education pilot and intervention workshops spaced over 12 months had an impact whereas the other interventions took much longer (9-12 months) (David et al., 2008; Faber & Benade, 2003; Yeudall et al., 2005). Therefore, this model shows the

strength of the combined horticulture and peer-led nutrition education approach together with the pilot sensitization to improve methods.

The mean attitude scores prior to and following the peer-led nutrition education intervention indicated that a significantly higher proportion of women in the intervention group reported having positive attitudes towards the recommended vitamin A practices. The proportion of women who said that it was extremely important to add orange sweet potatoes, carrots or squash to local foods such as *mukimo, githeri, uji* and *chapati* was significantly higher in the intervention relative to the comparison group after the intervention. This suggests that the combined horticulture and peer-led nutrition education intervention increased awareness of the benefits of the vitamin A yellow and green vegetables and fruits, thereby leading to increased consumption of the promoted foods similar to other similar interventions (Faber & Benade, 2003; Yeudall et al., 2005). The perceived benefits of the vegetables grown in the enhanced kitchen gardens, easy access to promoted foods and improved nutritional knowledge is believed to have influenced the women's attitudes positively. A number of scholars have suggested that nutrition education not only plays an important role in providing essential knowledge and skills, but also in clarifying misguided attitudes which have been shown to reduce unhealthy dietary habits and practices (David et al., 2008; Hagenimana et al., 1999; Reinbott et al., 2016).

Recommended nutrition practices improved overtime in the intervention group. Prior to the intervention, a significantly higher proportion of women in the intervention than the comparison group were implementing most of the recommended iron related food practices; evidence for the impact of the pilot study. With regards to the iron and

vitamin A practices score categories post-intervention, a significantly higher proportion of women in the intervention group were implementing all iron and vitamin A related food practices. The vitamin A related practices implemented by the intervention group women included adding vitamin A green and yellow vegetables to *mukimo*, *githeri* or *chapati*. In addition, more women in the intervention than comparison group were also using all of the protein recommended practices such as using 1:1 ratio of maize and beans. With regards to the iron-related practices, a significantly higher proportion of women in the intervention group were soaking dry maize and beans, eating a vitamin C rich fruit with or shortly after meals or adding more greens to food close to serving time. These results are consistent with those reported elsewhere that have linked improved nutrition knowledge with better nutrition practices over time (David et al., 2008; Faber & Benade, 2003; Gibson, 2011; Hagenimana et al.,1999; Low et al., 2007; Low, 1997; Yeudall et al., 2005). For example, in rural Malawi, Yeudall et al. (2005) promoted the use of simple dietary modification strategies to reduce the phytate content in children's maize based diets. By end of the intervention, a significantly higher proportion of women in the intervention group were soaking whole maize and beans, soaking whole maize flour, using whole grain maize and fermenting flour (Yeudall et al., 2005).

Therefore, this study's findings suggest that the combined horticulture and peer-led nutrition education had a positive impact on the nutrition knowledge, attitudes and practices of women. To a large extent the peer-led approach played a critical role in teaching the nutrition messages as well as in demonstrating practical ways of incorporating the new crops to local recipes through a cooking and food tasting session. Practical demonstrations and food tasting sessions have been associated with improved

dietary Behaviour (David et al., 2008; Faber & Benade, 2003). In South Africa, mothers were taught different ways of incorporating promoted crops (vitamin A rich foods) in their children's meals. The cooking demonstrations and the food tasting encouraged the women to plant the promoted crops such as orange fleshed sweet potatoes at home and to feed it to their children (Faber & Benade, 2003).

Several reviews have also documented the impact of peer-led nutrition education approaches in improving adult's nutrition knowledge, attitudes and practices as well as other health outcomes (Contento et al., 1995; Pérez-Escamilla, Hromi-Fiedler, Vega-López, Bermúdez-Millán, & Segura-Pérez, 2008). A recent systematic review examined the impact of peer-led nutrition education on type 2 diabetes, breastfeeding and nutrition knowledge attitudes and practices among Latinos (Pérez-Escamilla et al., 2008). The authors concluded that programs which had a peer educator component enhanced self-care of Latinos with type 2 diabetes, breastfeeding women as well as their overall nutrition knowledge, attitudes and practices (Pérez-Escamilla et al., 2008). Use of peer educators has also been linked to positive improvements in intake of fruits, vegetables and low fat foods among school children (Story, Lytle, Birnbaum, & Perry, 2002). In Canada, a one year peer-led nutrition education intervention showed positive improvements in the nutrition knowledge, attitudes and practices of children in elementary school (Stock et al., 2007). The pilot study trained older children in fourth through seventh grade as nutrition peer educators ("Healthy Buddies") with the aim of promoting a healthier lifestyle to reduce obesity. The pilot study emphasized three key areas which included healthy eating, exercise and positive body image. The peer-educators were then paired with younger children in kindergarten to third grade for a

whole school year. At the end of the intervention the knowledge, attitudes and practices scores of the older and younger students in the treatment school had improved compared to those in the control school, thereby reducing their risks of developing obesity (Stock et al., 2007). Generally, peer-led nutrition education interventions have had a higher acceptability among peers which makes it a better and more preferred platform of conveying important nutrition messages (Story et al., 2002). Despite the benefits of a peer-led nutrition education model, Pérez-Escamilla et al. (2008) identified that challenges still existed to identify the optimal characteristics of peer educators, the training they should receive, the frequency and amount of contact between peer-educators and clients, the educational approach that should be used (i.e. individual, small groups, large groups) and the settings (home or community site). This study's success indicates the context under which a peer-led nutrition education intervention can be planned, implemented and evaluated. It also provides ideal qualities for peer-educators based on the criteria used by group members to select their preferred candidates to be trained as champs (peer educators). As such, the following characteristics were observed from the six champs selected, they were confident, successful farmers, proficient cooks, demonstrated leadership skills (some of them were officials in the group), could read the local dialect *Kimeru*, teach and answer questions and were very inquisitive about the nutrition messages. While having an outsider (non-group member) teach a group has been shown to undermine the benefits of peer education (Perry & Sieving, 1991), these qualities may helpful for future food security studies that aim to use a peer-led approach.

4.3.4 Strengths and Limitations

The strengths of this study include the use of the quasi-experimental design which allowed evaluation of indicators such as food security and diet diversity that went beyond measuring the biochemical benefits of a food-based intervention (Bushamuka et al., 2005; Darnton-Hill, 2014; Gibson, 2011; Webb, Nishida, & Darnton-Hill, 2007). The high participant response rate, with a 99% completion, was yet another strength of this study. The high response rate could be attributed to the strong ties to FHF which has a proven track record of providing horticultural support to women and the provision of enhanced gardens to the intervention women. Further, the unique peer-led approach used in implementing the nutrition education intervention, as well as the active participation and involvement of all women in the intervention group in the food preparation and teaching, created a sense of pride and ownership. Hence, the success of the peer-led nutrition education approach can be attributed to its proper planning, implementation and evaluation. For instance, the use formal/existing women's group provided an appropriate learning platform for women with similar interests and defined goals. Again, allowing the members of the group to appoint their preferred peers to be trained as champs (peer educators), proper training of the champs and the ability of the champs to freely decide on how the educational activities were to be undertaken based on the intervention's defined objectives also contributed to the success of the peer-led nutrition education model. The use of validated tools to assess food security and diet diversity and the use of the same translator to conduct all 48 interviews were other strengths of this study as it may have increased the accuracy of dietary data collected. In addition, the use of trained nutrition students to conduct the interviews supervised by a University

nutrition faculty member and a Kenyan registered dietitian was another strength of this study. This study also used more than one measure of behaviour namely nutrition practices and diet diversity.

Study limitations include the lack of randomization of groups to the combined intervention which was not possible because FHF had preselected the intervention group to receive the horticulture component of the intervention. The high household food insecurity level of the intervention group was indicative of the fact that the intervention group was selected based in part on need. Another limitation of this study is the fact that all members of the comparison group were members of Naari Dairy, with only a portion of women in the intervention group selling their milk to the dairy. Having baseline data for household food security, diet diversity and nutrition knowledge, attitudes and practices of the participants could have made it easier to interpret the differences in household food insecurity between the intervention and the comparison group and among women in the intervention group with and without the enhanced kitchen gardens. Having no post-intervention data for the comparison group is also another limitation for this study. The small sample size could also have limited the statistical power of this study. Differences in household food insecurity may have been significant had there been a larger sample size. The language barrier was yet another limitation. Since all interviews were conducted in English, translation services were used which could have resulted in leading the responses. However, to reduce this potential bias, the same translator was used each time and was trained by the research team prior to conducting the home interviews. Further, employees of FHF who were fluent in the local dialect attended several early interviews to verify that the translation was accurate and

appropriate. Another limitation was that the nutrition Knowledge and Practices questionnaire was not validated.

4.10 Conclusions

This study suggests that the combined horticulture and peer-led nutrition education intervention has significant potential in diversifying local diets as well as improving the nutrition related knowledge, attitudes and practices of Kenyan women farmers. Focusing on women as the primary care giver is critical in the fight against food insecurity, particularly when designing an intervention that aims to increase food production as well as promote better nutrition practices. This is because women are the primary producers, food preparers and caregivers. Therefore, future food insecurity interventions should be designed in a manner that actively involves women through women's groups in order to build their livelihood capacity and their level of nutrition knowledge, attitudes and practices. Further food and nutrition security research is needed to investigate the long term impact of a combined horticulture and peer-led nutrition education interventions under the Kenyan context. Results suggest that the link between food production and consumption is bridged when people are educated through integrated interventions (Darnton-Hill, 2014; Talukder et al., 2010). This study also signals the need for further research to assess the long term impact of the champ's model, specifically in leading nutrition education beyond the project duration. Information derived from such a study will be helpful in gauging whether this approach is sustainable in the long term.

5.1 Chapter five: Discussion and Conclusion

This study assessed the effect of a combined horticulture and peer-led nutrition education intervention on household food security, diet diversity and nutrition knowledge, attitudes and practices of women smallholder farmers in the Naari area, Eastern Kenya. The overall aim of the horticulture component was to increase the capacity of the women to grow vitamin A rich green and yellow/orange vegetables, increase the availability of these vegetables to the households and the larger community, as well as provide a source of income for the household through sale of excess vegetables. The horticulture intervention was provided by Farmers Helping Farmers (FHF), a Canadian non-governmental organization, and included enhanced kitchen gardens featuring water storage tanks, drip irrigation and quality vegetable seeds. Horticulture support was also provided to the women to assist in the setting up and management of their enhanced kitchen gardens. The peer-led nutrition education component of the intervention aimed to increase women's nutritional knowledge and improve food related attitudes and practices in order to increase the consumption of the nutritious crops provided through the horticulture intervention, and increase the bioavailability of dietary sources of vitamin A iron and vitamin C. This was achieved through participatory teaching and cooking sessions led by six women from a local women's self-help group (intervention group) who were trained as peer nutrition educators or 'champs'. These sessions were meant to help the women learn practical ways of incorporating the enhanced kitchen garden crops into their typical foods.

A pilot study was first conducted in 2016 to identify measurement tools including the household food insecurity access scale questionnaire which was used to

determine household food security levels and a standard method of assessing diet diversity using a 24-hour recall and 21 food groupings. A tailored knowledge, attitudes and practices questionnaire which was used to evaluate the nutrition knowledge, food related attitudes and practices of the women participants. Pre-post intervention assessments were then conducted in order to enable the comparison of key outcomes within and between the two groups.

5.1.1 Diet Diversity

In both the 2016 and 2017 interventions, diet diversity scores improved significantly within the intervention group. Post intervention (2017), significantly more women consumed vitamin C vegetables. Other food groupings improved but were not significant (vitamin A green and yellow vegetables, dry beans and peas, other vegetables, other fruits and eggs). There were no significant increases in consumption of orange fleshed sweet potato and leafy green vegetables over the study in 2017 which were major target behaviours of both interventions. This may reflect low availability of these foods during the data collection periods. For instance, women had planted orange sweet potatoes in March 2018; since they take three to four months to mature, these root vegetables were not ready for harvest at the pre and post measurement times. . Changes in consumption may have been detected if there was a longer period of intervention or if the intervention was conducted later in the growing season. On the other hand, the consumption of vitamin A green leafy vegetables, which are planted on rotational basis in the enhanced kitchens, increased significantly at post intervention. This likely reflects a higher level of availability. Based on increased diet diversity scores and increases in some food groupings over the intervention periods, it is likely that that there was

improved dietary adequacy overtime. However, it is important to note that a mean dietary diversity score of seven suggests that there is still only an estimated 50% of women who had adequate micronutrient intakes (vitamins and minerals) (Arimond, Torheim, Wiesmann, Joseph, & Carriquiry, 2009). It is therefore important to continue efforts to improve the dietary intakes of these women farmers. In particular, iron intakes remains a concern given that few women consumed flesh-foods which is associated with low intake of iron (Arimond et al., 2011; Bwibo & Neumann, 2003; Neumann et al., 2003; Talukder et al., 2014). Therefore, small animal husbandry should be integrated with combined interventions to increase the intake of animal protein. Although increasing the consumption of eggs was not the focus of the nutrition messages, which may also help explain their low consumption, this study findings signal the need for future studies to consider including nutrition messages that focus on increasing intake of animal protein foods.

Although not part of the thesis objectives, the improvement in diet diversity in 2016 appeared to be sustained, based on pre-intervention measures in 2017. This could be due to positive effects of the 2016 horticulture intervention that improved availability of vegetables for ten households and potentially their neighbours, although this was not investigated as part of our study. It could also be due to retention of the nutrition messages taught during 2016 given that the consumption of vitamin A green vegetables, dry beans and peas, vitamin C vegetables and other fruits was relatively higher in the intervention group compared to the comparison group.

While diet diversity is an excellent reflection of diet quality (Arimond et al., 2011), future studies could consider assessing the vitamin A status of the women

participants in order to fully gauge the effectiveness of the intervention. However, such measures are invasive and expensive and may not be practical for studies in rural areas such as ours (Gibson & Ferguson, 2008). Further research is also needed to investigate the seasonal changes in production and consumption of vitamin A rich vegetables. Finally, identifying the specific types and number of vegetable varieties being produced from the enhanced gardens and the percentage sold or taken to the market could help explain observed changes in consumption patterns.

5.1.2 Food Security

Household food security improved within the intervention group in the post intervention period, with the decrease in the proportion of women experiencing anxiety over food approaching statistical significance. This suggests that the intervention had a modest positive impact on the household food security at post-intervention. This may be due to the small number of households in this study which limited the power to detect differences in food security levels and experiences. The lack of impact on the other food security domains (quality and quantity) could also be due to the length of the combined intervention. Specifically, five weeks may be too short a time to demonstrate the impact of the intervention on household food security status when the garden, the source of complementary foods and the crops take time to mature (Busse, Kurabachew, Ptak, & Fofanah, 2017). The harvest cycle also may have impacted findings as farmers depend on rain-fed agriculture to produce staple foods such as cereal (e.g. maize and beans) and starchy tubers (e.g. potatoes, cassava and yams) (GOK, 2013; KFSSG & CSG, 2017). The previous two consecutive crop seasons had failed which meant that the households were already experiencing food shortages at the pre-intervention period (KFSSG &

CSG, 2017; SRA, 2017). Besides that the below average rains received in March-May 2017 were associated with a 'lean period' of low staple foods (e.g. maize, beans) availability in Kenya (KFSSG & CSG, 2017; SRA, 2017), soil moisture was sufficient for livestock feed and some food crops. As a result, milk production was expected to increase. It is possible that the women in the intervention group felt they were more food secure at the post-intervention time because some crops (e.g. maize) were ready for harvest (SRA, 2017), which would help explain why fewer women experienced worry, reduced food quality or quantity at this time. Therefore, future studies should be conducted semi-annually in order to understand how this combined intervention impacts food security during the lean and abundant food supply seasons.

Differences in the socio-demographic characteristics of the intervention and the comparison group may partially explain the higher rates of food insecurity in the intervention group at the pre-intervention period. The intervention group was selected because of their higher rates of poverty which may explain the higher rates of food insecurity relative to the comparison group. Women in the intervention group also received the enhanced kitchen gardens in stages based on resource availability. It is unclear whether significant differences in household food insecurity would have been observed between the two groups had all 29 women received the enhanced kitchen gardens in 2015. In any case, food insecurity rates remained high in both 2016 and 2017 but improved modestly at the post-intervention period (July 2017). Our results are consistent with a three year comparative study conducted by our research group, in partnership with FHF in the neighbouring Kiirua and Murega area, which found that food insecurity rates decreased over the study period (Gamble et al., 2013). While other

integrated horticulture interventions have used the quantity of vegetables produced from the gardens as a measure of improved household food security (Schreinemachers, Patalagsa, & Uddin, 2016; Talukder et al., 2014; Talukder et al., 2001), this was not the focus of this combined intervention. This could help explain why such interventions found significant differences in this alternate way to assess household food security. Future interventions should therefore measure the volume of vegetables produced by the enhanced gardens in order to understand how this impacts household food security. Further research is also needed to determine the economic impact that results from the sale of the surplus vegetable and how this influences food security within the Kenyan context.

5.1.3 Nutrition Knowledge

Results indicate that the iron knowledge sores were significantly higher in the intervention group than the comparison group in 2016. This suggests that there was a short term retention of nutrition messages related to iron. In 2017, the combined intervention had a significant and positive impact on women's level of knowledge of the vitamin A and protein related messages taught. For example, the number of women giving correct answers to the question asking why one would add orange sweet potatoes to *githeri* was significantly higher after the intervention. Similarly, Faber and Benade's (2003) findings indicated that mothers in the experimental group had better knowledge of food sources of vitamin-A and could, on average, name one consequence associated vitamin-A deficiency compared to those in a control group 20 months after the intervention. Additionally, David and colleagues (2008) also found higher knowledge scores in school children who received a gardening and nutrition education intervention

than those in the control schools. One success of the current intervention is the women's acquisition of culturally appropriate nutrition knowledge and practices as well as change in attitudes. These changes in nutrition knowledge, attitudes and practices have been shown to play a significant role in reducing women's and children's vulnerability to micronutrient deficiencies (Busse et al., 2017; Faber & Benade, 2003; HKI, 2001; Yeudall et al., 2005).

5.1.4 Nutrition Attitudes

There were no significant differences in attitude scores following the 2017 intervention within the intervention group. This may be due to the very high proportion of women who had positive attitudes before the intervention (e.g. thought it was 'extremely' important to add greens to *githeri*, add orange sweet potatoes to *chapati* or *mukimo* and eat fruit with or shortly after meals). This attitude may reflect an increased awareness of the benefits of the vitamin A yellow/orange and green vegetables and fruits. The perceived benefits of the vegetables grown in the enhanced kitchen gardens, their easy access and improved nutritional knowledge is believed to have influenced the women's attitudes positively. This may also indicate the success of the pilot study conducted in 2016. The fact that the same women had participated in the pilot study for the combined intervention, therefore had been taught seven of the ten nutrition messages which may explain the lack of differences in attitudes pre-post intervention. For the iron related attitudes, few women indicated that it was 'extremely important' to implement practices to improve iron status which included an equal ratio of maize and beans. This may reflect an inability to increase the proportion of beans in *githeri* since there was a shortage of maize and beans during the study due to a lack of rain (KFSSG & CSG,

2017). There were fewer women who thought it was important to provide deworming medicine to their children, this may be because this message was less relevant to them: approximately one third of the women did not have small children at home.

The importance of attitudes in nutrition education was evident in a cross-sectional study conducted in Cambodia that concluded nutrition education integrated with an agriculture intervention significantly improved maternal attitudes (Reinbott et al., 2016). After two to three months of home-based nutrition counselling, the authors found that positive changes in caregiver's nutrition knowledge, attitudes and practices was associated with an improvement in children's dietary diversity to the positive change in caregiver's nutrition knowledge, attitudes and practices (Reinbott et al., 2016). Likewise, in South Africa, Faber and colleagues (2003) attributed the positive change in maternal attitudes to acquired nutrition knowledge and practices. The authors concluded that mother's awareness of what foods made their children healthy, the acquisition of new skills to produce those foods through home gardening and the close location of the gardens to the homestead created a sense of empowerment which was vital to the positive change in their attitudes (Faber & Benade, 2003). David et al. (2008) has suggested that improved nutrition knowledge and practices is positively associated with changed attitudes, which may explain the present study's findings.

5.1.5 Nutrition Practices

Women's reported practices related to improving iron and protein intake and iron absorption increased significantly over the intervention in 2017. Women in the intervention group were more likely to soak dry maize and beans, to rinse soaked maize and beans and discard the water, use one to one ratio of maize to beans and eat fruits

with or shortly after a meal. Vitamin A related practice scores (e.g. adding orange sweet potatoes, carrots, squash and green leafy vegetables to *githeri*, *chapati* or *mukimo*) were significantly different between the two groups in 2016. No significant change was observed in this practice after five weeks of the peer-led nutrition education intervention in 2017 in spite of the fact that this was a key component of the intervention messages. However, other specific practices focussed on increasing vitamin A intake did improve. For example, following the intervention, more women added one green and one orange vegetable to *githeri* or *mukimo,* in addition to tomatoes and onions, and added greens close to serving time. In a similar study in Malawi, the proportion of women who practiced simple dietary modification strategies to improve iron intakes increased one year after the implementation (Yeudall et al., 2005). Similarly, Reinbott and colleagues (2016) associated the improvement in the children's dietary intake to their mother's positive change in nutrition practices. This study did not examine the inter-relationships among levels of nutrition knowledge, attitudes and practices since it was outside the scope of this thesis. This analysis would provide insight as to whether the increases in knowledge were, in part, responsible for the positive changes in nutrition related practices. This, and the relationship of dietary practices and both diet diversity and food security, will be explored by the research team as part of future research projects.

5.1.6 Overall Impact of the Intervention

The improved food security and diet diversity outcomes in this study suggest that the combined intervention was effective. Although women in the intervention group were more food insecure than the comparison group prior to and following the intervention, they consumed a more diverse diet than women in the comparison group.

Further, women in the intervention group also had a significantly higher diet diversity scores post intervention. These results suggest that the intervention may have buffered the impact of food insecurity on diet diversity and, by extension, improved their intake of important vitamins and minerals.

The combined intervention could have impacted dietary quality and household food security both directly and indirectly. The main aims of the enhanced kitchen gardens were to produce sufficient amounts of vegetables for the family consumption and increase income from selling the excess. Thus, higher vegetable production in enhanced gardens at post-intervention could have had a direct impact of diet diversity which would have enabled the increase their intake of a variety of the promoted crops such as vitamin A yellow/orange and green vegetables as well as from sharing different vegetables with their neighbours. Income generated from selling the surplus vegetables to their neighbours or a local market could have provided the women with funds to purchase different foods, having a positive indirect impact on the diet diversity. Further, any additional income would directly and positively impact household food security. Since this study did not formally assess the increase in the amount of vegetables produced in the gardens or the income generated from the selling the excess produce, it is not possible to conclude that the intervention impacted these outcomes.

As is the case with other horticulture interventions, the horticulture component of this study may have changed the food environment in the Naari community by providing easier access to a variety of vegetables for both the intervention households and the larger community (Michie, Van Stralen, & West, 2011). The significant increase in the women's intake of micronutrient rich foods such as vitamin A yellow/orange and green

leafy vegetables and vitamin C containing vegetables following the intervention is likely related to the observed improvements in nutrition knowledge and vegetable availability over the course of the intervention. Further, the increased consumption of vitamin A yellow/orange and green leafy vegetables is indicative that the combined intervention increased intake of essential micronutrients (Busse et al., 2017; Faber & Benade, 2003).

A significantly higher proportion of women in the intervention group consumed the promoted crops which suggest that the horticulture intervention and pilot study conducted in the previous year had both immediate and long term impact on women's knowledge, attitudes and behaviours. It is important that future analysis confirm this long term impact, as well as examine the relationships between diet diversity, food practices and their knowledge of the nutrition messages.

Women's self-help groups were the target for the intervention for this study. Since its inception, Farmers Helping Farmers has worked with women's groups as a means of improving household food security. In fact, gender marginalization has been identified as a key predictor to food insecurity and women bear a heavy burden of micronutrient deficiencies in the developing countries (IFPRI, 2009). In particular, women smallholder farmers have limited access to participate in food production initiatives, they are also not able to learn about new agricultural technologies, and thus do not benefit from the associated positive economic impacts (FAO, 2010; Njuki et al., 2016). As such, the combined horticulture and peer-led nutrition education intervention mainly focused on women smallholder in order to address this marginalization; further, direct targeting of women has shown higher success rates and possibilities of long term sustainability of food-based projects (Negin et al., 2009). In fact, women's agricultural

yields increase when they have equal access to vital food production technologies as their male counterpart which positively impacts their income status and ability to access food (Doss, 2011; FAO, 2010; Njuki et al., 2016; Talukder et al., 2014). Food access and utilization for women and children significantly improved when women were targeted by food-based interventions and when nutrition education was incorporated in such projects (Berti, Faber, & Smuts, 2014; Darnton-Hill, 2014; Talukder et al., 2014; Talukder et al., 2000; Talukder et al., 2001). Improved food access and utilization have been shown to be significant contributors to reducing the burden of micronutrient deficiencies in the developing world (Berti, Krasevec, & FitzGerald, 2004; Low et al., 2007; Talukder et al., 2014; Yeudall et al., 2005). Other positive benefits for women observed in similar interventions were increased empowerment of women, enhanced capacity to make critical food production and food preparation decisions and increased engagement with the project (Haselow et al., 2016; Kumar & Quisumbing, 2010). Similarly, as part of our larger intervention and research project, focus group discussions found that both the champs and members of the women's self-help group (intervention group) felt that their social status had improved as they felt more respected by their community members due to their participation in the combined intervention (Wanjohi, 2018). As well, the women were felt more confident and knowledgeable about the recommended practices which made them engage the larger community by teaching the nutrition messages at church groups, other women's group and to their neighbours (Shileche, 2018; Wanjohi, 2018).

5.1.7 Strengths and Limitations

Contributing to the success of this study was the fact that the recommended dietary modification strategies were not only evidence based (Gibson, 2011; Gibson & Hotz, 2001; Walingo, 2009; Yeudall et al., 2005; Zijp, Korver, & Tijburg, 2000) but also practical and culturally appropriate. The peer-led nutrition education component of this combined intervention seems to have positively influenced the food consumption habits of the women likely through increased knowledge and consistently high positive attitudes towards the promoted practices which enabled the women to make informed food choices. Use of peer educators has shown positive improvements in intakes of fruits, vegetables and low fat foods among school children in the United States elementary schools (Story et al., 2002). Several reviews have also documented the effectiveness of peer-led nutrition education approaches in improving adult's nutrition knowledge, attitudes and practices as well as the overall health outcomes (Contento et al., 1995; Pérez-Escamilla et al., 2008). This success could also be attributed to the fact that the nutrition education messages and the questionnaires were translated into the local dialect, Kimeru, which enhanced understanding of the nutrition messages by the intervention group. Furthermore, the author and another graduate student who composed the messages are Kenyan dietitians and therefore had a good understanding of the context of the community's cultural food taboos and dietary behaviours. They worked with the research team, Farmers Helping Farmers staff in Kenya, and translators to ensure that the messages were culturally appropriate and easy to understand and implement.

This study benefited from including peer-educators that were well suited for the intervention: the peer educators (or 'champs') were selected by the women's self-help group and were confident, successful farmers, proficient cooks, demonstrated leadership skills (some of them were officials in the group), could read the local dialect Kimeru, teach and answer questions and were very inquisitive about the nutrition messages. These characteristics ensured that the champs were highly motivated and successful in preparing the nutritious meals and teaching the messages to their peers. In contrast, having an outsider (non-group member) teach a group has been shown to undermine the benefits of peer education (Perry & Sieving, 1991). Our approach to selecting peer leaders may be helpful for future food security studies that aim to use a peer-led approach.

This study also had some limitations. The small sample size could have limited the statistical power to detect significant differences in household food insecurity between the intervention and the comparison group as well as across women with and without enhanced kitchen gardens. Therefore, future research should explore the impact of this model using a larger sample size when feasible. Another limitation for this study is that comparison group data was only collected once, prior to the intervention. It is therefore unclear whether there were changes in household food security, dietary diversity or knowledge, attitudes and practices over the intervention time period.

While results indicate improved diet diversity accompanied by enhanced nutrition knowledge, attitudes and practices within the study population, we observed that some women consumed large portions of starchy staple foods and had abdominal obesity, suggesting that they may be in the early stages of nutrition transition (Popkin,

1993; Steyn & Mchiza, 2014). Therefore, it would be helpful for future studies to examine the weight status and/or waist circumference of participants prior to and following the integrated intervention. As such, there is need to explore and potentially develop impacts of appropriate nutrition messages that will promote consumption of appropriate portion sizes.

Future research is needed to investigate the long-term sustainability of combined horticulture and peer-led nutrition education interventions on food insecurity within the Kenyan context. At the end of the study in 2017, women were encouraged to continue to teach the nutrition content of the intervention to other women in their community using the laminated messages and cooking tips that we provided to them. It is hoped that the champs will continue to transfer their acquired nutrition knowledge and practices to other women in the community; this will be assessed in 2018 as part of the larger research project. However, as the project ends, it is unclear if the cooking demonstrations will continue, as the project provided funds for all the food ingredients used during the implementation of the project. Further research is needed to explore alternative models to ensure sustainability of the participatory workshops by the champs and not create dependence on outside inputs other than advice, training, and educational supports.

It is important that the combined horticulture and peer-led nutrition education model be explored as an avenue through which women in vulnerable households can increase their production, access and consumption of nutrient rich foods, by enhancing their capacity to adapt to changing climate and agriculture technology. This in turn reduces their dependency on food aid in times of seasonal food shortages. Furthermore,

this approach resulted in significant improvement in the nutrition knowledge, attitudes and practices of the women which plays a critical role in the long term sustainability of the project.

This study's findings suggest that combined horticulture and peer-led nutrition education interventions such as the one in this study have the potential to diversify monotonous diets, improve the nutrition knowledge, attitudes and practices, and reduce food related anxiety of women living in resource-poor settings. This model will inform the development of current and future interventions that aim to improve food production, access and utilization. In spite of these improvements, continued improvement in overall diet diversity is needed, including the increased intake of animal protein, in order to reduce micronutrient malnutrition. Furthermore, this model has demonstrated its ability to adapt to local and cultural contexts through active involvement of the high risk groups that are being targeted. Considering factors that contribute to food insecurity and micronutrient malnutrition such as climate change, low diet diversity and marginalization of women, projects such as this have the potential to positively impact availability, access and utilization of micronutrient rich foods at the household level. Thereby reducing donor dependency by promoting capacity development and self-sufficiency in unforeseen events.

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Appendices

Appendix A

Proportion of women in the intervention and the comparison group who reported that they never, rarely, sometimes or often worried about food in 2016

Frequency	Never		Rarely		Sometimes		Often		p value[1]
Questions	Intervention 'YES' (n)	Comparison 'YES' (n)	Intervention 'YES' (n)	Comparison 'YES' (n)	Intervention 'YES' (n)	Comparisor 'YES' (n)	Intervention 'YES' (n)	Comparison 'YES' (n)	
Did you worry your household would not have enough food?	55.2 (16)	73.7 (14)	44.8 (13)	26.3 (5)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.32
Were you not able to eat the foods you preferred	62.1 (18)	68.4 (13)	37.9 (11)	31.6 (6)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.89
Did you have to eat a limited variety of foods?	58.6 (17)	63.2 (12)	41.4 (12)	36.8 (7)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.99
Did you have to eat food you really did not want to eat?	41.4 (12)	52.6 (10)	58.6 (17)	47.4 (9)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.64
Did you have to eat a smaller meal than you felt necessary?	65.5 (19)	73.7 (14)	34.5 (10)	26.3 (5)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.78
Did you have to eat fewer meals in a day?	55.2 (16)	68.4 (13)	44.8 (13)	31.6 (6)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.54
Was there ever no food to eat in the household?	79.3 (23)	79.0 (15)	20.7 (6)	21.1 (4)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	1.00
Did you go to sleep at night hungry?	93.1 (27)	89.5 (17)	6.9 (2)	10.5 (2)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	1.00
Did you go a whole day and night without food?	96.6 (28)	94.7 (18)	3.5 (1)	5.3(1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	1.00

[1]Pearson Chi-square or Fisher's exact test

Appendix B

Proportion of women who gave 80% correct answers in each nutrient category: Pre and post-intervention

Nutrient categories		Pre-intervention			Post-intervention	
		Comparison (n=19)	Intervention (n=29)	p value[1]	Intervention (n=29)	p value[1]
		% (n)	% (n)		% (n)	
Iron score	<80%	79.0 (15)	31.0 (9)	0.01	17.2 (5)	0.01
	>80%	21.1 (4)	69.0 (20)		82.8 (24)	
Vitamin-A score	<80%	73.7 (14)	72.4 (21)	1.00	51.7 (15)	0.22
	>80%	26.3 (5)	27.6 (8)		48.3 (14)	
Protein score	<80%	100 (19)	89.7 (26)	0.40	75.9 (22)	0.06
	>80%	0.0 (0)	10.3 (3)		24.1 (7)	
Deworming score	<80%	31.6 (6)	31.0 (9)	1.00	48.3 (14)	0.40
	>80%	68.4 (13)	69.0 (20)		51.7 (15)	

[1]Pearson Chi-square or Fisher's exact test

Appendix C

Proportion of women in the intervention group who gave 80% correct answers in each nutrient category: Pre-post intervention (n=29)

Nutrient categories		Pre-intervention	Post-intervention	
		% (n)	% (n)	p value[1]
Iron score	<80%	31.0 (9)	17.2 (5)	0.36
	>80%	69.0 (20)	82.8 (24)	
Vitamin- A score	<80%	72.4 (21)	51.7 (15)	0.18
	>80%	27.6 (8)	48.3 (14)	
Protein score	<80%	89.7 (26)	75.9 (22)	0.30
	>80%	10.3 (3)	24.1 (7)	
Deworming score	<80%	31.0 (9)	48.3 (14)	0.28
	>80%	69.0 (20)	51.7 (15)	

[1]Pearson Chi-square or Fisher's exact test

Appendix D

Mean attitude score categories in the intervention group: Pre-post intervention (n=29)

Nutrient categories	**Pre-intervention** **Mean (SD)**	**Post-intervention** **Mean (SD)**	**p value**[1]
Iron attitude score	1.1±0.3	1.0±0.0	0.16
vitamin A attitude score	4.1±0.6	4.1±0.7	0.80
Deworming	1.34±0.5	1.4±0.5	0.43

[1]Paired sample t-test

Appendix E

Proportion of women in the intervention group who rated recommended nutrition messages as extremely important versus other categories (very important, important, not very important and not important at all): Pre-post-intervention (n=29)

Nutrient categories		Pre-intervention % (n)	Post-intervention % (n)	p value[1]
Iron attitude score	Extremely	6.9 (2)	0.0 (0)	0.47
	Other	93.1 (27)	100 (29)	
Vitamin A attitude score	Extremely	20.7 (6)	27.6 (8)	0.76
	Other	79.3 (23)	72.4 (21)	
Deworming	Extremely	34.5 (10)	44.8 (13)	0.59
	Other	65.5 (19)	55.2 (16)	

[1]Pearson Chi-square or Fisher's exact test

Appendix F

Household Food Insecurity Access (HFIAS) Questionnaire

1) In the past month did you worry that your household would not have enough food? Yes or No? Prompts: worry-scared, stressed, sleepless nights, high blood pressure household- home, family, my (your) people 1) **a) How often did this happen?** Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)
2) In the past month were you or any household member not able to eat the kinds of food that you preferred b/c of a lack of resources? Yes or No? Prompts: preferred foods- meat, potatoes, tomatoes lack of resources-poverty, not enough money, little yield from the garden 2) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)
3) In the past month did you or another household member have to eat a limited variety of foods b/c of a lack of resources? Yes or No? Prompts: variety-ugali, ugali, ugali or do you cook the same foods day after day after day? 3) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)
4) In the past month, did you or any other household member have to eat foods that you really did not want to eat b/c of a lack of resources to obtain other types of food? Yes or No? Prompts: Ugali and black tea? Porridge for lunch? Cooked green bananas? Unripen mango? Cooked pawpaw? 4) **a) How often did this happen? *** Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)
5) In the past four weeks, did you or any other household member have to eat a smaller meal than you felt you needed because there was not enough food? Yes or No? Prompts: AMOUNT 5) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)

6) In the past month, did you or any other household member have to eat fewer meals in a day b/c there was not enough food? Yes or No?

6) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)

7) In the past month, was there ever no food to eat of any kind in your household b/c of a lack of resources? Yes or No?

Prompts: Work for food?

7) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)

8) In the past month, did YOU or any other household member go to sleep at night hungry b/c there was not enough food? Yes or No?

Prompts:

"We understand that you are a being a good mother to your children; did this result in you being hungry?"

8) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)

9) In the past month, did you or any other household member go a whole day and night without eating anything b/c there was not enough food? Yes or No?

9) **a) How often did this happen? ***Never, Rarely (once or twice in past 4 wks), Sometimes (three-ten times in past 4 wks), & Often (plus 10 times in past 4 wks)

Appendix G

24 Hour Recall

Name: _____ **Date**: _____

ID #:_____ **Interviewer**: _____

Women's group: _____

Time/location	Food	Ingredients (for diversity)	Comments

Was yesterday a normal day for you or was it special (i.e. a funeral or visitor)? Yes/No (circle one)

Explain:

_____

_____

Appendix H
Knowledge, Attitudes and Practices Questionnaire (2016)

We are interested in your thoughts about the food that you eat and how you prepare them.

1. (a). Are you familiar with the practice of **soaking dry maize or beans** in water before cooking? Yes No

   (b). If yes, how did you hear about this?

2. Do you soak maize in water before cooking? Yes No

   Why or why not?

3. (a). Do you soak beans in water before cooking Yes No

   Why or why not?

   (b). If you soak maize and/or beans, why do you soak them?

4. (a). Do you use *mpembe* (whole grain) maize? Yes No.

   Why or why not?

5. When you make *ugali*, what percent extraction maize flour do you use?

   Why or why not?

6. (a) Do you add **greens** to your *githeri*?

   Why or why not?

   (b) When in the cooking process should one add greens to *githeri*?

   Why or why not?

7. Are you familiar with the practice of avoiding taking your **tea** at meal times? Yes No

   (b). Do you know why would this be recommended? Yes No.

   If Yes, please explain.

8. (a). Do you ever eat **fruit** with or shortly after your meals? Yes No

   (b). Do you know why would this be recommended? Yes No.

   If Yes, please explain.

9. (a). Do you think it is important for children to drink milk as a beverage? Yes No

   Why or why not?

   (b). Do you think it is important for women to drink milk as a beverage? Yes No

   Why or why not?

Appendix I

Knowledge, Attitudes and Practices Questionnaire (2017)

UPEI/Farmers Helping Farmers/ QE II Scholars
Knowledge Attitudes and Practices Questionnaire 2017

Name _____ ID _____

We are interested in your thoughts about the food that you eat and how you prepare them.

1. As you know, the ingredients in *githeri* are maize and beans. Do you know what *githeri* helps your body with? Yes No

If yes, please explain.

2. a) Are you familiar with the practice of soaking dry maize or beans in water before cooking? Yes No

b) If yes, how did you hear about this?

3. a) Do you soak maize in water before cooking? Yes No

b) Why or why not?

4. a) Do you soak beans in water before cooking? Yes No

b) Why or why not?

5. How long should you soak dry maize and beans?

6. What do you think should be done with the water used for soaking your dried maize and beans?

7. a) Do you use *mpempe* (whole grain) maize? Yes No

   b) Why or why not?

8. a) Do you add **greens** to your *githeri*? Yes No

   b) Why or why not?

   c) <u>When</u> in the cooking process should one add greens to *githeri*? Early Late

   d) Why should the greens be added at this time?

9. How important do you think it is to add greens to your *githeri*?

   - Extremely important
   - Very important
   - Important
   - Not very important
   - Not important at all

10. **<u>Last May (2016),</u>** we interviewed you at home.

    a) At that time, were you adding orange fleshed sweet potato (OFSP), squash or carrots to *githeri*? Yes No

    b) Why or why not?

    c) At that time, were you adding OFSP, squash or carrots to *chapati*? Yes No

    d) Why or why not?

    e) At that time, were you adding OFSP, squash or carrots to *mukimo*? Yes No

    f) Why or why not?

11. a) **<u>Currently</u> (2017),** are you adding OFSP, squash or carrots to *githeri*? Yes No.

b) Why or why not?

c) **<u>Currently</u> (2017),** are you adding OFSP, squash or carrots to *chapati*? Yes No

d) Why or why not?

e) **<u>Currently</u> (2017),** are you adding OFSP, squash or carrots to *mukimo*? Yes No

f) Why or why not?

12. How important do you think it is to add OFSP, squash or carrots to *githeri*, *chapati* or *mukimo*?

- Extremely important
- Very important
- Important
- Not very important
- Not important at all

13. How important do you think it is to add two different vegetables to *githeri* in addition to onions and tomatoes? For example, greens and OFSP OR greens and squash OR greens and carrots.

- Extremely important
- Very important
- Important
- Not very important
- Not important at all

14. a) Are you familiar with the practice of avoiding taking your **tea** at meal times? Yes No

b) Do you know why would this be recommended? Yes No.

If yes, please explain.

c) How important do you think it is to avoiding taking your **tea** at meal times?

- Extremely important
- Very important
- Important
- Not very important
- Not important at all

15. a) Do you ever eat **fruit** with or shortly after your meals? Yes No

b) Do you know why would this be recommended? Yes No.

If Yes, please explain.

c) How important do you think it is to eat fruit with or shortly after meals?

- Extremely important
- Very important
- Important
- Not very important
- Not important at all

16. **Last May (2016),** we interviewed you at home. At that time, how were you preparing your uji?

a) type of maize flour

- Used maize flour made from *muthokore* maize
- Used maize flour made from whole grain *mpempe* maize

b) uji ingredients

- Maize flour only
- Used maize flour and other grains. Please specify _____
- Added other ingredients. Please specify _____

17. **Currently (2017),** how are you preparing your uji?

a) type of maize flour

- Use maize flour made from *muthokore* maize
- Use maize flour made from whole grain *mpempe* maize

b) uji ingredients

- Maize flour only
- Use maize flour and other grains. Please specify _____
- Added other ingredients. Please specify _____

c) Do you know why *mpempe* maize would be recommended? Yes No.

If Yes, please explain.

d) How important do you think it is to use maize flour made from whole grain maize?

- Extremely important
- Very important
- Important
- Not very important
- Not important at all

18**.** How important do you think it is to deworm children?

- Extremely important
- Very important
- Important
- Not very important
- Not important at all

b) How often do your children receive deworming medicine?

- Monthly
- Every six months
- Once per year
- Less often
- Never
- Don’t know

c) When was the last time that your children received deworming medicine?

Date:

- Don`t know

d) How frequently do you think one should deworm their children?

- Monthly
- Every six months
- Once per year
- Less often
- Never
- Don’t know

Appendix J

Socio-demographic Questionnaire

1. Does your household own this structure (house, flat, shack), do you pay rent, or do you live here without paying rent?	Owns .....1 Pays rent/lease…….....2 No rent with consent of owner……....3 No rent, squatting……....4
2. Does your household own the land on which the structure (house, flat, shack) sits?	Owns…….....1 Pays rent/lease……2 No rent with consent of owner……3 No rent, squatting……4
3. Does any member of this household own any agricultural land?	Yes……..1 No……...2
4. How many acres or hectares of agricultural land do members of this household own?	Acres.....1 Hectares.....2 Plot size (SQ FT).....3 Don't know….....9
5. Does this household own any livestock, herds, other farm animals, or poultry?	Yes……..1 No……2
6. Do you own any of these animals?	If yes, **how many?** a) Local cattle..... b) Exotic/grade/dairy cattle……

	c) Horses/Donkeys/Camels..... d) Goats..... e) Sheep…….. f) Chickens.....
62. Do you own a bank account?	YES……1 NO.....2
7. DETAILS OF THE MOTHER	Age…… Marital status……. Level of education…… **Highest level completed:** Specify highest level (standard/form) completed…….
8. DETAILS OF THE HUSBAND/ partner/spouse (**if applicable**)	Age…… Occupation ……..…… **Level of education:** PRIMARY…… 1 POST-PRIMARY/VOCATIONAL .....……..2 SECONDARY/'A'LEVEL…… 3 COLLEGE(MIDDLELEVEL)……. 4 UNIVERSITY…….. 5

Socio-demographic questions adapted from the 2014 Kenya Demographic Health Survey

Appendix K

Consent Form

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.

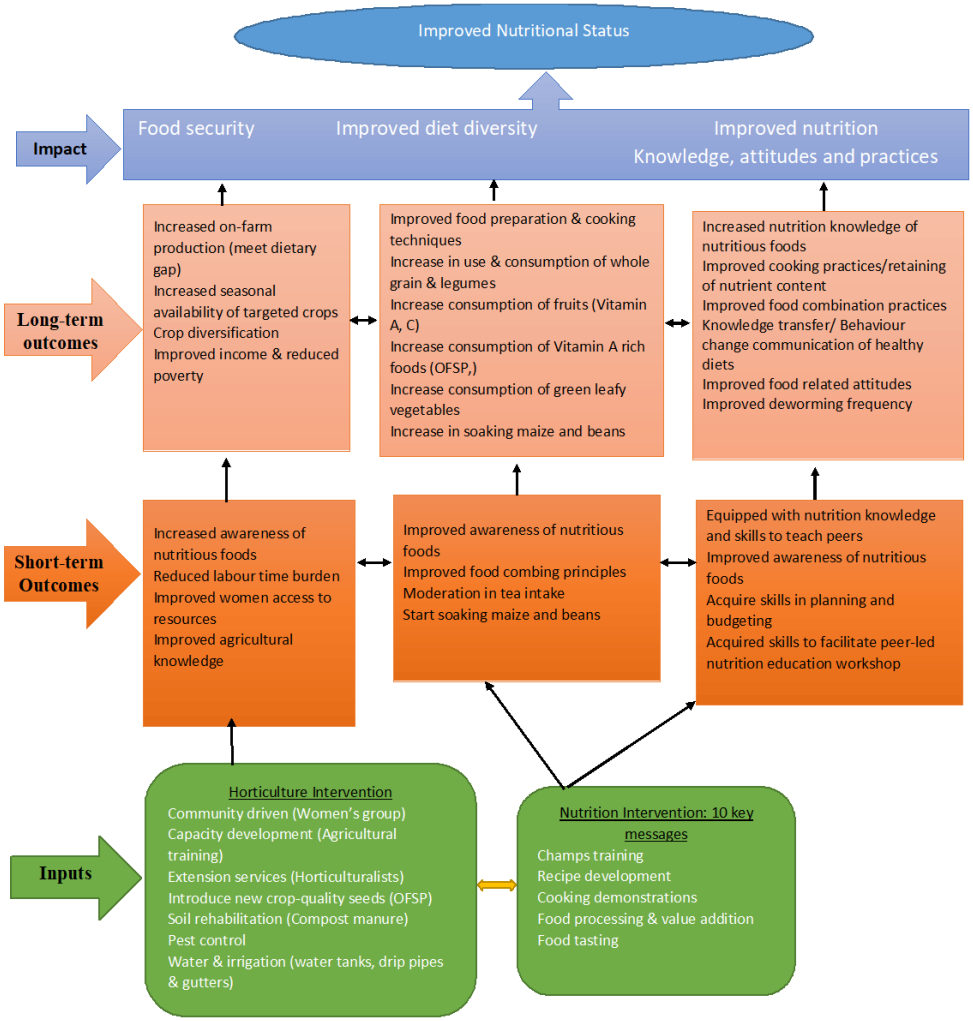
Signature of Researcher…….

Date……..

Appendix L

The Combined Horticulture and Nutrition Intervention Impact Pathway

"From the garden to the fork "



Appendix M

Contributions provided to the Queen Elizabeth II Diamond Jubilee Scholarships (QES) project led by the University of Prince Edward Island (UPEI), and contributed by the QES partners:

This appendix provides details of the contributions of the five main partners associated with the QES project led by UPEI and located in Kenya. The UPEI contributions were partially supported by QES funding ($499,842). Canadian Queen Elizabeth II Diamond Jubilee Scholarships are managed through a unique partnership of Universities Canada, the Rideau Hall Foundation (RHF), Community Foundations of Canada (CFC) and Canadian universities. This program is made possible with financial support from the Government of Canada, provincial governments and the private sector.

A. University of Prince Edward Island (UPEI) resources provided to the QES project

UPEI is a small but growing university in the province of Prince Edward Island in eastern Canada with a reasonably broad array of tertiary education programs, including programs in the Department of Health Management at the Atlantic Veterinary College, and in the Department of Applied Human Sciences in the Faculty of Science. From 2015 to 2018, UPEI provided the following resources to the QES project. These resources, in conjunction with other resources from other QES project partners, helped to achieve the QES project objectives.

Resources to Naari Dairy Farmers Cooperative Society Ltd. and members

- Training on cattle health management, in general, and in dairy cattle nutrition, reproduction and cow comfort specifically
- Training on cattle health management, medicine and surgery with Naari Dairy veterinary technician
- Arranged for interactions between QES interns and Scholars in Naari and Veterinarians without Borders veterinarians and interns from various locations including Wakulima Dairy
- Motorcycle for Naari Dairy veterinary technician, cost-shared with Naari Dairy
- Veterinary medicine and equipment and bonus for the Naari Dairy veterinary technician
- Leguminous shrub seedlings for augmenting cattle nutrition to Naari Dairy farmers
- Semen and semen storage equipment for Naari Dairy, cost-shared with Naari Dairy
- One silage chopper, cost-shared with Naari Dairy, and silage materials
- Dairy Health Management Handbooks (content)

Resources to Two Naari Women's Groups

- Face-to-face training on family nutrition
- Trained peer-nutrition trainers called "Champs"
- Provided nutrition training resources
- Cell phone text messaging on family nutrition
- Honoraria (maize, beans, cooking oil, cattle dewormer) for members participating in research projects
- Solar lights (with capacity to charge cell phones) to 24 members of a Naari women's group
- Funding for a tree seedling greenhouse and resources to grow leguminous shrub seedlings for augmenting cattle nutrition to Naari Dairy farmers

Resources to nine Naari area schools

- Nutritional quality assessment of school meals
- Reports for schools regarding the nutritional quality assessment of school meals, and recommendations and goal setting for nutritional enhancement of the school meals
- Nutrition education seminars for parents

In addition to these specific funds for the Naari Dairy, two Naari women's groups, and 9 Naari schools, UPEI also funded, either through QES funding or UPEI funding, general project costs.

- Selection of QES Scholars
- Training of QES Scholars and Interns
- Orientation and supervision of QES Scholars and Interns
- Management of the QES project
- Transportation costs to and from Kenya, and in Kenya for QES Scholars, Interns and supervisors
- Accommodation and food costs in Kenya for QES Interns and supervisors
- Living stipend costs in Canada and in Kenya for QES Scholars
- Tuition and other registration fees for QES Scholars

B. Farmers Helping Farmers (FHF) resources provided as part of the QES project

FHF is a Canadian based non-profit organization based in Prince Edward Island with a longstanding presence working with Kenyan farmer groups. From 2015 to 2018, FHF provided the following resources to the QES project. These resources, in conjunction with other resources from other QES project partners, helped to achieve the QES project objectives.

Resources to Naari Dairy Farmers Cooperative Society Ltd. and members

- Regular training on milk quality and milk production by FHF staff : Stephen Chandi and Leah Kariuki

- Training on bookkeeping with Dairy directors and groups
- Arranged for guidance from Wakulima Dairy on setting up a Savings and Credit Cooperative (SACCO)
- Two silage choppers, cost-shared with Naari Dairy
- Computers and printer to prepare monthly income statements for members of Naari Dairy
- Funds for a revolving cow loan program to lend money for a cow to needy youth and women
- Dairy Health Management Handbooks (content and printing)

Resources to Two Naari Women's Groups

- Horticultural extension support including:
  - Training on how to install and manage drip irrigation
  - Training in composting and soil tillage
  - Training in the use of recommended inputs, including establishing a small nursery to grow seedlings
  - Training in disease and insect control, etc. in gardens
- Training in book-keeping and provided book-keeping booklets
- Dairy production extension support from Leah Karioki and Stephen Chandi, including agronomy and milk quality
- Water tanks, drip irrigation and inputs for a vegetable garden for 45 women's farms
- Solar lights (with capacity to charge cell phones) for 35 members of a women's group in the Naari area

Resources to Naari area schools

FHF has established healthy school lunch programs at each of the following schools. School vegetable gardens and water tanks were funded and installed by FHF. Horticultural supports were provided by FHF staff in Kenya. With maize and beans from parents with children attending the school, and food from the school garden, lunches were prepared in a new cookhouse. The cookhouse and a gardener were funded by the Souris Village Feast in PEI.

2015	Muuti-O Thunguri Primary School
2016	Kiirua Primary School
2017	Michaka Primary School
2018	Muruguma Primary School Nkando Primary School Ndunyu Primary School Rugatene Primary School

In addition to these specific funds for the Naari Dairy, two Naari women's groups, and 7 Naari schools, FHF also assisted in:

- Selection of QES Scholars and Interns
- Training of QES Scholars and Interns
- Orientation and supervision of QES Scholars and Interns
- Management of the QES project

- Transportation costs in Kenya for QES Scholars, Interns and supervisors

C. Naari Dairy Farmers Cooperative Society (NDFCS) resources provided for the QES project

NDFCS is a cooperative located in Naari within Meru County of Kenya. It purchases milk from cooperative members, and sells the milk either retail or to a processor, either chilled or not chilled. From 2015 to 2018, NDFCS provided the following resources to the QES project. These resources, in conjunction with other resources from other QES project partners, helped to achieve the QES project objectives.

- Orientation and supervision of QES Scholars and Interns
- Providing board members to help locate farms
- Training of QES Interns
- Management of the QES project
- Training of farmer members on cattle health management, medicine and surgery, through the veterinary technician
- Cost-sharing of the motorcycle for the veterinary technician
- Cost-sharing of semen and semen storage equipment and silage choppers

D. University of Nairobi (UoN) resources provided for the QES project

UoN is a large university in Nairobi, Kenya, with a broad array of tertiary education programs, including veterinary medicine in the Faculty of Veterinary Medicine. From 2015 to 2018, UoN provided the following resources to the QES project. These resources, in conjunction with other resources from other QES project partners, helped to achieve the QES project objectives.

- Selection of QES Scholars
- Training of QES Scholars and Interns
- Orientation and supervision of QES Scholars and Interns
- Management of the QES project

E. Kenyatta University (KU) resources provided for the QES project

KU is a large university in Nairobi, Kenya, with a broad array of tertiary education programs, including programs in the Department of Community Resource Management and in the Department of Foods and Nutrition, both in the School of Applied Human Sciences. From 2016 to 2018, KU provided the following resources to the QES project. These resources, in conjunction with other resources from other QES project partners, helped to achieve the QES project objectives.

- Selection of QES Scholars

- Training of QES Scholars and Interns
- Orientation and supervision of QES Scholars and Interns
- Management of the QES project