Moringa oleifera: Potential as a Sustainable Therapeutic Solution for Under-nutrition

Master's Thesis

International Care and Community Development

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Abstract

The nutrition intervention project proposed herein is written for the rural Ugandan, East African context. This thesis first examines the Ugandan context, including general demographics, political history since independence, and the contemporary setting. Next, childhood nutrition in developing nations is discussed, followed by a consideration of health and under-nutrition within the framework of social justice. Social justice is then expanded from the perspective of environmental justice, including the impacts of climate change and poverty on the health of Ugandan children. *Moringa oleifera* is introduced, beginning with its historical and contemporary human uses, medicinal properties, and remarkable nutritional composition. *M. oleifera* is subsequently proposed as a potential therapeutic and sustainable (indigenous) solution for under-nutrition, including an analysis and discussion of the needs assessment conducted by the author in 2012 from the village of Nawanpunda, Uganda. Lastly, a description and protocol for the project proposal is outlined and augmented with additional methodological suggestions for conducting social research with participants in developing countries.

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The Ugandan Context

Uganda is a small land-locked country in east Africa with 85 percent of its population living in rural areas. Subsistence farming is the mainstay of the rural population, and maize (corn) is the major staple food crop (Tabuti, 2002). According to the Ugandan Population and Housing Census Report (2002), the majority of Ugandans (84%) identify with Christian religious traditions, followed by those practicing Islam (12%). The CIA World Factbook reports that in 2012 life expectancy in Uganda was 53.45 years and infant mortality rate was 61 deaths per 1000 live births. In contrast, people born in developed countries have a life expectancy in the 70's and often 80's, and infant mortality is between 1-4 deaths per 1000 live births.

Uganda gained independence from the United Kingdom in 1962, and the **political** climate since has had extensive tribal rivalries, insurgencies, military coups, dictatorships, and elections (Mutibwa, 1992). Although Uganda has now experienced 20 years of a relatively stable political climate, the devastating economic policies and instability from prior years has left Uganda as one of the poorest countries in the world (Clark, 2010). Poverty still remains deep-rooted, especially in the rural areas, and as discussed earlier, poverty adversely impacts the health and nutrition of Ugandan children.

Political history

Uganda's political history is rife with instances of instability and violence that have affected the country's economic and structural development in such a way to adversely affect the health of its children (Wamani, 2005). Milton Obote was Uganda's first Prime Minister after independence from Britain in 1962, and was in power for

multiple stages in Uganda's history. During his first reign (1962-1971), Obote was over-thrown by his army commander Idi Amin (1971). Later, he regained power from Amin in 1979 with the help of the Tanzanian government. During his second stent of power, he became known for repression and the deaths of civilians during the Ugandan Bush War. In 1967, while president, Obote created an executive presidency by abolishing the federal structure of the constitution that had been in place since independence (Mutibwa, 1992: Dicklitch & Lwanga, 2003).

Idi Amin was Uganda's notoriously ruthless military dictator from 1971-1979. Initially, Ugandans were pleased with Amin's takeover, desperate for a reprieve from the repression imposed by Obote (Clarke, 2007). Ultimately, Amin's regime would become known for its human rights abuses, political oppression, nepotism, corruption, economic mismanagement, ethnic persecution, and murders. Disappearances also became common, including prominent people such as Amin's own Attorney General (Amnesty International, 1994). In 1979, with the help of the Tanzanian government, he was given passage out of Uganda to Saudi Arabia where he lived to his death in 2003 (Mutibwa, 1992).

After Amin's exile, Uganda experienced a relatively innocuous year with an interim government (Mutibwa, 1992). Then in 1980, Obote's party was re-elected. The validity of the elections was widely disputed by Yoweri Museveni (Minister of Defense for the interim government) and the accusation resulted in a **civil war** between the Obote and Museveni powers (powers ethnically and politically derived). The civil war concluded after almost six years with Museveni's National Resistance Army taking power in 1986 (Mutibwa,1992; Clark, 2007). Museveni was elected by the majority and

popularly supported in Uganda into the new millennium. More recently Museveni has abolished term limits, creating growing opinion within Uganda and the world that open elections are needed (Clark, 2007).

After the civil war, Obote's regime fled to the North causing continued ethic and political instability. Factions soon morphed into the **Lord's Resistance Army** (LRA) led by Joseph Kony, who developed his own combined religious and political agenda. The LRA's stated aim was to overthrow the government and replace it with Kony's own 'perverted' version of the Ten Commandments (Clark, 2007). The LRA strategy involves small to medium sized bands of armed militia groups that prey on remote villages for new recruits and supplies. Kony recruited support (arms and training camps) from the Sudanese government, motivated by revenge for Uganda's previous support of the Sudan People's Liberation Army (SPLA) –a Christian group fighting the Muslim government in the north. SPLA viewed the support of Kony as a means to facilitate the destabilization of Northern Uganda to route supplies through the region (Pham, Vinck, & Stover, 2008). Recently Uganda has succeeded in forcing Kony out of Uganda and into the Central African Republic and the Democratic Republic of Congo, however, the LRA is still extremely brutal in their treatment of local populations. Kony justifies his brutality against civilian villagers as punishment, such as those prescribed by Moses when the Jews broke Old Testament laws. For example, if Kony thinks people are not listening or talking, their ears or lips are cut off (Clarke, 2010). Sudanese weapons supported Kony's still effective strategy of kidnapping and dehumanizing children for recruit replenishment. While Kony was still in Uganda, the government's attempt to protect

people and deny the rebels supplies included placing people into Internally Displaced People (IDP) camps (Clarke, 2010).

Uganda's political history has created an environment of political instability that has **influenced the health** of its people, especially the most vulnerable, young children. The health effects of political violence are extensive and include adversely impacting the quality and extensiveness of the national health care system, negative psychological ramifications for its citizens, and increased poverty (Farmer, 1999). Political violence and war always present a significant negative impact on public health and health care delivery systems (Farmer, 2005; Etienne et. al, 2002). Uganda has fallen behind with regards to modern medical practices and practitioners. Furthermore, decades of terror inflicted by the LRA have restricted people to IDP camps laden with psychological hopelessness and despair (Clarke, 2010).

Contemporary Uganda has made progress in a number of areas including its response in combating the HIV/AIDS epidemic, economic growth, and stabilizing the north from the LRA. Many challenges still exist for Uganda including but not limited to its health statistics, rapid population growth, corruption, inflation, and recent disputed parliamentary and presidential elections (US State Department).

Childhood nutrition in developing countries

Globally, hunger affects nearly one billion people. Deadly acute malnutrition affects 55 million children worldwide and is predictable, preventable, and treatable (Action Against Hunger). In 2006 over 143 million children under five years of age were malnourished (UNICEF, 2007) and the World Health Organization (WHO) estimates that

underlying malnutrition contributes to over half of the child mortality in sub-Saharan Africa (WHO, 2000; Pelletier, 2003). Malnutrition is a category of physical conditions with varying degrees of severity that arise from an unbalanced diet in which nutrients are lacking, in excess, out of proportion (Boyle & Holben, 2011). The WHO cites malnutrition as the greatest single threat to the world's public health.

Other leading causes of death for young children in developing countries include diarrheal disease, tuberculosis, malaria, acute respiratory infections, and HIV/AIDS, all of which are all complicated by malnutrition (Neumann, 2004). This has led many development experts to believe that nutrition-specific interventions are the most effective form of aid (Marmot, 2008). Similar to the rest of sub-Saharan Africa, nutritional deficiencies are rampant in Uganda, and the most vulnerable are young children due to their rapid stage of growth and development.

Various nutritional disorders fall under the broad category of malnutrition. The term malnutrition refers specifically to severe conditions of malnutrition, however, it is frequently used to mean various states of **under-nutrition** (caused by a diet lacking in adequate calories, protein, and/or micronutrients). Under-nutrition includes stunting, wasting, and micronutrient deficiencies (vitamins and minerals). Stunting, or linear growth (height-for-age), is the result of lifelong/chronic nutritional problems, either energy deficiency (calories), protein, micronutrients, and also encompasses; recurrent infections, and/or inadequate care and stimulation (Wamani, 2004). In contrast to stunting, wasting (weight-for-height) is considered acute compared to stunting because typically episodes of wasting are shorter in duration (Nichols, 2012). Micronutrient deficiency, often called the “silent form of malnutrition”, can accompany any variation of

malnutrition or under-nutrition and is often reflective of a diet lacking animal-source foods. Especially dangerous to fetal growth and young children, common micronutrient deficiencies include iron, vitamin A, iodine, zinc, nutritional rickets, and vitamin B-12 (Neumann, 2004).

Nutritional disorders considered **severe malnutrition** include protein-energy malnutrition (PEM), kwashiorkor, and marasmus. PEM is often the result of severe micronutrient deficiency and can include kwashiorkor, marasmus, or both. Kwashiorkor is caused by inadequate intake of protein paired with sufficient caloric intake (Neumann, 2004). Symptoms of kwashiorkor include edema, wasting, liver enlargement, hypoalbuminaemia, and depigmentation of skin and hair. Kwashiorkor is most often identified by the swelling of extremities and is commonly preceded by a serious infection such as measles (Neumann, 2004). Marasmus, literally meaning “to waste away”, is caused by the lack of both protein and energy. Symptoms of marasmus include severe muscle wasting, low serum albumin levels, minimal subcutaneous fat, and a gaunt expression (Boyle & Holben, 2011; Nichols, 2012).

All children under 5 years-old are extremely vulnerable to nutritional disorders due to their rapid rate of growth. An especially sharp decline has been observed between 6 months to 1 year as children transition through the **weaning period** from exclusive breast feeding to breast feeding with supplementary foods. This decline in health is even more pronounced in food insecure households and/or in unsanitary surroundings plagued with unsafe drinking water. Typically, children are weaned onto a diet high in carbohydrates and low in protein with little to no animal source foods (King & Burgess, 1995; Neumann, 2004; Boyle & Holben, 2011; Nichols, 2012; Wamani, 2006).

According to the Ugandan Ministry of Health, by 9 months of age 30% of Ugandan children are stunted and by 18 months 50% are stunted.

Nutritional disorders in combination with **infection** are the leading cause of death for young children in developing countries. Similar to under-nutrition, young children and pregnant or lactating women are most susceptible to infection due to their increased nutritional requirements from rapid growth (Neumann, 2004). The adverse effects are synergistic, typically an infection precipitates clinical malnutrition, and under-nutrition will cause susceptibility to infection (Rice, 2000). Physiologically, under-nutrition compromises the mechanical barriers of connective tissue that provide protection against infection from microorganism (skin, eye, respiratory tract, and gastrointestinal tract) due to decreased levels of vitamin A and B, ascorbic acid, protein, and zinc. In severe cases of malnutrition, immune response (natural and vaccination) to typhoid, diphtheria, and yellow fever can be significantly reduced. However, immune response to measles seems to be less impacted by micronutrient deficiencies than other infections. Lastly, white blood cell and inflammatory responses to pathogens are also diminished due to micronutrient deficiencies, often causing a reduction of antibody secretion and reducing immune response effectiveness in cases of moderate and severe under-nutrition (Neumann, 2004).

Long-term and intergenerational **functional consequences** of under-nutrition vary from mild impairment to severely detrimental. Inter-temporal transmission is poor nutrition and stunting during childhood development that impacts the physical outcome in adulthood. Causal relationships have been established between the nutritional status of children and their ability to learn in school and the physical height and cognitive ability

attained as adults. Lost growth velocity in children under-5 years of age can only be partially recovered after improvements in health and nutritional status have been made. Conversely, older children do not suffer the same consequences, affirming the existence of heightened 'sensitive' periods in development where external impacts are more influential and have longer-lasting ill effects (Sabates-Wheeler, Devereux, & Hodges, 2009; Neumann, 2004).

Developmental delays (mental and/or physical) that result from poor nutrition can impair school and work performance in children and adults. The physical, cognitive, and economic consequences demonstrate that the nutritional status of young children has long-term human capital implications, both private and public (Sabates-Wheeler, Devereux, & Hodges, 2009).

There are also long-term developmental impacts of **malnutrition in utero**. Intrauterine growth retardation (IUGR) is a term used for infants that never reach their full growth potential as adults. IUGR can be the result of the mother's stature (a reflection of her own poor childhood nutritional health), maternal nutritional status at conception (due to a lack of nutritional knowledge or of chronic poverty), or insufficient weight gain during pregnancy (from disease, parasites, malaria, and other infections). All cited are scenarios commonly experienced by poor people in developing countries (Neumann, 2004).

The fetal origins hypothesis (IUGR) provides evidence that poor nutritional outcomes are propagated throughout **multiple generations.** As stated above, maternal malnutrition directly results in low birth-weight infants. Subsequently these infants become children with stunted growth, cognitive impairment/poor educational

performance, impaired psychological development, decreased activity levels, and a failure to develop at normal rates. The result is another generation with long-term decreased life chances from malnutrition and poverty (Sabates-Wheeler, Devereux, & Hodges, 2009).

Social justice: Why should we care?

"No one should have to die of a disease that's treatable" Paul Farmer

Where a child is born can greatly impact their risk and vulnerability to nutritional disorders, life chances and health. Often, in developing countries, structural forces shape disparity in the health and social conditions experienced by impoverished and marginalized children that result in unjust **health inequalities**. An alarming proportion of deaths experienced by impoverished children occur from preventable diseases (such as nutritional disorders and infectious diseases discussed herein) that are virtually non-existent for the fortunate few in developed countries with access to biomedical health care (Farmer, 2005). Many advocates for social justice believe this obligates those with privilege to promote justice for child protection from the preventable malaise of childhood malnutrition and a child's right to be healthy and free of preventable and/or easily curable diseases.

Paul Farmer (2005) defines **structural violence** as "the ways in which epic poverty and inequality, with their deep histories, become embodied and experienced as violence." In other words, how social forces such as racism, gender inequality, poverty,

political violence, and war can determine who become sick and who has access to care. Farmer believes that poorer health (such as excessive malnutrition) exist in poor nations in part from social structures and normalized institutions that impede equal access to resources, political power or voice, education, and health care and considered "structural" because they are deeply embedded in the social organization of our world and help to explain the nature and distribution of suffering.

Environmental justice focuses on the fair distribution of environmental benefits and burdens (Claudio, 2007). Currently, environmental degradation and harm is disproportionately produced by developed nations, however, the burdens of these adverse effects transcend geographic borders and disproportionally affect poor, marginalized, and vulnerable populations. Far too often, the ramifications are embodied by people living in poverty in developing nations such as Uganda as ill health and decreased life chances. The problem is compounded by the fact that the least developed nations and people living in extreme poverty have less economic capacity to combat and protect themselves against environmental health threats (Cockerham & Cockerham, 2010). Injustices such as this are precisely why those living in privileged developed nations need to be aware that human rights and social justice, as they pertain to the environment, should have no boundaries because pollution has no boundaries.

It is imperative to remember that, especially in the context of the environment, the reality impoverished people face is never very far removed from the actions of the more affluent. Decisions made in the West, directly or indirectly, impact the health of other people throughout the world. Although the health of everyone in the world is

affected by environmental degradation in some way, the most vulnerable members of our global society, malnourished children in developing nations, are disproportionally affected. Malnourished children will be exposed to the adverse effects for the longest period of time (now and into the future) and are less able to withstand the toxic effect of pollutants (Ebi, 2008).

Climate change, poverty, and Health in Uganda are inextricably linked and an example of environmental injustice. All of Africa combined contributes only 4% to global carbon dioxide emissions (Oxfam, 2008). The people of Uganda have proportionally contributed a negligible amount global warming, and yet they feel the impacts of climate change before and, more severely than more developed nations. In Uganda, climate change impacts agriculture and pastoralism, health and water, the economy and overall development. Climate change is compounded by other environmental factors such as deforestation, soil degradation, and declining food security and fish stocks (Oxfam, 2008).

Historically, the climate in Uganda has been consistently bimodal, with two predictable rainy seasons. In recent years with increased temperatures, rainfall has become less reliable and falls in erratic patterns of heavier rain. Deforestation and the draining of wetlands have decreased the ability of the land to retain water which causes an increase in the incidences of flooding. Although scientists are not certain which changes can be attributed to human induced climate changes (due to the lack of monitoring data in Uganda), it is quite certain that the majority of Ugandans are extremely vulnerable to the effects of climate change. One such reason is that the majority of the Ugandan population is rural and relies on subsistence farming, this

means that crops destroyed by increased dry spells followed by heavy damaging rains present a major food security issue (Oxfam, 2008). Although climate change induced food insecurity issues present health risks for most Ugandans, young children are the most at risk and vulnerable to experience the consequential morbidly and mortality.

Climate change in Uganda impacts the quality of **water** and therefore the **health** of Ugandan children. According to the WHO, diarrheal disease kills 1.6 million children every year from unsafe drinking water and poor sanitation. The effects of climate change on rainfall patterns disrupt fresh water supplies, a condition known to compromise hygiene and lead to subsequent increased risk of diarrheal disease (Oxfam, 2008). Again, this is an environmental injustice when Ugandan children living in poverty, and not contributing to or benefiting from carbon emissions processes, are the most vulnerable and likely to die of diarrheal disease from disrupted water supplies. As detailed above, the effects of infectious diarrheal disease causes and increases the severity of malnutrition.

Malaria killed 700,000 people in 2010, and according to the WHO, 90% were children under five years old in Africa. **Malarial disease** can be exacerbated as a result of vector proliferation from poor water management and storage, inadequate housing, flooding from climate change, and loss of biodiversity and deforestation (Ebi, 2008). Deforestation has been linked to increases in the mosquito vector since forest soil is typically not a favorable breeding habitat (O'Sullivan, 2008). Consequentially, most children living in poverty in developing countries cannot afford bed nets for protection or medication to eliminate the malaria parasite from their bodies (Oxfam, 2008). Therefore, young children in Uganda, most having absolutely no relation to the cause, are the most

likely to suffer from the adverse health effects of increased malaria from the various forms of environmental degradation discussed herein.

Climate change affects social and environmental determinants of health including sufficient food, infectious disease patterns, and malnutrition (Rice, 2000). Poverty and poor health are intimately interconnected and ill health is often cited as the most immediate reason people fall into poverty (Farmer, 2010). As discussed above, major killers of children in Uganda such as diarrheal diseases and malaria are highly climate-sensitive and are expected to worsen with climate changes. Diet variety is limited when the growth of some crops is adversely impacted by climate change (weather, floods, and pests). A reduction in food variety decreases nutritional status, which in turn, increases susceptibility to diseases, which propagates decreases in human productivity (Oxfam, 2008).

Moringa oleifera

M. oleifera has been referred to by many as the “miracle tree” or “magic tree” due to its astonishingly wide range of nutritional, pharmacological, and industrial applications, all of which are capable of significant human impact (Amagloh & Benang, 2009; Anwar, 2007; Babu, 2000; Rahim, *et. al.,* 2007; Fuglie, 1999; Fahey, 2005). There has been increasing interest and attention around the potential nutritional benefits of *M. oleifera* with regards to the developing world, where the tree is indigenous (see Figure 1). Trees for Life (US based non-profit) has widely promoted that "Gram for gram fresh leaves of *M. oleifera* have 4 times the vitamin A of carrots, 7 times the vitamin C of oranges, 4 times the calcium of milk, 3 times the potassium of bananas, 3/4 the iron of spinach, and 2 times the protein of yogurt" (Trees for Life, 2005).

M. oleifera trees are fast growing and usually reach a height of from 5 to 10 meters and thrive in humid tropical climates (Anwar, 2007; Rahim, 2007; Seshadri & Nambiar, 2003). *M. oleifera* are also well adapted for hot dry lands or extremely wet conditions, making it a hearty and drought resistant crop for tolerating a wide range of rainfall. (Anwar, 2007; Seshadri & Nambiar, 2003). The tree produces long pods (12-20 inches) containing winged seeds (Seshadri & Nambiar, 2003), bright green leaves, and a soft useful wood. *M. oleifera* can be propagated using either seeds or cuttings and sprouting usually occurs within two weeks. Once rooted, the leaves are usable within a few months, and pruning the tree close to ground level (coppicing) can dramatically increase leaf production (Thurber & Fahey, 2009).

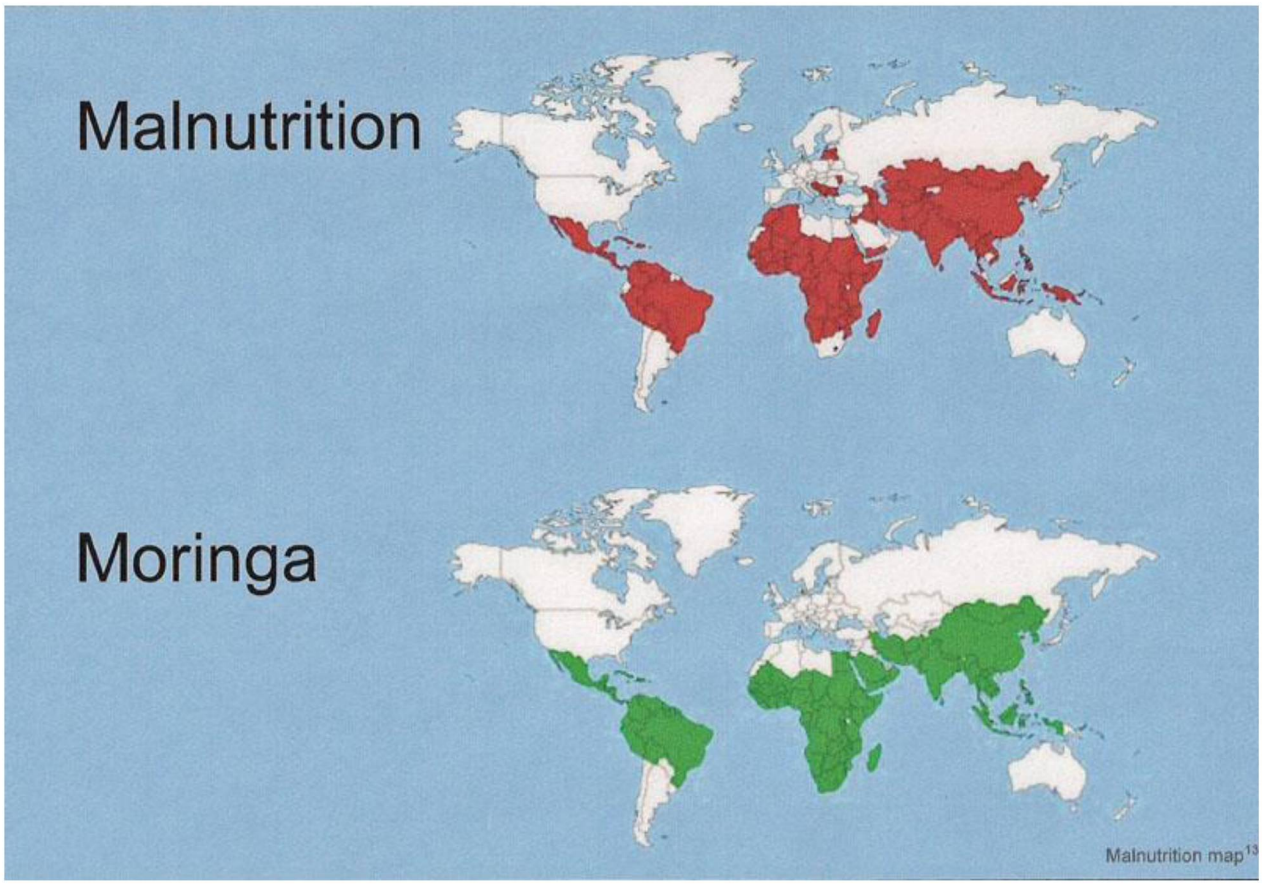

Figure 1

History of human use

In various parts of the world *M. oleifera* is known as the 'drumstick tree' or the 'horse radish tree'. Native to sub-Himalayan regions of India, Pakistan, Bangladesh and Afghanistan, *M. oleifera* and has been widely used in folk and Ayuvetic medicine for centuries (Fahey, 2005). Currently, the tree is widely distributed throughout the world and can be found in most countries in tropical regions. In most of these countries *M. oleifera* is a commonly known herb used in traditional medicinal practices (Kasolo *et. al.*, 2010). Indigenous medicine has a use for almost every part of the tree including the root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil (Anwar, 2010). In addition, multipurpose industry uses for *M. oleifera* include yielding food, fodder, fuel wood, biomass production, animal forage, domestic cleaning agent, blue dye, fertilizer, green manure, gum, ornamental plantings, biopesticide, pulp, tannin, agroforestry, perfume, oil, lubricants, and water purification (Fahey, 2005; Rahim, 2007).

Powder extracted from *M. oleifera* seeds contain a cationic polyelectrolyte that has proved to be effective in **water treatment** as a substitute to aluminum sulphate and other flocculents. There is substantial scientific evidence that *Moringa* seeds are pH correcting, effective on turbidity, and a capable anti-microbial (Amagloh & Benang, 2009, Anwar 2007). Furthermore, *M. oleifera* seed power can be used for heavy metal (lead) detoxification from water sources contaminated by increasing global industrial, agricultural, and domestic activities (Mataka *et. al.*, 2006). The use of *Moringa* seed power verses the standard aluminum treatment not only utilizes a locally-produced and biodegradable water purification substance, but can also be available in areas without other means to clean drinking water.

Medicinal properties

Historically throughout the world, many medicinal properties have been ascribed to *M. oleifera* by traditional healers. Recently scientific evidence has been mounting regarding *M. oliefera's* potential as a valid and important source of naturally occurring pharmacological properties (Fahey, 2005). Essentially every part of the tree has been medicinally utilized, including the root, bark, gum, leaf, fruit (pods), and seeds (Anwar, 2007). Medicinal uses include, but are not limited to; cardiac and circulatory stimulant, antitumor, antipyretic, antiseptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, hyperthyroidism treatment, antioxidant, antidiabetic, hepatoprotective, antibacterial, and antifungal (Anwar, 2005; Fahey, 2007; Tahiliani & Kar, 2000).

Diuretic properties and lipid and blood presser lowering compounds make *M. oleifera* useful for treating **cardiovascular disorders**. Juice from the leaves have a stabilizing effect on blood pressure and have been found to lower serum cholesterol including Low density lipoproteins (LDL) and very low density lipoproteins (VLDL) (Mehta, 2003). The responsible compounds, nitrile and thiocarbamate glycosides, are fully acetylated glycosides, a phenomenon rarely found in nature. Additionally, diuretic activities from the roots, leaves, and flowers have a physiological effect of decreasing blood pressure (Anwar, 2005). There is also evidence of *M. oleifera* inhibiting platelet aggregation, a condition known to contribute to cardiovascular disease (Arabshahi, *et. al.,* 2009).

Antitumor/anticancer properties attributed to activities derived from *Moringa* leaves are attributed to its inhibitory effects on the tumor-promoter-induced Epstein-Barr virus (EBV) activation (Anwar, 2007). EBV is associated with some forms of cancer, such as Hodgkin's lymphoma, Burkitt's lymphoma, nasopharyngeal carcinoma, and conditions associated with human immunodeficiency virus (HIV) such as hairy leukoplakia and central nervous system lymphomas (Rubin, 2001). There is also preliminary lab evidence demonstrating the effectiveness of *M. oleifera* on hepatic and skin carcinogen metabolizing enzymes (Fahey, 2005). Lastly, the seeds contain Niazimicin, a known inhibitor of tumor proliferation (Anwar, 2007).

There is ample evidence, both scientific and anecdotal, supporting *M. oliefera's* **antibiotic activity**. Treatment or prevention of infectious diseases utilizing *M. oliefera* can be achieved by dietary consumption or topical administration (Fahey, 2005). The roots contain the antifungal and antibacterial agent pterygospermin, and juice from the stem bark has a known antimicrobial effect against *Staphyloccus aureus* (Mehta, 2003; Fahey, 2005; Anwar, 2007). *M. oliefera* also contains antimicrobial isothiocyanate compounds that *Helicobacter pylori* are susceptible to (Haristoy, 2005). This is a particularly exciting discovery because *H. pylori* is an endemic pathogen in developing countries, medically underserved populations, and for people living in extreme poverty (Engleberg, *et. al*, 2007). Usually present in the stomach, *H. pylori* is the major cause of gastritis, gastric and duodenal ulcers, and chronic infection often leads to gastric (stomach) cancer (Fahey, 2005; Devaraj, 2007). Stomach cancer is the fourth most common cancer worldwide, with the majority of morbidity and mortality concentrated in developing countries (Parkin, 2005). Although, *H. pylori* is susceptible to many

commonly prescribed antibiotics, patients will often become re-infected within a short period of time since the pathogen is omnipresent in the environment for people living in poverty (Fahey, 2005). Daily consumption of *M. oliefera* presents a possible sustainable solution to *H. pylori* infection and thus stomach cancer.

Nutritional composition

Nutritionally, *Moringa* leaves stand out as one of the most highly nutritious and ecofriendly vegetables in the world. Leaves are dark green when mature, and tender leaves are preferred for human consumption due to their less fibrous nature (Seshadri & Nambiar, 2003). The leaves are considered by many to be the ideal dietary supplement due to high concentrations of ascorbic acid, calcium, iron, copper, phosphorus, vitamins A, and B, riboflavin, folic acid, pyridoxine, β-carotene, protein, and the essential amino acids methionine, cysteine, tryptophan and lysine (Anwar, 2007; Seshadri & Nambiar, 2003; Thurber & Fahey, 2009; Fahey, 2005; Moyo *et. al.*, 2011).

The leaves are a natural **antioxidant**, containing the compounds ascorbic acid, flavonoids, phenolics and carotenoids (Anwar, 2007). Antioxidants and flavonoids are known protective agents against many degenerative diseases and play a potentially significant role in reducing mortality and morbidity to coronary heart disease and cancer patients. Additionally, ascorbic acid helps to achieve better stability of carotenoids in food systems and protects vitamin E from oxidation, thus enabling the vitamin to perform its function of free radical scavenging (Seshadri & Nambiar, 2003).

The high levels of antioxidants and carotenoid pigments also positively impact the **bioavailability** of other nutrients such as calcium, iron, phosphorous, and

magnesium (Boyle & Holben, 2010). Green leafy vegetables usually contain high levels of oxalic acid, a compound that interferes with absorption of calcium, magnesium, and iron. Studies have shown that *M. oleifera* contains significantly lower quantities of oxalic acid than other common leafy greens (radish, spinach, fenugreek). Therefore, nutrients important for human growth and maintenance (iron and calcium) are more bioavailable in *M. oleifera* than other leafy greens due to its high levels of ascorbic acid and low levels of oxalic acid (Seshadri & Nambiar, 2003; Nambiar, & Seshadri, 2001).

Ugandan history, knowledge, and use

In the 1980s, *M. oleifera* was a common crop in Uganda, promoted by the media as a cure to numerous diseases including symptoms of HIV/AIDS. Industrialists imported seeds and leaves to use as raw materials and the government promoted Ugandan families to grow the crop (Kasolo *et. al*., 2010). After the government failed to follow through with purchasing *M. oleifera* crops as promised, many farmers and families uprooted the trees. Consequently, general knowledge of *M. oleifera* was widely dispersed throughout Uganda and many trees still remain, especially in rural areas.

Kasolo *et. al*. (2011) found 24 uses of *M. oleifera* in rural Ugandan villages. Respondents of their study were of low income and lived farther than 5km from a public health clinic were therefore more likely to use herbs and traditional medicine first for illness management before visiting a clinic. Despite the highly nutritious composition of *M. oleifera*, few respondents mentioned its use for the prevention or treatment of malnutrition. Without dissemination, among rural Ugandan communities, the result is inadequate and inaccurate knowledge regarding the nutritional and medicinal values of

M. oleifera leaves. There is a need for community education in order to utilize *M. oliefera* for the prevention of malnutrition among young Ugandan children.

Potential as a sustainable therapeutic solution for under-nutrition

A diet able to provide the impressive nutritional array of micronutrients and bioactive compounds found in *M. oleifera* has the propensity to be an indigenous and sustainable solution to many nutritional problems that vulnerable children in developing nations like Uganda face. *M. oleifera* appears to be unique in its combination of nutrient profile, utility, high yield, rapid growth habit, and ability to survive in harsh climates (Thurber & Fahey, 2009). The nutrient-dense leaves can be eaten fresh or dried for later use providing an economically sound and sustainable nutrient-rich food option for children suffering from chronic or seasonal macro and micro-nutrient deficiencies needed for their growth and maintenance (Seshadri & Nambiar, 2003). The need for a sufficient indigenous solution is compounded when diet (crop) variety has been limited by the adverse climate change factors discussed above. *M. oliefera* has the potential to balance decreases in food variety that impact nutritional status (Oxfam, 2008).

Needs assessment

In Uganda in 2012, a needs assessment was conducted in a single village (Nawanpunda) to:

1. Determine if rural Jinja District, Uganda is a good candidate for the following proposal and why.
2. Determine baseline community perceptions and uses of *M. oleifera.*

3. Determine general dietary knowledge, beliefs, and behaviors in households with at least one child age 6-60 months.
4. Determine baseline nutritional health.

Methods

The principle investigator (author) and a research assistant fluent in the local language (Lusoga) and English conducted 52 random (door-to-door) **surveys** in the village of Nawanpunda. The main caretaker (primarily the mother or grandmother) in households with at least one child 6-60 months of age was interviewed. Consent for survey was obtained through verbal agreement at the time of the interview (in Lusoga) and respondents were informed of the purpose and nature of research. A semi-structured questionnaire consisting of open-ended (qualitative) and closed-ended (quantitative) questions was used to elicit data regarding baseline knowledge of nutrition in general and *Moringa*. Additionally, caretakers' and children's social-demographic characteristics such as age, sex, education level, household size, distance to nearest clinic, occupation, dietary habits (meal frequency and typical food types), and livestock owned were obtained.

Quantitative **anthropometric data** was collected from each child age 6-60 months from the households participating in the surveys. Measurements obtained included height, weight, middle upper arm circumference (MUAC), birthdate, and gender. Anthropometric data was collected on a total of 78 children. Weight was measured to the nearest 0.1 kg using a Salter hanging scale and height was measured to the nearest 0.1 cm using a locally constructed standard length board.

To obtain qualitative data, **focus groups** were conducted from female caregivers of at least one child 6-60 months old. Each of the two focus groups consisted of six caretakers and was moderated by the principle investigator and a research assistant fluent in Lusoga and English. Consent was obtained by each participant prior to start of each focus group and sessions were recorded, transcribed, and coded. Structured focus group questions were as follows:

"What is your name?"

"Where do you live?"

"How many children under five years old do you have?"

"What is your favorite food?"

"What types of food do you usually feed your children?"

"What do you think are the benefits your children get from this food?"

"What would you like to feed your children and why?"

"What do you think is the most nutritious food?"

"Would you be interested in incorporating Moringa into your child's diet?"

Results

The **surveys** revealed that the median household size was 12.7, the median total number of children 4.1, and the median of children under 6-60 months of age per household was 2.2. All of the primary care givers of children under five years old were women, 11 out of 74 were grandmothers, 63 were mothers, and 5 were unknown. Virtually all of the mother caretakers had at least a primary school education and all except two of the caretaking grandmothers had no formal education. The median

number of daily meals given to children was 2.1. Of the 78 children surveyed, 21 reported that they currently had a *M. oleifera* tree at their residence, while only 6 of them reported ever eating it. Three quarters of the families owned livestock (chicken, duck, goat, or cow).

Anthropometric indicators for the purpose of this study are defined as follows: under-nutrition is classified as stunting (height-for-age) z-score of -2 through -3, or wasting (weight-for-age) z-score of -2 through -3, or MUAC of z-score of -2 through -3, or any combination of the three. Children with z-scores > -2 are considered to be within normal healthy growth standards and children with z-scores < -3 are considered to be severely malnourished. Z-scores were calculated gender specific and to the nearest .25 according the World Health Organization Child Growth Standards.

Anthropometric data was obtained from 32 males, 42 females, and 2 children of unknown gender; the median age was 34 months. Height-for-age z-score was collected from 67 children (23 within normal healthy range, 33 stunted (-2 through -3), and 11 severely stunted <-3), weight-for-age z-score collected from 66 children (46 within normal healthy range, 16 wasted, and 4 severely wasted), and MUAC from a total of 67 children (48 were within normal healthy range, 14 under-nourished, and 5 severely malnourished).

Stunted (height-for-age)	Wasted (weight-for-age)	MUAC
34% healthy range	70% healthy range	72% healthy range
49% stunted	24% wasted	21% under-nourished
16% severely stunted	6% severely wasted	7% severely malnourished

All participants in the **focus group** sessions were women from the village of Nawandunda and their number of children under-five years old ranged from one to five (with a median of 2.1). Consistent with survey findings, focus group caretakers most commonly fed their children posho (maize flower cooked with water) or matoke (steamed plantains). Answers regarding what benefits the participants thought their children were receiving from posho and matoke included "helps them grow well", "energy giving food", "good body building food", "they achieve good health", and "when they eat well their healthy status rises and children get resistance against diseases". Answers regarding what they would like to feed children and why included "baby soya because has proteins", "beans and fish", "eggs and milk because it has proteins in it", "powdered milk", "fish", "posho because it gives them energy", and "porridge because it protects them from getting dangerous diseases". Respondents had an array of answers to what they believe is the most nutritious food including "posho", "millet", "milk", "powered milk", and "fish". All of the focus group participants were interested in learning more about and incorporating *Moringa* into their children's diets.

Discussion

Anthropometric data obtained from the needs assessment indicates that indeed high rates of under-nutrition in young children is endemic in rural Jinja District Uganda and therefore the region is a good candidate for the nutritional intervention project proposed below. Survey data revealed that there are currently a moderate number of mature *M. oleifera* trees already in Nawanpunda village indicating that presumably other rural villages in Juinja District are similar in this regard. Survey and focus group data

also revealed that general knowledge of *M. oleifera* is common, however most, if any, human use is rare and for medicinal purposes only. Few respondents in Nawanpunda village are aware of or use *M. oleifera* for the prevention or treatment of under-nutrition signifying the need for community education regarding its nutritional benefits. Additionally, focus group data exposed incorrect assumptions and disconnect regarding the nutritional needs of children indicating the need for a broad community nutrition and diet education component to be included in the proposed project.

Project Proposal

Pre-post village intervention case study trial of the therapeutic impact of *M. oleifera* consumption on underweight Ugandan children age 6-60 months

Objectives:
1) Gather quantitative and qualitative data from a rural village in Jinja District, Uganda and subsequently implement a nutrition service project consisting of community education and supplemental feeding with *M. oleifera* to determine the feasibility of a larger scale program to treat under-weight and nutrient deficient children age 6-60 months.

2) Utilize the study's findings to create a model for a sustainable and scalable solution to improve nutrition and food security in rural East African settings.

Study design –non-randomized pre-post village intervention 8-week trial

Phase 1: Pre-intervention

Conduct a needs assessment analysis in a single village to determine baseline community nutritional health, perceptions and uses of *M. oleifera,* and general dietary knowledge, beliefs, and behaviors in households with at least one under-nourished child age 6-60 months.

- Collect random surveys (one per household) until 25 households with at least one under-nourished child age 6-60 months are identified. Under-nourishment eligibility will be determined if weight-for-age plus either height-for-age or middle upper arm circumference (MUAC) z-scores are between -2 and -3. Head circumference data will also be obtained.
- 3-5 focus groups consisting of 5-10 primary female caregivers of at least one under-nourished child age 6-60 months will be conducted. A research assistant fluent in Lusoga and English will be trained on the study objectives and how to properly moderate focus groups. Sessions will be recorded, transcribed, and coded. Furthermore, the principle investigator will be present and record additional field notes.

Phase 2: Intervention

The intervention phase will last 8 weeks and include:

- Educational component will include sessions (and printed material) on general nutrition, incorporating *M. oleifera* consumption into daily diets (including community cooking classes), correct drying and processing method for *M. oleifera* leaves, and effective cultivation (planting, pruning, etc.) of the *M. oleifera* tree
- Weekly supplies and specific instructions on amount of leaf powder to incorporate into diet.
- 3 small (10") *M. oleifera* trees for each household as compensation for Phase 1 participation and to incent proper incorporation of *M. oleifera* into diets for the remainder of the study.
- Building and testing a solar dryer with the community at the LC1 residence to facilitate the sustainable production of their own *M. oleifera* leaf powder post study.
- Anthropometric measurements (weight, height, and MUAC) will be obtained at week 2, 4, and 6.

Phase 3: Post-intervention

- Obtain final anthropometric readings (weight, height, MUAC, and head circumference) and analyze all anthropometric readings descriptively and statistically for weight gain and other nutritional benefits (change from baseline at week 2, 4, 6, and 8).
- Analyze qualitative data (focus group and interview transcripts, field notes, and open-ended survey questions) for themes.
- Additional small *M. oleifera* trees and seeds will be available to participant households and the rest of the village for purchase for a subsidized price. Printed educational materials will be provided to anyone interested at no cost.

Additional methodologies

Participatory action research (PAR) is typically utilized within the context of social research and conducted by the action researcher and members of a community that seek to improve their situation. Hart (1992) describes PAR as conceptualizing new roles for the researcher as a democratic participant that seek to minimize the expert/non-expert division. PAR co-generates meaningful research by promoting this broad participation in the research process. The researcher and participants together define the problem, co-generate knowledge, execute the social research techniques, and interpret results together (Ramos, 2002). This process leads to an increasingly flexible research environment, engaging the participants in demographic dialog and providing opportunities further empowered.

Participatory Action Research requires the researcher to adjust epistemically and become progressively cognizant of the worldview and "theories" that they themselves bring to the research situation. A researcher needs to be able to enter the PAR research context with a clear understanding of their own theories of social change and be ready to share these with the participants in a democratic way (Ramos, 2002). The PAR researcher's obligation is to combine their own research frameworks with participants' superior understanding of local context into a third 'local theory' that emerges from the co-research (Ramos, 2002). This process can enable local participants by learning how to conduct action research on their own, furthering their empowerment.

Respecting the community's story, their history, current survival strategy, and indigenous knowledge is imperative for researchers to work effectively within a community. Throughout the needs assessment that was conducted for this thesis in Uganda, the concepts of conscientization and empowerment through participation from Freire's Pedagogy of the Oppressed (1968) were considered and will be incorporated into future projects. Other authors have emphasized how active participation can be essential to establishing a sense of identity within a community (Myers, 1999). It is equally important to remember that valuable resources for development already exist in the community, and that development workers need to have the humility to remember that they will never know enough to do another's development for them and that seeking local participation is the best way to combat this. Once there is quality participation from the people served, a genuine sense of ownership and personal investment in their development can be established.

PAR research "Rules" (Ramos, 2008)

1. The dialogue is a process of exchange: points and arguments move to and from between participants.

2. All concerned must have the opportunity to participate.

3. As a point of departure, all participants are equal.

4. It must be possible for everyone to develop an understanding of the issue at stake.

5. All arguments which pertain to issues under discussion are -as a point of departure - legitimate.

6. The dialogue must continuously produce agreements which can provide a platform for investigation and practical action.

While conducting the needs assessment in Uganda and formulating the proposal for the research project contained herein, it became apparent that a substantial limiting factor would be convincing the village participants to follow the protocol of eating the *M. oleifera* supplement and feeding it to their children correctly. Therefore, the concept of PAR in the research process will be utilized by having the participants help the principle researcher initially define the problem and plan the details of the study's protocol; how to best incorporate nutritional education and *M. oleifera* supplemental feeding into their daily lives and their children's diet. Furthermore, incorporating Freire's (1968) concept of conscentization can serve to empower the participants (mothers and children) involved in the study, subsequently instilling a sense of ownership and invested interest in the project as their study too. Similar to PAR, conscentization, or awareness rising, uses education as a means of consciously shaping people and their perspectives. According to Freire (1968), the process can awaken study participants to their personal worth and

group strength. It can assist them in gaining confidence in themselves as capable women and mothers (or grandmothers) by helping them to examine, analyze, and work out a plan together for action to improve their children's nutritional health. When critical awareness is raised and linked to the needs of their local village, it has the potential to help the participants find the energy and motivation required for effective action and therefore be a powerful influence on how a project like this can impact a community.

Conclusion

"Although the world is full of suffering, it is full also of the overcoming of it" Helen Keller

The political history of Uganda is replete with instances of instability and violence that have impacted the country's economic and structural development in such a way to adversely affect the health and nutrition of its children. Nutritional disorders and the increased vulnerabilities associated with them harm the lives of millions of children worldwide. This pleads the question as to why such health inequalities exist, and why children some parts of the world are subjected to such suffering while others are spared. The answer is complex and largely unknown, although it is certain that some phenomenon such as the adverse effects of human triggered climate change disproportionately affect vulnerable and impoverished populations. It is problems such as these that necessitate an innovative solution.

Moringa oliefera contains an astonishingly wide range of nutritional, pharmacological, and industrial applications, all of which are capable of significant human impact. *Moringa* has the propensity to be an indigenous and sustainable solution

to many nutritional problems that vulnerable children in developing nations like Uganda face. The needs assessment conducted by the author in 2012 confirmed that high rates of under-nutrition in young children is endemic in rural Jinja District Uganda and therefore the region is a good candidate for the proposed nutritional intervention project. The proposal seeks to implement a nutrition service project consisting of community education and supplemental feeding with *M. oleifera* to determine the feasibility of a larger scale program to treat under-weight and nutrient deficient children age 6-60 months.

References

Action Against Hunger (2013) Retrieved from: http://www.actionagainsthunger.org/

Amagloh, F. & Benang, A. (2009) Effectiveness of *Moringa oleifera* seed as coagulant for water purification. *African Journal of Agricultural Research*. 4(1): 119-123.

Amnesty International. (1994) *Disappearances and political killings: Human rights crisis of the 1990s: A manual for action.* Amsterdam. Retrieved from: http://amnesty.org/en/library/asset/ACT33/001/1994/en/4d0691f2-ec14-11dd-85b9-0939011eabc9/act330011994en.html

Anwar, F., *et. al.* (2007) *Moringa oleifera:* A food plant with multiple medicinal uses. *Phytotherapy Research*. 21: 17-25.

Arabshahi-Delouee, S., Aalami, M., & Krishnakantha, T.P. (2009) *Moringa oleifera* leaves as an inhibitor of human platelet aggregation. *Pharmaceutical Biology*. 47(8): 734-739.

Babu, S. (2000) Rural nutrition interventions with indigenous plant foods –a case study of vitamin A deficiency in Malawi. *Biotechnol. Agron. Soc. Environ.* 4(3):168-179.

Boyle, M., & Holben, H. (2011) *Community nutrition in action: An entrepreneurial approach* (6th ed.) Belmont, CA: Wadsworth.

Parkin, D., Bray, F., Ferlay, J., & Pisani, P. (2005). Global Cancer Statistics. *Cancer*

Journal for Clinicians. 55 (2): 74–108.

Clarke, I. (2010) *How deep is this pothole?* United Kingdom: self-published.

Claudio, L. (2007) Standing on principle: The global push for environmental justice. *Environmental Health Perspectives*. 115(10): 500-503.

Cockerham, G. & Cockerham, W. (2010) *Health and globalization*. Malden, MA: Polity Press.

Devaraj, V.C., Asad, M., & Prasad, S. (2007) Effect of leaves and fruits of *Moringa oleifera* on gastric and duodenal ulcers. *Pharmaceutical biology*. 45(4): 332-338.

Dicklitch, S., Lwanga, D. (2003) The politics of being non-political: Human rights organizations and the creation of a positive human rights culture in Uganda. *Human Rights Quarterly*. 25: 482-509.

Ebi, K. (2008) Adaptation costs for climate change-related cases of diarrhoeal disease, malnutrition, and malaria in 2030. *Globalization and Health*. 4(9).

Engleberg, C., DiRita, V., & Dermody, T. (2007) *Mechanisms of microbial disease*. Baltimore, MD: Wolters Kluwer.

Etienne, K., et. al. (2002) The world report on violence and health. *The Lancet*. 360: 1083-1088.

Fahey, J. (2005) *Moringa oleifera*: A review of the medical evidence for its nutritional,

therapeutic, and prophylactic properties. Part 1. *Trees for Life Journal*. 1:5.

Farmer, P. (2010) *Partner to the Poor.* Berkeley, CA: University of California Press.

Farmer, P. (2005) *Pathologies of power: Health, human rights, and the new war on the poor.* Berkeley, CA: University of California Press.

Farmer, P. (1999) *Infections and inequalities: The modern plagues.* Berkeley, CA:University of California Press.

Freire, P. (1968) *Pedagogy of the oppressed.* New York, NY: Continuum Publishing Company.

Fuglie, L. (1999) The miracle tree: *Moringa oleifera*: Natural nutrition for the tropics. Senegal, Dakar: Church World Service.

Haristoy, X., *et. al.* (2005) Evaluation of antimicrobial effect of several isothiocyanates on *Helicobacter pylori. Planta Medical* 71: 326-330.

Hart. R., (1992) *Children's participation: From Tokenism to citizenship*. (No. Inness92/6). UNICEF Innocenti Research Centre.

Kakengi, A. (2007) Effect of *M. oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. *Livestock Research for Rural Development*. 19(8).

Kasolo, J., *et. al.* (2010) Phytochemical and uses of *Moringa oleifera* leaves in Ugandan rural communities. *Journal of Medicinal Plants Research*. 4(9): 753-757.

King, F. & Burgess, A. (1995) *Nutrition for developing countries*. New York, NY: Oxford Medical Publications.

Marmot, M., et. al (2008) Closing the gap in a generation: Health equality through action on the social determinates of health. *The Lancet*. 372: 1661-1668.

Mataka, L., Henry, W.,& Sajidu, M. (2006) Lead remediation of contaminated water using Moringa stenopetala and Moringa oleifera seed powder. *Int. J. Environ. Sci. Tech*. 3(2): 131-139.

Mehta, L., *et. al*., (2003) Effect of fruits of *Moringa olifera* on the lipid profile of normal and hypercholesterolaemic rabbits. *Journal of Ethnopharmacol*. 86: 191-195.

Moyo, B., Masika, P., & Muchenje, V. (2011) Nutritional characterization of *Moringa oleifera* leaves. *African Journal of Biotechnology*. 10(60): 12925-12933.

Mutibwa, P. (1992) *Uganda since independence: A story of unfulfilled hopes.* Trenton, NJ: African World Press, Inc.

Myers, B. (1999). *Walking with the Poor*. Orbis.

Nambiar, V. & Seshadri, S. (2001) Bioavailability trials of β-carotene from fresh and dehydrated drumstick leaves (*Moringa oleifera*). *Journal of Plant Human Food.* 56: 83-95.

Neumann, C., Gewa, C., & Bwibo, N. (2004) Child nutrition in developing countries. *Pediatric Annals*. 33(10): 658-673.

Nichols, B. (2012) Malnutrition in developing countries: Clinical assessment. *UpToDate*.

O'Sullivan, L., Jardine, A., Cook, A., & Weinstein, P. (2008) Deforestation, mosquitoes,

and Ancient Rome: Lessons for today. *BioScience*. 58(8): 756-760.

Oxfam (2008) *Turning up the heat: Climate change and poverty in Uganda*.

Pham, P., Vinck, P., and Sover, E. (2008) The Lord's Resistance Army and forced conscription in northern Uganda. *Human Rights Quarterly*. 30(2): 404-411.

Pelletier, D., *et. al.* (1995) The effect of malnutrition on child mortality in developing countries. *Bulletin of the World Health Organization*. 73: 443-448.

Rice, A., Sacco, L., and Black, R. (2000) Malnutrition as an underlying cause of childhood deaths associated with infectious disease in developing countries. *Bulletin of the World Health Organization*. 78(10): 1207-1221.

Rahim, M. *et. al.* (2007) Moringa: An indigenous minor vegetable can play a great role in nutrition and poverty alleviation in north western region of Bangladesh. *Acta Hort*. 752.

Romos, J. (2002) Action research as foresight methodology. *Journal of Futures Studies*. 7(1): 1-24.

Rubin, P. (2001) *Clinical oncology: A multidisciplinary approach for physicians and students.* Philadelphia, PN: Saunders.

Seshadri, S. & Nambiar, V. (2003) Kanjero (*Digera arvensis*) and Drumstick Leaves (*Moringa oleifera*): Nutrient profile and potential for human consumption. *World Review of nutrition and dietetics.* 9:41-59.

Tabuti, J., *et. al.* (2002) Traditional medicine in Buamogi county, Uganda: Its practitioners, users, and viability. *Journal of Ethnopharmacology*. 85: 119-129.

Tahiliani, P., & Kar, A. (2000) Role of *Moringa oleifera* leaf extract in the regulation of thyroid hormone secretion status in adult male and female rates. *Pharmacological Res.* 41: 319-323.

Thunber, M. & Fahey, J. (2009) Adoption of *Moringa oleifera* to combat under-nutrition viewed through the lens of the "Diffusion of Innovations" theory. *Ecology of Food Nutrition.* 48(3): 212-225.

Trees for Life (2005) *Moringa* Book [Brochure]. Wichita, KS.

UNICEF (2007) Progress for children: A world fit for children statistical review number 6 revised. *United Nations Children's Fund*. New York. Retrieved from: http://www.unicef.org/progressforchildren/2007n6/files/Progress_for_Children_-_No._6.pdf

Wamani, H., *et. al.* (2004) Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda. *International Journal Equity of Health*. 3(8): 320-326.

Wamani, H. et. al. (2006) Predictors of poor anthropometric status among children under 2 years of age in rural Uganda. *Public Health Nutrition.* 9(3) 320-326.

Appendix

Malnutrition occurs when the body does not receive the vitamins and nutrients it needs to be health

- Infants, young children, teenagers, and pregnant or breastfeeding mothers are growing and need more nutrients
- Nutrient loss (malnutrition) can be accelerated by diarrhea/vomiting, malaria, measles, or other sickness
- Nutrient loss (malnutrition) can also make a child sick more often
- Faulty feeding causes nutrient loss (malnutrition)

Prevention

- To prevent malnutrition you child needs to eat the correct food types
- There are 3 food types:

Protein	Starch	Vitamins
Beans	Matoke	Avocado
Groundnuts	Millet	Banana
Meat	Cassava	Greens
Fish	Rice	Jackfruit
Soya	Yam	Papaya
Milk	Sweet Potatoe	Mango
Sim sim	Maize	Pineapple
Silverfish	Posho	Tomato
		Eggplant
		Pumpkin
		Pepper
		Onion

- All children need a variety of foods every day from every food group
- Your children should eat equal amounts of protein and starch, along with vitamins
- Proteins are important for growth, especially muscles, blood, and immunity
- Starches are important for energy and growth
- Vitamins are important for disease prevention, development and growth

Moringa leaves prepared properly contain protein, starch, and a wide variety of vitamins

- Something about staving off disease to be healthy

- To make any food extra nutritious, add 25mg (one large spoonful) of Moringa powder each person's meal. You can add it to porridge, beans, G-nut sauce, greens, cabbage, eggplant, or any other sauce you like to feed your children

Example of a good meal (insert picture)

1. Break hand size portion of posho or matoke into small pieces
2. Take a hand size portion of beans or G-nut sauce
3. Mix the two together very well into a paste and add 25mg (one large spoonful) of Moringa powder to each child's meal
4. Make sure your child eats all the sauce and not only the starch (posho/matoke) alone. It is very important for your child to eat enough sauce!

Helpful cooking tips

- Wash your hands with soap and water before cooking. This will help to prevent parasites, diarrhea and weight loss.
- For porridge, boil the milk and boil the porridge separately. Take 1 cup of each and then mix the cups together well. Do not add much water. Make sure you have a thick porridge.
- When cooking dodo, only boil it for 5 to 10 minutes so that it is not overcooked. When you over-boil greens they lose many nutrients.
- Heat leftovers before giving them to your child to prevent bacteria, diarrhea, and weight loss.
- Make sure to keep leftovers covered.

Timing

- Children should be fed 5 times a day
- Do not put your children to sleep before dinner is ready. Children need to eat dinner.

Example of an ideal day of meals

- Heated leftovers for breakfast
- Porridge with Moringa and tea after working in the garden
- Posho and beans for lunch
- Mango, Jack Fruit, or Papya as a midday snack
- Posho mixed with G-nut/Moringa sauce and greens for dinner

Breastfeeding

- For the first 6 months, your baby should be fed only breast milk.
- **No FOOD or WATER, breast milk only for the first 6 months**

- If you do not produce enough breast milk, you can five cow's milk with very little water added
- After 6 months, a baby needs more than just breast milk. Feed your baby a variety of soft foods like cow's milk, porridge, mashed up posho, rice, beans, avocados, or greens (anything mashed is good for your baby)