The Effect of Mung Bean on Improving Dietary Diversity of Women and Children in Senegal

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ABSTRACT

Since 2015, a U.S. Agency for International Development (USAID) and Virginia Tech Education and Research in Agriculture (ERA) collaboration has introduced and tested mung bean as a potential crop to alleviate malnutrition and food insecurity in Senegal. This MS thesis describes a study conducted to assess the impact of mung bean on dietary diversity of Senegalese women and children in the Kaolack, Matam and Bakel localities of Senegal. A mixed-methods research approach included individual surveys to determine dietary diversity scores (DDS) and focus groups to assess the perceived impacts of mung bean. The dietary diversity survey was conducted with 194 participants including adult women, ages 15 to 70 years (n=109) and children, ages 0-10 years (n=85). Half (52%) of the population were mung bean consumers. The dietary diversity surveys revealed an average DDS of 5.73 on a scale of one to 10, with 5.83 and 5.62 for mung bean and non-mung bean-consuming groups, respectively. There was a statistically significant difference in DDS between mung bean consuming women and both mung bean and non-mung bean children, and between mung bean and non-mung bean consumers in Bakel; however, there was no significant difference between overall mung bean and non-mung bean groups DDS. Focus groups (n=11) with mung bean consuming women identified perceived agricultural, health, and financial benefits associated with mung bean consumption. These results can increase our understanding of how mung bean may influence policy-relevant issues for the Senegalese population, including agricultural, health and financial outcomes that are not reflected in dietary diversity surveys.

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GENERAL AUDIENCE ABSTRACT

Since 2015, a U.S. Agency for International Development (USAID) and Virginia Tech Education and Research in Agriculture (ERA) collaboration has introduced and tested mung bean as a potential crop to alleviate malnutrition and food insecurity in Senegal. This MS thesis describes a study conducted to assess the impact of mung bean on dietary diversity of Senegalese women and children in the Kaolack, Matam and Bakel localities of Senegal. Individual surveys (n=194) to assess dietary diversity scores (DDS) were conducted with both mung bean and non-mung bean consuming women and children. The results of these surveys revealed that there were statistically significant higher DDS in mung bean consuming women compared to both mung bean and non-mung bean children, and statistically significant higher DDS in mung bean vs non-mung bean consumers in the Bakel locality. However, there was no significant difference between overall mung bean and non-mung bean groups DDS. Additionally, focus groups (n=11) were conducted with only mung bean consuming women. The focus group results indicated perceived agricultural, health, and financial benefits associated with mung bean consumption. Combined, these results can increase our understanding of how mung bean may influence policy-relevant issues for the Senegalese population, including agricultural, health and financial outcomes that are not reflected in dietary diversity surveys.

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List of Acronyms

CLM	Cell against Malnutrition
DDS	Dietary Diversity Score
BMI	Body mass index
FANTA	Food and Nutrition Technical Assistance Project
FAO	Food and Agriculture Organization
HIV	Human immunodeficiency virus
IMACT	International Model for Policy Analysis of Agricultural Commodities and Trade
Kcals	Calories
MB	Mung bean
Mg	Milligrams
SUN	Scaling Up Nutrition
US	United States
USAID	United States Agency for International Development
WFP	World Food Programme

Chapter 1: Introduction

Introduction

According to the 2016 Global Nutrition Report, malnutrition of young children in low-income countries may manifest as poor child growth and development leading to wasting or stunting; micronutrient deficiencies (especially vitamin A, iron and iodide); and overweight or obesity.[1] The repercussions of malnutrition, in all of its forms, permeate every level of a community and nation. Malnutrition experienced by children or adults may cause deleterious effects on their health by impairing cognitive and physical development. These effects may also reduce work capacity and limit human capital that impedes economic growth and progress by fostering dependency on foreign assistance.[2] Micronutrient malnutrition is estimated to contribute to more than one third of all child deaths worldwide with combined direct and indirect effects of malnutrition.[2] Many factors contribute to poverty and feed into the vicious cycle of malnutrition including: low environmental, economic, and human resources; suboptimal infrastructure, poor sanitation, and low educational achievement. Malnutrition is not easily addressed by one intervention or program. Many development projects and programs have been designed to address malnutrition, but few have resulted in large-scale, community-based success to eliminate malnutrition especially in Africa.[3] The number of stunted (low height-for-age) children under five years is declining in every region of the world except Africa and Oceania.[1] The U.S. Agency for International Development (USAID) launched Feed the Future in 2010 as the major U.S. government initiative to tackle malnutrition and promote food security in 19 focus countries worldwide through the integration of individual, community, and policy interventions.[4] In 2012, a USAID Virginia Tech collaboration for Education and Research in Agriculture (USAID-ERA) began to research and promote agricultural training and education systems in Senegal and other

African and Asian countries.[5] In 2015, USAID-ERA began researching the potential utilization of mung bean as a new crop with a nutrition-led agriculture focus, recognizing that acceptance and consumption of mung bean may simultaneously address malnutrition and food insecurity in Senegal.[6]

Statement of Problem

The USAID-ERA collaboration was initiated based on the many nutrient, agricultural, and climate-tolerant advantages of using mung bean to address food insecurity and malnutrition in Senegal. Although these implementation trials are still ongoing, preliminary results were promising.[6,7] There is a lack of research on the potential nutritional impact of mung bean on community food security and dietary diversity where it has been accepted and regularly consumed in Senegal. Thus, research is needed to determine the nutrition impact of mung bean on the diet quality and dietary diversity of the Senegalese population. Comprehensive research designs would include mixed methods, including a controlled trial to measure the blood serum levels of pertinent micronutrients and anthropometric measurements before and after long term acceptance of mung bean with the vulnerable populations (e.g, women and children). However, given that mung bean is already implemented and consumed within the study population, it is more feasible to conduct an assessment of the impact of mung bean by comparing the dietary diversity of individuals who currently consume mung bean when available versus those who do not consume mung bean. It is also important to assess the impact of mung bean from the Senegalese population's perspective and determine the impact of mung bean aside from the dietary diversity.

Significance of the Study

This MS thesis addresses the lack of knowledge concerning the nutritional impact of mung bean implementation and consumption in women and children who are among the most vulnerable segments of the Senegalese population. This study used a dietary diversity survey to assess the impact of mung bean consumption on the dietary diversity of these two populations. The dietary diversity survey is a tested valid and reliable tool that can also be used as a proxy indicator for the nutritional adequacy and food security status of a targeted population.[8,9] These data may provide objective results to inform the USAID-ERA and partner organizations involved in the introduction of mung bean to these Senegalese communities. Finally, this information can address existing knowledge gaps about the diet of women and children in the Kaolack, Bakel, and Matam localities of Senegal. Finally, this study may elucidate the effectiveness of crop centered nutrition- led agriculture programs to improve nutrition status of the Senegalese population.

Main Hypothesis

This study tested the hypothesis that mung bean consumption will be associated with better nutritional adequacy and food security (as reflected by a higher dietary diversity score) among women and children in Senegal compared with non-mung bean consuming populations.

Chapter 2: Literature Review

Micronutrient Malnutrition

Malnutrition can be related to acute and/or chronic deficiencies from a wide range of macronutrients (i.e. proteins, carbohydrates, fats) and essential micronutrients (i.e. vitamins and minerals). Iron is one of the top three micronutrients for which a deficiency increases disease susceptibility in infants, young children under 5 years, and adults.[10] The worldwide prevalence of iron deficiency anemia, a form of micronutrient malnutrition, is highest among preschool children, women of reproductive age, and women who are pregnant.[11] During pregnancy, the maternal requirement for iron increases from 22 milligrams (mg)/day to approximately 1,000 mg/day.[11]

Numerous studies indicate the significance of low maternal hemoglobin levels related to low birth weight and mortality rates among infants.[5] A multivariate analysis of data from a study that enrolled 691 mothers in Nepal indicated a U-shaped relationship between maternal hemoglobin concentrations and low birth weight.[12] This study displayed that both abnormally high and low levels of iron are correlated with increased risk for low birth weight. Additionally, an iron-folic acid supplemented group of women in rural China led to a 54% decrease in neonatal morality and longer gestation duration compared to a folic acid control or "multiple micronutrient" supplementation group.[13] Christian et al. (2009) assessed the long-term effects of four different maternal supplements, all containing vitamin A, on Nepalese children who were born during a cluster-randomized, double-blind, controlled trial.[14] Christian found a significant 31% decrease in mortality between birth and age 7 for children who were born to the iron-folic acid supplemented mothers.[14] These results were the highest compared to the folic acid and other micronutrient combination supplements.[14]

Folic acid is another essential nutrient that supports proper neural tube development in babies. Closure of the neural tube occurs during the first 21-28 days of post-conception.[15] Due to the multitude of trials displaying the relationship between maternal folic acid levels and neural tube disorders, the Centers for Disease Control and Prevention (CDC) recommended in 1992 that all reproductive-aged women should consume 0.4 mg of folic acid in addition to a folate-rich diet.[15] The specific folic acid requirement during the first trimester of pregnancy, or general need, such as increased caloric intake, are both essential for the proper development and birth of a healthy child. Both inadequate intakes of calories and micronutrients contribute to the cycle of malnutrition in infants and young children under five years of age.

Effects of Malnutrition on a Child Development and Health

There is widespread data from both developed and developing countries to reflect a direct relationship between proper maternal nourishment and fetal health during the 1,000-day window.[16–19] This window represents the first 1,000 days of a child's life, from conception to two years of age, when the child is dependent on specific nutrients and environmental factors to support proper development.[18] During the 1,000-day window, malnutrition is more likely to cause irreparable damage to cognitive and physical development in the child.[19]

When discussing malnutrition and neural development, Morgane et al. (2002) determined that all amino acids that are essential for a pregnant mother.[17] Likewise, all amino acids are essential for the fetus and absence of any of the essential amino acids from the maternal diet can have a damaging effect on fetal brain development.[17] These authors concluded that undernutrition before birth will result in a deficit in cell numbers at birth and cause a permanent neuron deficiency throughout postnatal life.[17] Moreover, a child's first two years of life are incredibly important for brain development and growth. The majority of dendritic growth, synaptogenesis and glial cell

proliferation occurs and by the age of two, a child's brain should reach 80-90% of the weight of an adult brain.[20] Li et al. (2016) evaluated the effect of prenatal and postnatal malnutrition on the intellectual functioning of children and determined that four of the five composite scores from the Wechsler intelligence scale, including full scale intelligence quotient, verbal comprehension index, working memory index, perceptual reasoning index and processing speed index, were significantly lower in low birth weight children after adjusting for confounds.[21] Similarly, Hoddinott et al. (2013) followed up with 1,338 Guatemalan adult men who were studied as children in 1969-1977 and found that being stunted at 2 years old was associated with lower test performance in the Raven's Standard Progressive Matrices Test, an assessment of nonverbal cognitive ability.[22] Therefore, impaired cognitive development resulting from malnutrition may be silently effecting the mass majority of children who were malnourished and stunted within the 1,000-day window.

As previously determined, a malnourished mother is more likely to give birth to a low birth weight baby, increasing the baby's susceptibility to diseases, stunting, impaired development and premature death. Any of these impairments only further contributes to the inhibited economic development of the family, society, and perpetuates the cycle of poverty and malnutrition.[23] Thus, malnutrition is a positive feedback cycle that physically and cognitively limits an individual's potential to escape poverty or progress their communities' development. To tackle malnutrition, it is important to recognize the opportunities to prevent and alleviate it in all phases of life. Prentice et al. (2013) analyzed interventions outside of the 1,000-day window and determined that interventions beyond 24 months may offer opportunities to improve nutritional status by improving woman's reproductive life and further benefiting future generations.[18] Recognizing that malnutrition creates a vicious feedback cycle, any intervention program needs to target not only

the malnourished individuals but also their families, communities, and encourage government involvement to break the cycle of malnutrition.

Malnutrition in Senegal

Different forms of undernutrition are observed in a growing child such as stunting (low height-for-age), wasting (low weight-for-age) and micronutrient malnutrition (one or more essential vitamin or mineral deficiencies). According to Scaling up Nutrition (SUN), within Senegal in 2016: 15.9% of children are born at a low birth weight, 19.4% of children under five are stunted, 5.8% of children under five are wasting, and 57.5% of women aged 15-49 are anemic.[24] Since 2010, the 2016 rates of stunting and wasting in children under five have decreased from 27% and 10%, respectively.[25] USAID has identified Senegal as a country suffering with "hidden hunger" as micronutrient deficiencies are extremely high.[25] In 2010, 63% of children in Senegal had a moderate form of anemia and the prevalence of severe anemia is two to 10 times higher in more rural regions compared to large urban areas such as Dakar and Ziguinchor.[26]

Food Security in Senegal

Food security occurs when people have reliable access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy life.[27] The Food and Agriculture Organization (FAO) of the United Nations identifies four components of food security including food availability, food access, food utilization, and food stability.[28] *Food availability* is recognized when there is a sufficient quantity and diversity of food. *Food access* refers to a lack of any physical, financial, and cultural barriers related to obtaining foods. *Food utilization* refers to the capacity and resources needed to safely use and store food and water. *Food stability* is related to the ability to maintain access to food over seasonal fluctuations as well as any abrupt economic or

environmental disruptions.[28] In February, 2017 the UN World Food Programme (WFP), the world's largest humanitarian agency fighting hunger worldwide, projected that around 800,000 Senegalese people will be severely food insecure in the upcoming lean season.[29] The WFP stated that Senegal's food insecurity is related to recurrent droughts, floods, desert encroachment, persistently high food prices, low resilience to emergency situations and dependency on local markets, amongst other factors.[29] Regarding the four components making up food security, Senegal is tackling barriers in food availability, access, utilization and stability.

Benzekri et al. (2015) tested the prevalence of food insecurity and malnutrition among HIV-infected adults in the capital city Dakar and town of Ziguinchor in Senegal.[30] Benzekri used household food insecurity and dietary diversity surveys to assess malnutrition and food security. Benzekri found high prevalence of food insecurity (85% and 90%) and severe food insecurity (60% and 75%) in Dakar and Ziguinchor, respectively, with infected populations.[30] Benzekri noted that food insecurity caused the majority of individuals to decrease individual meal size so all members of the household could have food.[30] Almost half of the food-insecure participants claimed to skip meals and some went twenty-four or more hours without eating due to lack of food.[30] Fanzo noted that half of the world's food insecure can be described as poor, smallholder farmers that live in low-income countries, like Senegal, cultivating on marginal lands to simply produce the food and income they need for their own survival.[31] Targeting smallholder farmers for improved food security and dietary diversity as a result of an agricultural program is conducive to potential transferability and generalizability of this research and program with other food insecure smallholder farmers around the world.

Dietary Diversity in Senegal

Dietary diversity can be defined as the number of different foods or food groups consumed over a given period of time.[32] USAID- Food and Nutrition Technical Assistance Project (FANTA) project determined that dietary diversity can be used as a reliable proxy for food security as changes in dietary diversity are a good indicator of changes in household per capita consumption and household per capita caloric availability, which are all measures of the access component of household food security.[32] The Feed the Future multi-year strategy plan for Senegal states that 58% of the Senegalese diet consists mainly of cereals such as millet, sorghum, and particularly rice, which leads to a lack of dietary diversity. [33] These foods are known as "staples" because they make up the largest amount of food and tend to be the most constant throughout the seasons in the year. For example, in times of harvest and plenty, a typical Senegalese plate could have a grain, vegetable, animal protein, and more. The hungry season is the time between the end of the previous year's food crops yet before the harvest of the following year.[33] In this "hungry season" after the food from one harvest has been consumed and income is low, the remaining food would be the cheap staple grains and vegetables. This grain heavy diet revolving around one harvest per year causes a lack of dietary diversity, and furthermore a lack of food security and nutritional adequacy in the Senegalese diet.

Feed the Future is a US based initiative to combat global hunger and poverty by working from farms to markets to tables to improve incomes and nutrition.[34] The Feed the Future plan recognizes that during the "hunger season" more expensive items, like meat, are eliminated and number of meals are often reduced.[33] Anderson et al. (2010) analyzed the diet of fifty Senegalese men in the capital city, Dakar and found that based on a 24-hour dietary recall, 43% of the diet was compromised of fruits and vegetables, 11% grains, and 12% meats.[35] This dietary recall

potentially represents a very affluent diet on the spectrum of diets in Senegal. First, men typically get priority in the serving of food and in this study 40% of the men had some level college education.[35,36] Despite the difference in target population, Anderson's analysis reveals that even in a large city with well-educated men, 54% of their diet is vegetable, fruit, and grain based compared to 12% for protein rich meats. To an even greater extent, it is anticipated that the diet of rural Senegalese women and children will have even fewer or less consistent sources of animal based protein in their diet.

The USAID's Feed the Future plan focuses on high growth of three staple grains including: rice, maize and millet, as well as a non-grain, fish. From an agricultural perspective, these crops have high growth potential, scalability and potential to improve the overall agricultural economy. However, increases in these specific crops (i.e., rice, maize and millet) will likely not increase dietary diversity and ultimately address malnourishment of the Senegalese population. USAID recognizes that education and awareness are needed to reinforce the importance of diversifying the household food basket.[33] This strategy focuses on increasing staple grain production to improve local economy and household ability to afford food diversity. Without measuring individual or household dietary diversity, it is not appropriate to assume the families with improved grain yields are using also diversifying their diets. Therefore, it is essential to assess dietary diversity to ascertain whether the nutrition programs are actually improving diversity and nutrient adequacy in addition to improving access to sufficient quantities of quality food.

Nutrition Policy in Senegal

Senegal has many nutrition-centered policies, programs, and initiatives to address malnutrition from a local to national level. Senegal is currently investing over 10% of its national budget to address agriculture and food security-related issues.[25] In 2001, Senegal gathered previously

uncoordinated actors in nutrition policy to draft national policies and plans to address malnutrition and food security. This meeting created the foundation for the Cellule de Lutte contre la Malnutrition, or Cell against Malnutrition, (CLM). The CLM is a nutrition convening body within the Prime Minister's office that provides technical assistance in the definition and implementation of national nutrition policy.[37] The CLM initiated the Unit for the Fight Against Malnutrition in October, 2001.[37] The Unit for the Fight Against Malnutrition works on a national policy level to assist the Prime Minister to define national nutrition policies and strategies, examine and approve collaborative proposals, promote communication promotion policy, strengthening national capacities for effective conduct of nutrition programs, and develop a framework for consultation between government, nongovernment and community based organizations working with and under nutrition policies.[37] The CLM is currently implementing nutrition programs/interventions targeted to children less than five years old which address alleviating the negative impacts of food price increases; poverty and hunger, the fortification of oil and flour, and salt iodization.[25] Looking forward, the CLM is revising the 2013-2018 National Nutrition Policy, to use a multi-sectoral plan that includes common results framework with a participative approach to involve all relevant sectors to address malnutrition.[25] These programs and policy developments reflect the large national level policy efforts that Senegal is using to address food security and decrease the malnutrition rates over the past 15 years.

On the side of international policy, Senegal joined the SUN movement in 2011. SUN is a global organization that strives to unite national leaders, civil society, community organizations, businesses, researchers and donors in a collaborative effort to improve nutrition.[25] In June 2013, Senegal joined the New Alliance for Food Security and Nutrition, a partnership between leaders of Africa to invest over $134.4 million from private sector companies into the agricultural sector

to provide market opportunities for smallholder farmers.[25] Similarly, USAID initiated the Yaajeende program to accelerate the growth of rural economy by catalyzing sustainable development within the agriculture sector via an adaptive community-oriented design and nutrition-led agriculture approach.[25] These combined national and international policy driven programs have directed local level economy and power to address malnutrition and improve local economy. Yet, despite these extensive policy-oriented organizations and field-based programs, there is still persistent levels of malnutrition, food insecurity, and halted economic growth in Senegal.[25]

From a global perspective, the nutritional status of children can be seen as a primary indicator of socioeconomic development and progress in any society.[23] Senegal averaged an economic growth of 4% from 2010 to 2013 and 3.3% since 2006, while the sub-Saharan average was a 6% economic growth.[25] Msangi et al. (2011) analyzed results from the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) to determine how socioeconomic and demographic changes effect long-term evolution of food consumption for key commodity groups.[38] Msangi stated that amongst other key factors, economic growth that generates employment and reduces inequality is needed to alleviate poverty, which can then cause significant progress in diminishing malnutrition.[38] In the process of reducing malnutrition rates, Yaajeende aims to increase the participation of the low socioeconomic status community members in the development of rural economy by providing opportunities in the agriculture sector.[25] Thus Yaajeende is working to empower all community members, especially women, to have greater agricultural resources, contributing to economic growth, leading towards a long-term solution for malnutrition. Simultaneously, diminishing malnutrition would allow current and future members of the community to hold a job and progress economic development.[39]

Agricultural practices in many countries across Africa have not received proper attention and financial support from the government, which has inhibited agricultural productivity and fostered food insecurity.[40] According to the United Nations Department of Economic and Social Affairs, there has been a transition towards sustainable agricultural when addressing malnutrition in efforts to create sustainable systems that utilize and replenish the country's resources rather than relying on long term aid.[41] Therefore, "Nutrition-sensitive agriculture" has developed with the focus on improving the nutritional outcomes of a population by maximizing the food and agriculture systems while minimizing any negative effects on the economic and production-driven goals.[42] Although nutrition-sensitive agriculture is focused on improving food security and dietary diversity, the complex interactions among these factors require an interdisciplinary response rather than solely using agriculture programs to focus on malnutrition.

Lachat et al. (2015) used Senegal as a case study to review nutrition-sensitive agriculture policy development in order to identify gaps and opportunities to strengthen the impact of these policies. Lachat noted that there is a general consensus that agriculture programs contribute to nutrition, and many have it as a goal or objective, yet many agricultural programs do not target communities based on their nutritional vulnerability.[40] Lachat and colleagues also concluded that within the agricultural sector, most people do not acknowledge the health dimension of nutrition, and misunderstand the full impact of nutrition on health.[40] Many individuals who live under food-insecure situations have little education and little to none nutrition education.[25] Therefore, it is crucial to not just provide families with improved access to food, but also nutrition education to emphasize dietary diversity and balanced diet for full nutritional adequacy. After reviewing multiple agriculture programs in Senegal, Lachat and colleagues concluded that most nutrition education conducted with agricultural extension was done in an ad hoc and informal fashion.[40] In

addition to general nutrition education being advantageous within the agricultural extension community, it would be an ideal opportunity to always couple nutrition education with agriculture programs. Consequently, for agriculture programs to be effectively addressing malnutrition, a shared understanding of the full impact of nutrition on health is needed between the agriculture sector, policy makers, and health professionals. This awareness is needed not just for agricultural professionals, but also among the target populations.

US Agency of International Development Projects

As previously stated, USAID's Feed the Future Initiative is a food security program that works to address malnutrition and food insecurity in 19 countries in Africa, Asia, Latin America and the Caribbean.[34] Yaajeende is a specific seven year Feed the Future Food security program that aims to reduce malnutrition in Matam, Bakel, Kedougou and Kolda regions, representing the northeastern one third of Senegal.[43] Yaajeende is designed to improve food security through an integrated approach that promotes community-based solution provider that aims to link local entrepreneurs, microfinance institutions and banks, suppliers, cooperatives and civil society members, and consumers together.[25] Yaajeende's four primary strategies include: nutrition-led agriculture, asset-building for women, local private businesses and farmers, as well as implementing research-based resources.[44] Between 2010-2015 Yaajeende aimed to reduce number of underweight children by 35% and stunting by 25% in the Yaajeende target zones.[45] Yaajeende is unique in that it is an agriculture centered program that also incorporates nutrition and food sanitation education workshops.[44] The USAID-ERA collaboration began as a capacity-building initiative within the USAID Feed the Future Initiative. In 2015, USAID-ERA and USAID-Yaajeende started a collaborative effort to introduce and test the potential of using mung bean as an alternative food legume in Senegal.[6] Currently USAID-ERA and USAID-Yaajeende

are collaborating to assess the growth, development, and adaptability of mung bean across Senegal's ecological and climatic zones. No research has been done thus far to assess the nutrition impact that mung bean has had on the communities where mung bean has been accepted and regularly consumed within the Senegalese diet.

Why Use Mung Bean

Senegalese people primarily utilizes traditional farming methods, such as using little to no fertilizer or mulch, and habitual removal of all crop residues. These methods unfortunately have led to extremely poor and depleted soil that is deficient in nutrients.[7] In addition to nutrient deficiency, this poor soil composition also leads to higher rates of erosion, low cation exchange capacities, and low water-holding capacity.[7] Currently, many smallholder farmers in Senegal do not have access to the resources or education to change their traditional farming methods, and as a result most struggle to sustain sufficient yields.[7] Mung bean is a grain legume crop that is drought tolerant, prefers warm temperatures (20C-45C or 68F-113F), and has a short growing season (55-110 days).[7] In addition to growing well with the climate and weather of Senegal, mung bean fixes nitrogen in the soil that helps maintain soil fertility and texture for future harvests rather than deplete it.[46] In 2013-2014, field studies were conducted to test the effect on millet yields when intercropping mung bean with millet vs cowpea with millet. Results showed that with intercropping either mung bean or cowpea, millet yields increased up to 55% and increased up to 70% when also using mulch.[7] This suggests mung bean is a low-cost, sustainable and environmentally appropriate option to improve crop yields, food security, and dietary diversity in Senegal.

Due to mung bean's agricultural advantages, mung bean could potentially provide an excellent source (>20% daily value per reference amount customarily consumed) of protein, fiber,

iron and folate when other sources of these macronutrients and micronutrients are scarce. Oftentimes during the hunger season the remaining foods in a household are the low cost, low nutrient staple grains. These staples alone do not provide adequate nutrients for a healthy lifestyle. **Table 1** below shows the macro and micronutrient comparison of mung bean to the main grain staples, white rice and millet, in the Senegalese diet. Naturally, mung bean provides less protein compared to animal meat, but is a greater source of protein and fiber when compared to its cultural counterpart, cowpeas, and other staple grains. Mung bean is high in much needed iron and folate, potentially combatting iron deficiency anemia and folate deficiencies in pregnant women. With the agricultural favorability of growing mung bean, the legume presents an extremely nutrient-dense resource for families to incorporate as a staple during the hunger season.

Food (1 cup)	**White Rice Medium Grain Unenriched Raw**	**Millet Raw**	**Cowpeas Raw**	**Mung bean Raw**
Kcals	702	756	561	718
Fat (g)	1.13	8.44	2.10	2.38
Carbs (g)	154.71	145.70	100.25	129.62
Fiber (g)	.6	17	17.7	33.7
Protein (g)	12.89	22.04	39.28	49.39
Iron (mg)	1.56	6.08	13.81	13.95
Magnesium (mg)	68	228	307	391
Phosphorus (mg)	211	570	708	760
Potassium (mg)	168	390	1857	2579
Folate (mcg)	18	170	1057	1294

Kcals- Calories, Carbs- Carbohydrates, g- grams, mg-milligrams

Table 1: Comparison of nutrient information of white rice versus millet versus cowpeas versus mung bean.[47] Nutrient information from USDA National Nutrient Database for Standard Reference Release 28

Summary

Malnutrition is pervasive and detrimental to individual health and community development around the world. Malnutrition tends to have the greatest effect on children and mothers who are both dependent on specific nutrient needs for proper development. The combination of low dietary diversity and food security in Senegal perpetuates the consistent rates of malnutrition despite local, national, and international policy implementations and programs directed at significantly reducing malnutrition. USAID has identified mung bean as a potential crop to be used to improve food security and nutritional adequacy in Senegal. These programs focus on measuring the agricultural success yet fail to measure the impact of mung bean on nutrition status. Therefore, a dietary diversity survey will be conducted with women and children in Senegal to assess the impact of mung bean on their dietary diversity, nutritional adequacy and food security.

Chapter 3: Study Design and Methods

Specific Aims

This research had three aims that included:

1. Provide objective and clear evidence as to whether dietary diversity is improved by mung bean consumption.

2. Contribute to the limited protocol and research regarding nutrition focused evaluation and assessment methods for crop implementation programs.

3. Provide information that will inform USAID or other development-based programs of the impact of introducing alternative crops on dietary diversity rather than focusing on improving quantity of low-nutrient staple foods.

Research Design

The USAID-ERA/ Yaajeende collaboration in Senegal has been working since 2015 to introduce mung bean as a potential crop to improve food security and dietary diversity of women and their households. This research study was conducted as a cross-sectional study within the larger program to extract observational data on the nutritional impact of the program. This research was only conducted within localities that had already been introduced to mung bean through USAID-ERA/ Yaajeende program. This would allow the data to be compared across mung mean to non-mung bean consumers within the same localities.

A dietary diversity survey is a valuable tool that determines the number of unique foods and food groups consumed over a given period of time.[32] USAID-FANTA used linear regression techniques to analyze the magnitude association between dietary diversity and household food access across 10 middle and low-income countries including five African countries. USAID found

that across the 10 countries, dietary diversity appears to show a promise of measuring household food access, particularly when resources for such measurements are scarce.[32] Savy et al. (2005) used a 24-hour recall with 691 mothers in Burkina Faso and determined a clear relationship with dietary diversity scores (DDS) and nutritional indices as well as nutritional status of women.[8] Savy concluded that a DDS measured at the individual level are good proxies for overall dietary quality of women living in poor rural African communities.[8] Savy et al. (2007) concluded in a separate study that a 1-day dietary diversity is a sufficient measure for women's nutritional status compared to a 3-day period, and that the 3-day period is more likely to be affected by memory bias.[48] Steyn et al. (2006) found that dietary diversity surveys are a reliable measure of micronutrient adequacy in the diet of 2,200 South African children aged 1-8 years old.[9] Thus, a 24-hour dietary diversity survey was determined to be a validated and appropriate tool to measure and compare nutritional adequacy of women and children's diets within this study.

A 10-point food group score was chosen to assess dietary diversity in this study. All food stated in a dietary recall would be broken up into the following 10 food categories: cereals, white roots and tubers; dark leafy greens, vitamin A rich vegetables, fruits and red palm oil, other fruits and vegetables, organ means, flesh meats, fish and seafood, eggs, nuts and seeds, legumes and pulses, and milk products. In 2014, the Food and Agriculture Organization and USAID-FANTA facilitated a meeting with academic professionals, international research institutes, the United Nations, and donor agencies to select between the 9-point and 10-point dietary diversity survey as the best indicator for global use in assessing micronutrient adequacy of women's diets.[49] Based on data previously collected to measure the effectiveness of each indicator, the participating groups at this meeting concluded that the 10-point food group score is appropriate for assessing Women's

minimum dietary diversity. For this 10-point score, having at least five of the 10 food categories indicates having a greater likelihood of meeting micronutrient needs for women.[49]

A modification to this survey was added to include questions regarding specific protein consumption within the growing season when mung bean is available. This additional information allowed for the categorization of participants into mung bean and non-mung bean consumers, which is needed for the recruitment of the mung bean consuming focus groups. The results of this survey will provide information on the current dietary intake of the Senegalese population in these specific regions, identify any relationship between mung bean and dietary diversity, identify protein sources of the population, and provide concrete data to be used by USAID-ERA/ Yaajeende to evaluate the nutrition impact of mung bean on their target populations. All interviews were conducted during February and March, 2017, during the dry season of Senegal (November to April).[50]

Study Sample

All participants within this study were randomly selected from women and children in villages within the localities of Kaolack, Bakel and Matam (illustrated in **Figure 1** below) in Senegal. These localities were selected according to where mung bean had already been introduced by USAID-ERA/Yaajeende. USAID-ERA/Yaajeende originally selected these amongst other localities for their high levels of food insecurity.[44]

Figure 1: Map of Senegal[51]

Participants and Recruitment

Women above the age of fifteen and children under the age of 10 years were recruited to participate in this study as women and children experience the most fatal or damaging effects of malnutrition.[33] Also, in many Sub-Saharan African rural cultures, men in a family household tend to eat first and consume the highest quality and quantity of food. Therefore, assessing the dietary diversity of men may not be reflective of the true impact of mung bean on the household.[52] All participants were screened to determine if they had an abnormal day of eating related to fasting, celebration, illness, or any other reason they day before.

Recruitment occurred three weeks prior to the start of data collection. Local USAID-ERA extension agents responsible for each locality were provided IRB approved recruitment scripts to

actively recruit both mung bean and non-mung bean participants. Individuals were informed of the date and time to participate in a study and that participation is voluntary and optional.

Mixed Method Research and Interpreting Conflicting Results

Mixed method research is a form of research that utilizes the combination of both quantitative and qualitative data collection within a single research study.[53] This study uses a mixed method approach by combining quantitative data collection through DDS in individual surveys and qualitative data from focus groups. Mixed method research emerged along with the progressive perspective that research is not always quantitative versus qualitative data, rather the complexity of most situations call for data that lies somewhere on a continuum between the two.[54] Using a mixed method approach is useful when multiple types of data are needed to best provide an understanding of the question at hand.[55] The value of using mixed method research is in addressing a wider range of questions than what just qualitative or quantitative data alone would address. A review of mixed method research in the health services setting revealed how qualitative research is needed to engage with the complexity of health, health care interventions, and the environment in which the studies took place.[56] Moffatt et al. (2006) found that these mixed methods assessments can lead to different and sometimes conflicting data, but only enhance the robustness and overall quality of a study by providing more in depth information.[57]

Methods

Individual survey: Prior to data collection, a multilingual local translator was trained on interview techniques for the individual survey and focus group survey. The intent and reasoning behind each question was explained for translation accuracy into French and Wolof, one of the native Senegalese languages.

If a child was too young or shy to respond, the mother became a proxy for the survey. A verbal consent form was used to inform the individuals of the study aim, participant expectations, and explain how the participant could stop at any time (Appendix A). Infants' data were collected but later excluded from analysis due to significant difference in dietary diversity analysis related to breast feeding.

If the individual agreed to participate in the study, the dietary diversity survey was then conducted for the individual's dietary intake during the past 24 hours. Additional questions were added to assess specific protein intake within the harvest season when mung bean, amongst other foods, are available. This protein intake section was used to determine whether the individual would be considered a mung bean or non-mung bean consumer. Individuals who consume mung bean twice a week or more were counted as mung bean consumers while individuals who eat mung bean once a week or not at all were categorized as a non-mung bean consumers.

Finally, the last section on the survey assessed the most and second most common source of food for the participant such as purchasing food, farming, bartering, food aid, etc. To ensure confidentiality, a code was used a replacement for the individual's name. This data should provide insight in average dietary diversity, sources of protein intake and source of food of Senegalese women and children who have and have not had access to mung bean.

Focus Group: To elucidate the perceived impact of mung bean on food security, focus group discussions were conducted in each locality. Only women, fifteen and older, who were categorized as mung bean consumers were given the opportunity to participate in the focus group. During the individual survey, women who reported consuming mung bean two or more times per week in the individual survey were categorized as mung bean consumers. The group discussions

were held at a neutral and central location within the village with five to 10 women participating in each discussion.

The seven focus group questions were developed from previous research by the Economic Research Service Community Food Security Assessment Toolkit and focused on food security and how mung bean has impacted their household's access to food.[58] These questions were reviewed by the principal investigator who had extensive research experience in Senegal. Once in Senegal USAID-ERA Senegalese project coordinator and a local extension agent reviewed the questions and an IRB amendment was requested to add an additional question. The focus group survey can be found in **Appendix C**. All focus groups were translated through one USAID Senegalese employee who was fluent in English, French, and local languages such as Wolof.

The focus groups started by being read a verbal consent form to verify the intent of the study, how the information will be used, and that they can chose to not answer or leave at any time. After gaining consent, the focus group survey began in the local language and the women's responses were translated to the moderator who asked necessary follow up questions to facilitate discussion and receive complete answers to the questions. An audio recorder was used to record the women's translated answers and field notes were also taken by the moderator. Within a week of conducting the survey, the audio recordings and notes were both used to manually transcribe the translated responses verbatim.

Data Analysis

The individual survey data were analyzed through descriptive statistics, t-tests, and frequencies to compare the demographics and mean DDS. The focus group data were analyzed separately by two researchers. A thematic analysis was used independently by two researchers to

code the transcripts.[59–61] Based on these findings, the researchers collaborated to identify the emerging major and minor themes of the data.[62]

Chapter 4: Results

Participants

Individual interviews (n=200) and focus groups (n=11) were conducted, with an average of eight women per focus group, between February and March 2017. Six of the individual interviews were later excluded from data analysis due to the exclusion of infant data and one survey in which they participant had been a part of a celebration the previous day and therefore had an abnormally high food intake (n=194). The demographics and division of the sample between women vs children and mung bean vs non-mung bean consumer can be found in **Table 2** below. Mung bean will be referred to as MB within all tables and graphs for simplicity.

Demographics of Sample	
Total sample	n = 194
Total number of women	109
Total number of children	85
Percentage of mung bean consumers within sample	52%
Women Average Age	40
Children Average Age	5
Women who had children aged 0-10 years	63%
Overall Average DDS	5.73
Overall DDS Standard Deviation	1.565
1st source of food	Own Production: farming, hunting, gathering
2nd source of food	Purchasing
3rd source of food	Other: food aid, gifts, bartering

Table 2: Demographics for women and children participating in individual surveys

Quantitative Data Results

The quantitative data is based on the dietary diversity survey and additional information collected with the individual surveys. A comparison of mean DDS is created to show the DDS of women vs children, by locality, and by dietary diversity groups.

Mung bean vs non-mung bean consumer analysis

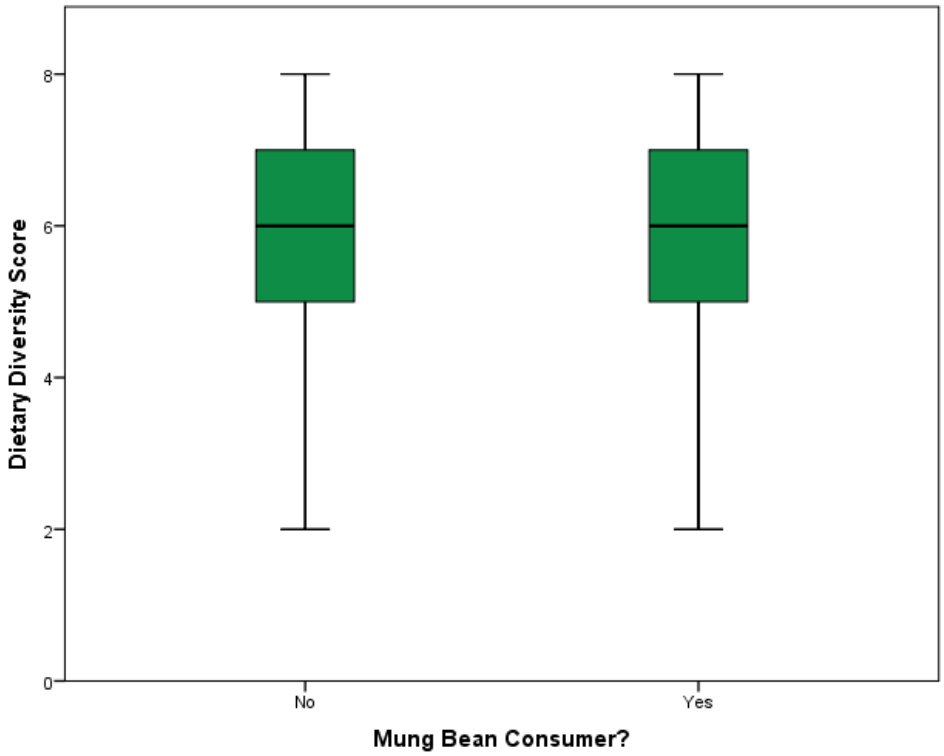

Figure 2: Dietary Diversity Scores in MB vs non-MB consumers

Mung Bean Consumer?	N	Mean	Std. Deviation	Std. Error Mean
Yes	100	5.83	1.577	.158
No	94	5.62	1.553	.160

Table 3: Average dietary diversity score MB vs non-MB consumer

The average DDS for mung bean consuming individuals was slightly higher at 5.83 compared to the non-mung bean consuming group's average of 5.62. According to an independent t-test of the mean DDS of mung bean vs non-mung bean consumers, there is not a statistically significant difference between average DDS of mung bean and non-mung bean consuming groups (p=.345). **Figure 2** displays their nearly identical range and distribution. The ANOVA analysis of locality DDS shown below in **Table 7** revealed a statically significant relationship between DDS and locality, specifically in the relationship between Bakel and Matam DDS (p=.002). When

controlling for the locality covariate in a one-way ANCOVA, the DDS of mung bean vs non-mung bean consumers was still not statistically significant (p=.141).

Women vs Children analysis

Code	n	Mean DDS	Std. Deviation	% MB Consumer within sample
Children	85	5.44	1.54	54% of children
Women	109	5.95	1.55	49% of women
Total	194	5.73	1.57	52% overall

Table 4: Overall average DDS women vs children and % MB consumers within sample

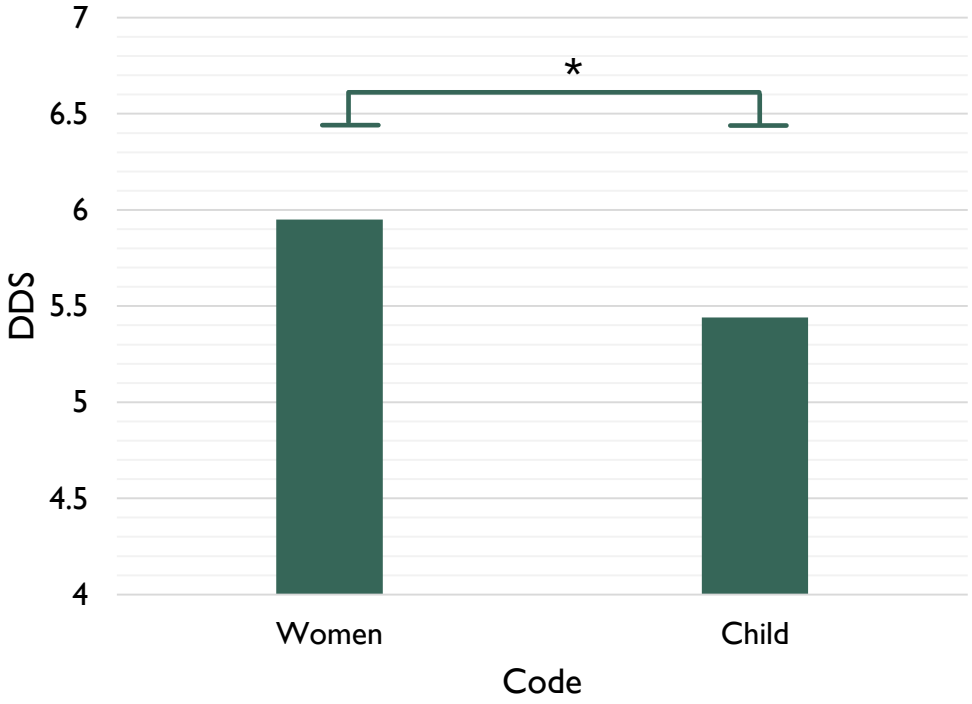

Figure 3: Overall Women vs Children DDS

			Mean DDS
Children	**Mung Bean Consumer?**	Yes	5.47
		No	5.39
Women	**Mung Bean Consumer?**	Yes	6.15
		No	5.77

Table 5: Dietary Diversity Score in Women and Children: MB vs non-MB

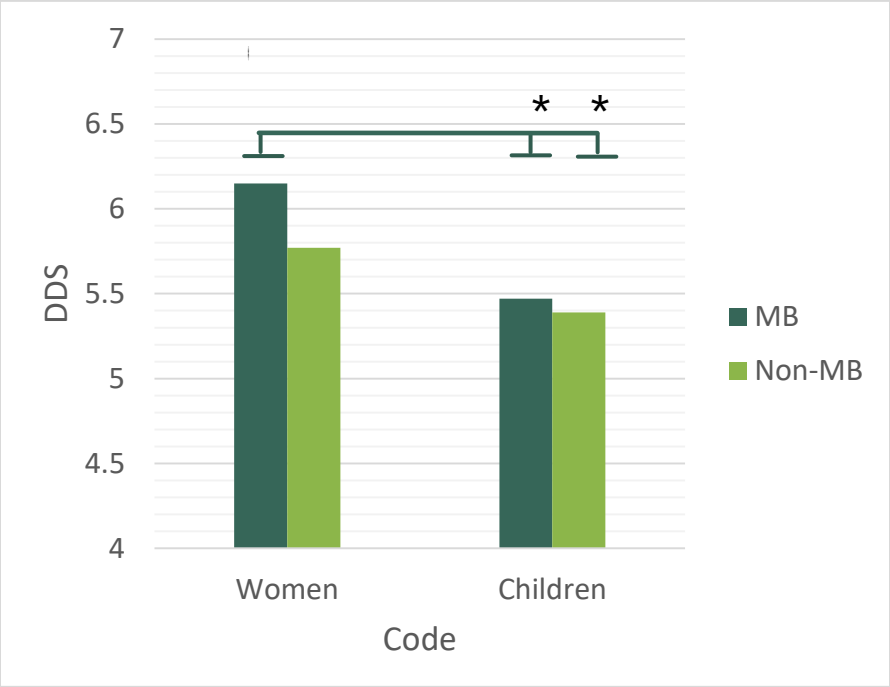

Figure 4: MB and non-MB Women vs MB and non-MB children DDS

Above, **Table 4** and **Figure 3** reflect that overall, women have a statistically significant higher average DDS than children (p=.022). An independent t-test revealed a statistically significant difference between MB consuming women vs MB consuming children (p=.03) and MB consuming women vs non-MB consuming children (p=.01) as shown in **Table 5** and **Figure 4**. Contrastingly, there was not a statistically significant relationship between non-MB consuming women and MB or non-MB consuming children. Therefore, the overall statistically significant relationship between women and children is driven by the increase in DDS from MB consuming women compared to both groups of children.

Locality analysis

	n	Overall Mean DDS	Mean DDS for MB	Mean DDS for Non-MB	% MB Consumer within sample by locality
Bakel	54	5.22	5.78	4.11	66% of Bakel
Kaolack	43	5.49	5.35	5.58	40% of Kaolack
Matam	97	6.11	6.04	6.18	48% of Matam

Table 6: Average Dietary Diversity Score by Locality and % MB consumers by locality

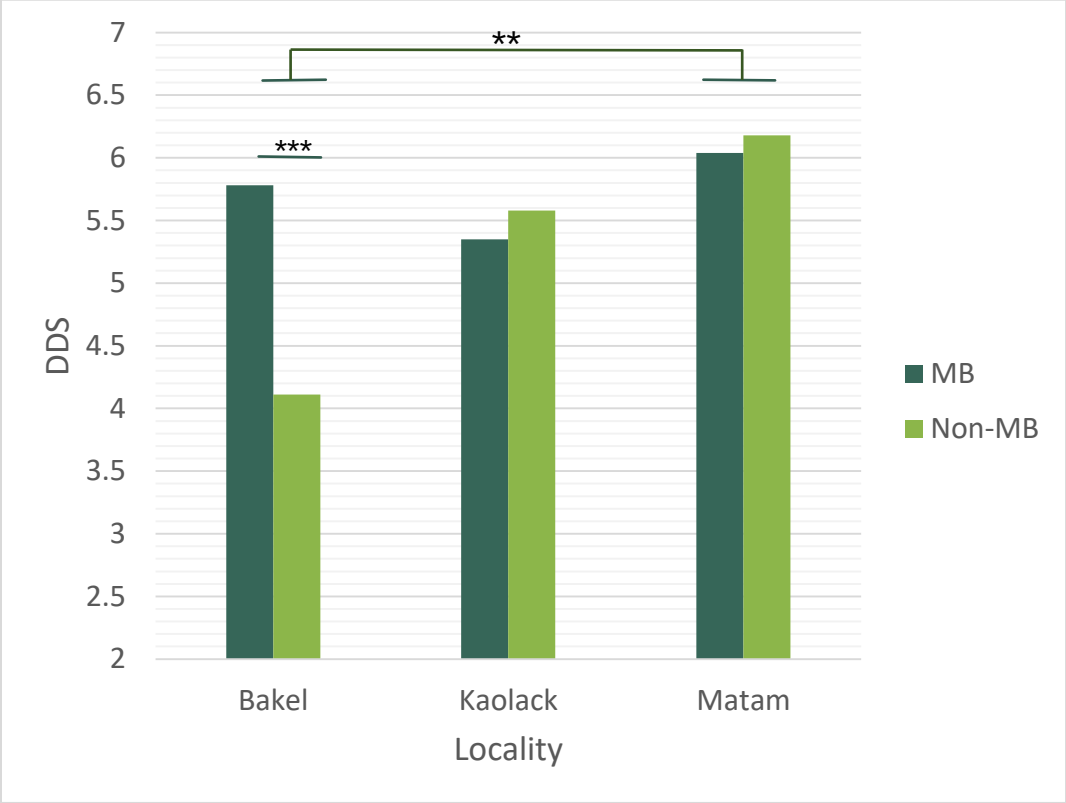

Figure 5: Average DDS MB vs non-MB by Locality

Table 6 displays the overall mean DDS by locality, average DDS for MB consumers by locality, and DDS for non-MB consumers by locality. This data is represented in **Figure 5,** which displays the mean DDS of mung bean and non-MB consumers by locality. **Table 7** and **Table 8** below display a one-way ANOVA and post-hoc analysis that the overall locality mean DDS. These analyses found a statistically significant difference between the localities of Bakel

and Matam (p=.002). **Figure 5** also reflects the statistically significant relationship found between MB and non-MB consumers in Bakel (p=.001) determined by an independent sample T-test. **Figure 6** below displays a comparison of distribution of DDS for women and children by locality and reflects that women have a consistently higher spread than children DDS.

Oneway- ANOVA
DDS and Locality

	Sum of Squares	df	Mean Square	F	Sig.
DDS Between Localities	30.691	2	15.345	6.634	.002

Table 7: Oneway-ANOVA Analysis of DDS by Locality

Post Hoc Test: Tukey HSD

Dependent Variable: Dietary Diversity Score

(I) Locality_Code	(J) Locality_Code	Mean Difference (I-J)	Std. Error	Sig.
Bakel	Kaolack	-.266	.311	.669
	Matam	-.891*	.258	**.002**
Kaolack	Bakel	.266	.311	.669
	Matam	-.625	.279	.067
Matam	Bakel	.891*	.258	**.002**
	Kaolack	.625	.279	.067

*. The mean difference is significant at the p<0.05 level.

Table 8: Post Hoc Test to compare specific Locality vs DDS

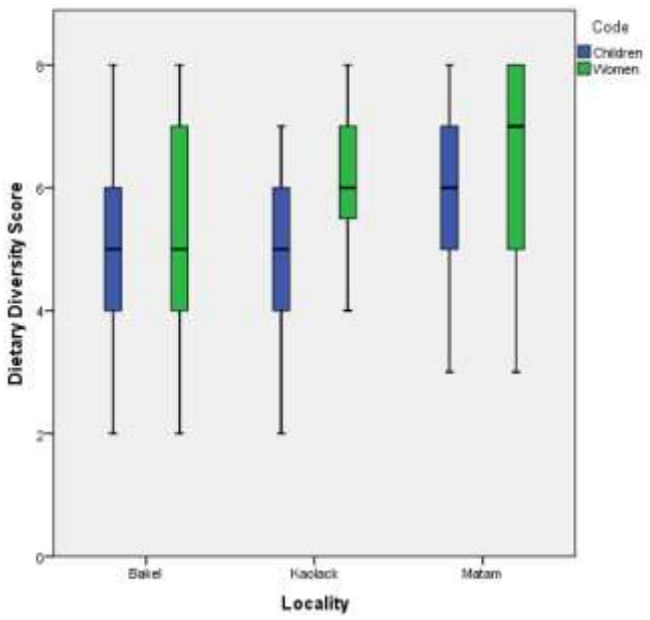

Figure 6: DDS of women vs children by locality

Food group analysis

For this analysis, the respondents were categorized into low, medium and high DDS groups. Low includes scores one to three, medium is four to six, and high is seven to ten. **Table 9** below shows the percent of individuals within each DDS group (low, medium, high) that had consumed each specific food category within their dietary recall. For example, only 10% of the people who had a 1-3 DDS had consumed a white root or tuber (white potato, cassava, turnip, etc.) while 53% of the individuals who had a DDS of 4-6 had consumed a white root or tuber in their 24-hour recall. **Table 10** displays which food groups $\geq$ 50% of the participants consumed within each dietary diversity group. This table emphasizes the differences in which food groups are typically always consumed in a Senegalese diet when dietary diversity is at its lowest compared to which foods groups are added in last at the highest dietary diversity levels. Nuts and seeds, pulses and legumes, and dark leafy greens are only added in when attaining the highest

dietary diversity group (7-10 DDS). **Table 11** reflects the percentage of mung bean consumers vs non-mung bean consumers within each dietary diversity group. The percentage of mung bean consumers increases from 40% for low, 50% for medium and to 58% for the highest DDS group.

Food Group	Low DDS (1-3)	Medium DDS (4-6)	High DDS (7-10)
Cereals	100%	100%	100%
White Roots and Tubers	10%	53%	64%
Dark Leafy Greens	15%	21%	85%
Vitamin A Rich Vegetables and Tubers	0%	68%	96%
Vitamin A Rich Fruits	0%	0%	3%
Red Palm Oil	0%	2%	4%
Other Vegetables	30%	94%	100%
Other Fruits	0%	16%	7%
Organ Meats	0%	0%	0%
Flesh Meats	5%	17%	33%
Fish and Seafood	75%	86%	90%
Eggs	0%	5%	12%
Legumes and Pulses	5%	38%	84%
Nuts and Seeds	20%	36%	100%
Milk and Milk Products	35%	60%	64%

Table 9: Percent individual consumption of food groups by Dietary Diversity groups

Low DDS (1-3)	Medium DDS (4-6)	High DDS (7-10)
Cereals	Cereals	Cereals
Fish and Seafood	Fish and Seafood	Fish and Seafood
	Vitamin A Rich Fruits	Vitamin A rich Vegetables and Tubers
	Other Vegetables	Other Vegetables
	White roots and tubers	White roots and tubers
		Dark Leafy Greens
		Legumes and Pulses
		Nuts and Seeds

Table 10: Food groups consumed by ≥50% of households by dietary diversity group

		Dietary Diversity Scores			
		1-3	4-6	7-10	Total
Mung Bean Consumer?	No	12 (60%)	54 (50%)	28 (41%)	94
	Yes	8 (40%)	53 (50%)	39 (58%)	100
Total		20	107	67	194

Table 11: Ratio of MB consumers within each dietary diversity group

Qualitative Data Analysis

The separate analysis of the focus groups (n=11 groups,) by two researchers revealed a combination of reoccurring minor themes that reveal three major themes. **Table 12** below displays these themes and which minor themes contribute to the overall three major themes extracted from the qualitative data analysis.

Major Themes	Minor Themes
Food Security: barriers and strategies	Environmental Causes
	Coping Mechanisms
Impact of mung bean	Intake
	Agriculture
	Health
	Finance
Current support systems vs perceived needs	Community Needs
	Individual Needs
	Government and International program support

Table 12: Major and Minor themes from Qualitative Data Analysis

Food Security: Barriers and Coping Strategies

Across all focus groups, times of food insecurity, barriers to consistent access to diverse foods, and specific coping mechanisms were mentioned. The barriers were predominantly related to the environment and specifically the seasonal effect on food, limited access to water, and high

prices for protein food sources. Participants explained their region specific dry vs rainy season and how these seasons impact food intake. Seasonal effect on increasing and decreasing specific types of food varied between each village as shown in **Table 13** below. Depending on the resources available to the women within the village, one might have the opposite seasonal effect on food than another village in the same locality. Overall each focus group expressed feelings that their food choices being controlled by the season. Participants often explained how specific foods fluctuate in availability throughout the year due to inability to grow and afford foods. **Table 13** below displays the foods mentioned within each food group that are affected by seasonality.

"During the dry season food will be most difficult to access, we have beans but it's still difficult to have a diverse plate."

In addition the effect of seasons on household food intake, those who have livestock explained how seasonality impacts consumption of milk as many reported having more milk and yogurt in the rainy season.

"In the rainy season there is a lot of grass so the livestock will eat more and they can have milk from cow…During dry season it's hard to have nutrition for livestock, so there's no milk."

	Dry Season		**Rainy Season**	
	More	**Less**	**More**	**Less**
Kaolack 1	Cowpeas, dry fish	Fresh fish	Fish	Less of everything until harvest
Kaolack 2	Beans	Fresh Fish	Fish	Beans
Kaolack 3	Dry fish and cowpea	Fresh fish, peanuts, flesh meat	Fresh fish and peanuts	Flesh meat
Bakel 1	Beans	Vegetables	Smoked fish, milk, fruit	Cereals
Bakel 2	Meat, fish		Beans	Meat and fish
Bakel 3	Vegetables	No meat or Fish	Smoked fish	No meat
Bakel 4	Beans, meat and smoked fish	Milk	Milk, smoked fish, occasional meat	

Matam 1	Dry fish, peanut, Senegalese beans, mung bean	Fresh fish, beef	Fresh and dry fish, peanut, beef	
Matam 2	Beans, dry fish, peanut		Beans, dry fish	
Matam 3	Beans, meat, dry fish	Milk	Meat, beans, fresh fish, milk, yogurt	
Matam 4	Dry fish, beans	Vegetables	Fresh fish, peanuts, yogurt, milk, beans, vegetables	

Table 13: Women's perception of seasonal effect on food access by focus group

The beginning of the rainy season was repeatedly mentioned by participants as the time when food access is the hardest. This hunger season occurs as the stores of cereals and beans are running out but the crops are not ready to be harvested yet.

"Access to food can be difficult between dry and rainy season. You've already eaten all your storage, vegetables and cereals are still growing, so you're not harvesting yet"

"During the hard season they run out of storage and have to go to weekly market."

Women in all focus groups presented the common strategy of decreasing specific food intake to attenuate the impact of food insecurity on the household. This coping mechanism focusing on decreasing the quality of the meal by having less nutrient rich food sources, but still having a consistent amount of rice or base cereal.

"One might prepare Mafe, a dish with white rice, oil, peanut sauce and meat, without peanuts. They don't reduce number of meals per day, just change composition of meal."

The most divisive topic was related to skipping meals. Some women reported skipping meals or snacks during the hardest time of the year while other women stated that they would never skip a meal.

"If needed, the child will get three meals and the parents will skip breakfast"

"They will skip dinner and just take their breakfast with milk to be satiated longer so they can eat lunch later and go to bed without eating dinner."

"Tradition is to not skip meals, quality decreases but quantity is there."

Whether it be decreasing meals or type of foods, there's a ubiquitous and unavoidable decrease of food intake throughout the year.

Impact and acceptance of Mung Bean

Feedback regarding the impact of mung bean was categorized into four minor themes, Intake, health, agriculture, and finance.

Intake*:* Most participants reported that mung bean was easy to cook, satiating, and good tasting for both adults and children, and often favored it over other legumes,

"Mung bean is easy to cook because you don't have to shell it like you have to with cowpea, so it's easier to prepare."

"Kids and adults both like it and use it. Eat mung bean for breakfast and dinner."

"If you eat it you can go a long time without being hungry."

Health: Mung bean is a nutrient dense bean that offers a good source of many nutrients such as protein, fiber, iron, folate. While health outcomes were not measured in comparison to consumption, many participants discussed perceived benefits in health associated with mung bean consumption. These benefits ranged from increased breastmilk production, increased energy, combating anemia, less constipation, less hunger and improved weight status for children.

"Every time she eats mung beans she feels energy in her body. Even if you are very tired and you eat mung bean, when you wake up you'll feel energized."

"She had a child that had clinically diagnosed anemia, they suggested she feed the child soup with mung bean and two days later he was feeling good."

"When they just eat it [mung bean] at dinner, when they wake up they don't feel as hungry."

Agriculture: Mung bean was selected by USAID as a crop to introduce in Senegal partially for its agriculturally compatibility to the Senegalese environment. The main conclusion that was repeated about Mung bean from an agricultural perspective was that it has a short harvest cycle. This means that the families who had mung bean could grow it quickly, eat it while other crops

were still growing, and then replant and harvest mung bean up to three times in one season for large yields.

"Mung bean is the first to grow and harvest in the rainy season, you can eat it while other crops are still growing."

"If you're hungry, you need something short in cycle, so they'll chose mung bean because you'll have it before other legumes."

Finance: The financial benefits mentioned in association with eating mung bean were also consistently mentioned throughout the groups. Rather than selling mung bean for profit, women often mentioned that consuming mung bean or mung bean leaves allowed them to save money on other foods such as rice, millet, moringa leaves, and the local Senegalese beans. Either they would save money on buying these foods or they would be able to make these foods last longer because they would typically eat mung bean in a meal without rice or millet. Women also commonly commented on increased volume in lactation, which allowed them to save money that would be spent on infant formula.

"Mung bean is very important in their food because they were using moringa to cook green leaf sauce but now they're using mung bean leaf, so they can have the sauce without buying the green leaf. This allows them to save money."

"Breastfeeding when eating mung bean, she says that when she eats mung bean her breasts are full of milk and she's saving money, because if you don't have milk in your breasts you have to buy formula for your infant."

Community Resources

The third major theme which emerged from participants was centered on a need for sustainable community resources, specifically the perceived community needs and current support systems. Many people mentioned receiving assistance from a governmental or international program while others expressed not having any outside support. In terms of perceived needs, a community garden with a fence and a source of water was consistently

mentioned. Many participants mentioned a need for training and education rather than money, so they could support themselves rather than relying on outside support. Multiple women also mentioned that it would be advantageous to own a processing machine such as a grinder to grind millet or peanuts for personal consumption or to sell.

> "Would like to have mung bean seed so they can give it to all women in the village or all village people to produce high quantity of mung bean because it's very good, nutritious, and helps to fight hunger."

> "Want something that is sustainable, want livestock for milk, meat, to sell and buy stuff they don't have…If you're just coming to give them a bag of rice, it will not be forever or sustainable."

Overall, the qualitative data revealed data saturation with three main themes including a combination of minor reoccurring themes. First, barriers and coping strategies related to food insecurity were expressed. Second, the perceived advantages of mung bean for agricultural production, health status, and financial resources were recognized. Finally, the current support systems were identified in comparison to perceived community and individual needs which were related to a desire for sustainable growth and education.

Chapter 5: Discussion

Impact of Mung Bean on Dietary Diversity Scores

This study tested the hypothesis that mung bean consumption will be associated with better nutritional adequacy and food security (as reflected by a higher dietary diversity score) among women and children in Senegal compared with non-mung bean consuming populations. The quantitative data did not find a significant difference between overall DDS of mung bean vs non-mung bean groups; however, there was a statistically significant increase in DDS between MB consuming women and both MB and non-MB children and between MB and non-MB consumers in Bakel. Due to the lack of statistically significant data between overall MB and non-MB consumer's DDS, we fail to reject the null hypothesis. Overall, dietary diversity was barely above the minimum recommended five out of 10 on the DDS scale at 5.83 and 5.62 DDS for mung bean and non-mung bean consumers, respectively. Although dietary diversity is not greatly increased, mung bean is accepted within the Senegalese population and can potentially contribute to improving the health of the household outside of increasing a DDS further above the minimum recommendation for nutritional adequacy.

Within this study, the impact of mung bean on dietary diversity has seemingly contrasting results between the quantitative and qualitative data. This contrast doesn't decrease the validity of the results, rather it creates a better picture to understand exactly how mung bean is impacting women and children in Senegal. The qualitative data suggested that there were positive health, financial, and agricultural impacts of mung bean consumption on the households. Data saturation (defined as the point in data collection and analysis when new information produces little or no change to the existing themes and codebook), occurred with these perceived positive impacts mentioned repeatedly and consistently.[63] Combined, this qualitative and quantitative

data reveals the potential gaps in the Senegalese women and children's diet that Mung bean may be filling.

Increased micronutrient intake

A 24-hour dietary recall would not reflect improvement of dietary diversity related to increased consumption of mung bean when it replaces consumption of another bean, adds to a daily intake that already has beans, prolongs use of other foods throughout the seasons, or is being consumed at a different time of year. For example, mung bean can be consumed in one day and provide a long term health, financial, and agriculture benefits, but not necessarily change the dietary diversity for the day if the benefit is related to delayed consumption of another crop during the hunger season.

Reported mung bean consumption for breakfast or dinner is an opportunity for increased protein and micronutrient consumption within the standard Senegalese intake. Typically an individual's breakfast is made up of coffee, bread, and maybe an oil based sauce or spread. Dinners are also typically lighter, with high rates of grain and milk consumption. Therefore, most of the daily intake of proteins and vegetables are consumed at lunch, which is traditionally the largest meal of the day. If an individual consumes mung bean for breakfast or dinner, it would provide a new opportunity to increase overall daily intake of protein, fiber, iron and essential micronutrients.

The data presented in **Table 9** and **Table 10** revealed that dark leafy greens, legumes and pulses, nuts and seeds were only consumed by $\geq$50% of the participants who scored a 7-10 DDS which was only 35% of the total women and children surveyed (n=67). Therefore, when mung bean is added to the intake of individuals consuming a diet at $\leq$ 6 DDS it is likely to be filling a potential gap in the diversity and nutritional adequacy of their diet.

Agricultural Resources

In addition to mung bean being advantageous for nutritional adequacy of the Senegalese diet, the short harvest cycle of dietary diversity makes it a useful crop during the hunger season. Within the individual survey, 66% of respondents claimed own production to be their 1st source of food. With a family that is relying on their own food production, mung bean is an extremely useful crop in the time when access to food is the hardest. Mung bean was repeatedly reported to be one of the first crops for harvest during the rainy season and can be replanted and harvested up to three times in one season. Thus, mung bean can improve dietary diversity within the hunger season when most crops are yet to be harvested and storage is limited.

Use of mung bean and mung bean leaves in this time also allows for more money to be spent on other foods to diversify the plate. Economic literature supports the fundamental relationship between crop diversification and improved economy in agrarian based economies.[64] Agricultural diversification through crops can impact household dietary diversity by improving household crop consumption and/or through sale of the crops that could affect household income and food purchasing options.[64] Although many families did not mention it, the potential to grow large quantities and sell mung bean is also a possibility for financial gain and furthermore improved dietary diversity through greater food purchasing options. Crop diversification therefore has a potential positive health impact, but has had varying effects on nutrition in previous research and is not consistently correlated to improving household food intake.[64,65] Coupling agriculture based programs with nutrition and health education is always important as families could sell all their mung bean in order to buy high quantities of cheaper less nutritious staple crops such as rice and millet. Thus, if consumed rather than sold, mung bean could serve as a key resource to improve the financial stability of households to therefore diminishing the use of coping mechanisms, such as decreasing quality or quantity of food, during the hard season.

Policy Implications

Although the results do not reflect a quantifiable benefit to consuming mung bean, the qualitative benefits show how mung bean consumption impacts the Senegalese women's perceived agricultural, health, and financial benefits. These benefits show how impactful availability of one crop can be on sufficient dietary intake of diverse foods, overall health status, and household income. Considering the government's priority to diminish the rate of malnutrition and undernourishment amongst the Senegalese population, providing support or resources for growing mung bean could be extremely advantageous. A review of mung bean's impact on Asian economic growth revealed that seed policy and price policy can play a crucial roles in mung bean growth and sales.[66] Lack of quality seeds in sufficient quantity at a reasonable price is a major barrier for mung bean growth amongst the general population.[66] The Senegalese government policies could address this by encouraging and promoting transnational and national seed companies to engage in mung bean seed production and distribution. In the Asian countries reviewed, farmers were also concerned with fluctuating prices for mung bean and national guidelines for mung bean prices encouraged farmers to include mung bean in their cropping systems.[66] Recognizing the significant relationship between DDS and locality can be helpful in recognizing specific localities that need more assistance with increasing dietary diversity and furthermore nutritional adequacy of their diet. Setting a standard price could be a potential option cost effective option for improving mung bean growth sales once seeds are move available to the general population.

Study Limitations and Strengths

Dietary diversity assessments have been scrutinized as being an ideal measurement tool to evaluate nutrient status. Bukania et al. (2014) concluded that child nutritional status was not

dependent on dietary diversity for a sample of children in Kenya.[67] Bukania did recognize that this dietary diversity data was only collected for one recall and that the survey was conducted during a time of plenty, thus seasonal variations may have influenced the association of dietary diversity and nutritional status. For example, 62.3% of the women had below minimum levels of dietary diversity (DDS< 5) and less than 8% had high levels (DDS > 7). This finding could be related to the timing of the survey that was immediately after the harvest season (May/June). Consequently, dietary diversity is a valuable assessment tool to compare the nutrition status of individuals at the same time of year, but could be insignificant and faulty if compared at different seasons. The study was design to the two groups (mung bean vs non-mung bean consumers) within the same season to avoid the effect of seasonal difference on DDS.

Another potential limitation of this study is related to the nature of a 24-hour recall time period. The 24-hour recall is a limited in tracking the day-to-day variability that occurs throughout a week of intake which influences overall nutritional adequacy of a diet. However most individuals cannot remember all they consumed for the past week or even past three days. Therefore, a 24-hour recall has been repeatedly vetted as a reliable time period for dietary diversity assessments and is recognized to be potentially limited but sufficient.[48] Although dietary diversity might be improved over the span of a multi-day period, the daily average would likely remain the same. Therefore, a 24-hour dietary recall may not be the most appropriate measurement tool to reflect the effect of a specific crop on the overall dietary diversity.

The advantage of the 24-hour recall is that it has minimal burden or requirements for the participants but it is possible that participants had a participant bias with their dietary recall.[68] To diminish any recall bias, the translator was trained on appropriate probing and the researcher would ask to double check on specific food groups that were missing in the recall as instructed in

the 2013 *Guidelines for Measuring Household and Individual Dietary Diversity* from the United Nations.[69] In effort to diminish the chance of someone over reporting their mung bean consumption, causing them to inappropriately be placed in the mung bean consuming group, we did not ask anything about mung bean consumption till the end of the dietary diversity survey. This way, participants knew that they were involved in a research study regarding what they eat but did not know that we were specifically interested in mung bean consumption. Bias could also present within focus group responses as participants could have felt that if they expressed greater success and satisfaction with mung bean that they would receive more mung bean seed from USAID-ERA/Yaajeende.

Future Directions

This dataset contributes to the limited information regarding the dietary diversity of women and children in Senegal. For crop specific nutrition evaluation studies, or general dietary diversity studies, it would be advantageous to conduct dietary diversity surveys during other seasons of the year to compare DDS. Due to the annual bimodal rainy and dry season of Senegal, dietary diversity may be significantly different in the middle of the rainy season or during the hunger season. One consideration to take in for future studies in different seasons would be fasting associated with the predominant religion, Islam, which may have on individual's intake during certain times of the year.

Nationally, the Senegalese government may have more information and concrete reason to support the mung bean program based on the health, agricultural, and financial benefits discovered within the qualitative data. Internationally, this data should be used by USAID and other international development organizations for understanding one way to assess the nutrition impact of agriculture focused programs. Additionally, the information regarding the women and

children's average dietary diversity, whether mung bean consumers or not, should be an encouragement to continue agriculture and nutrition focused programs to improve dietary diversity and food security in Senegal.

Based on the findings of this study, future research could develop standard assessment protocols to determine the multi-faceted/multi-component benefits of introducing mung bean as a staple crop to women in Senegal. Based on the strengths and weaknesses identified about this study, there is a need for an approved and modifiable mixed method research that could be used across the world for evaluation of other program's impact.

Conclusion

The findings in this study found that there was a statically significant difference between DDS of mung bean consuming women and mung bean consuming children ($p=.03$) as well as mung bean consuming women and non-mung bean consuming children ($p=.01$). There was also a statically significant relationship between the localities of Matam and Bakel DDS ($p=.002$) as well as between mung bean and non-mung bean consumers in Bakel ($p=.001$). However, there was not a statistically significant difference between the overall average DDS of mung bean and non-mung bean consuming groups of women and children in Senegal as hypothesized. Therefore based on the lack of difference between mung bean and non-mung bean consumers DDS we fail to reject the null hypothesis. However, the qualitative data in this study revealed the multidimensional benefits of mung bean in women's health status, finances, and agricultural production. The qualitative data also identified the surveyed Senegalese women's perceived need for sustainable community resources in the form of skills focused education, access to water, community gardens, and processing machinery. The 24-hour dietary recall displays the lacking

foods within low, medium and high dietary diversity groups and that nuts and seeds, legumes and pulses, and dark leafy greens are the last food groups added in at the highest DDS (DDS= 7-10) This data could provide a platform for individualized and geographically strategic nutrition education regarding food groups based on dietary diversity scores. This study also serves as an example of the usefulness of mixed method research and how together quantitative and qualitative data provided insight to the impact of mung bean that would not otherwise be understood. Therefore, the methods and findings from this research should be extended and utilized for future research and policy concerning DDS of women and children in developing countries, nutrition focused impact evaluation, and Senegal specific dietary diversity information.

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Appendix A: Verbal Consent From

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Verbal Consent

Title of Project: The Effect of Mung Bean on Dietary Diversity of Women and Children in Senegal
Investigators: Dr. Ozzie Abaye and Taylor Vashro

The purpose of this study is to assess the impact of mung bean consumption on dietary diversity for women and children in Senegal.

- In agreeing to participate, you will be asked to complete a questionnaire on what you and your child eat and how often, what you believe about food, and any plants or crops you currently grow.

This research has minimal risks to participants.

There is no direct benefit or promise of benefit to participants in the study.
The research will also help in the development of programs and resources to address food access in Senegal.

To help maintain confidentiality your name will be assigned a code when any data is transcribed and coded.
We will carefully maintain procedures to protect confidentiality. At no time will the researcher release any identify information to anyone other than individuals working on the project.

Note: In some situations it may be necessary for an investigator to break confidentiality. If a researcher has reason to suspect that a child is abused or neglected, or that a person poses a threat of harm to others or him/herself, the researcher is required by Virginia State law to notify the appropriate authorities.

There is no compensation for this study.

You are free to withdraw from the study at any time.

Please answer the following question with a YES or NO.

I have understood this information. I have had all my questions answered. I agree to participate.

If YES: Great. Let's begin if this is still a good time for you.

If NO: Okay, that's fine. Thank you for your time today and have wonderful week. Thank you so much

APPENDIX B: DIETARY DIVERSITY SURVEY

Comprehensive Food Questionnaire and Interview Protocol

Participant Code: _____

Demographic Questions

1	In what month and year were you born?	Month _____ Year _____
2	Please tell me how old you are. What was your age at your last birthday?	Age:
3	Do you have a child under the age of 10 years?	Yes = 1 No = 0
4	Is this child a male or female? *If multiple children under 10, ask respondent to choose one child to answer for.*	Male = 1 Female = 2
5	In what month and year was the child born?	Month _____ Year _____
6	Please tell me how old the child is. What was he/her age at their last birthday?	Age:

*If child is 3 years and older, have the mother complete the Dietary Diversity Questionnaire for her child.
*If the child is 0-23 months, complete the Child Dietary Diversity Quetsionnaire.

Dietary Diversity Questionnaire – *Woman*

Was yesterday a celebration where you ate special foods or where you ate more, or less than usual?

YES or NO

Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.

Interviewer: Write down all foods and drinks mentioned. When mixed dishes are mentioned, ask for all items included. When the respondent has finished, probe for meals and snacks not mentioned.

Breakfast	Snack	Lunch	Snack	Dinner	Snack

When recall is complete, fill in the food groups based on the information recorded above. Underline the corresponding foods in the list under the appropriate food group and write "1" in the column next to the food group if at least one food in this group has been underlined.

If the food is not listed in any group, write in the the margin and discuss with the project coordinator later. For any food groups not mentioned, ask the respondent if a food item from this group was consumed. Write "0" in the right hand column of the questionnaire when it is certain that no foods in that group were eaten.

	Food Group	Examples	*Yes = 1* No = 0
1	CEREALS	corn/maize, rice, wheat or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)	
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside	
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as amaranth, cassava leaves*	
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) + *other locally available vegetables*	

6	VITAMIN A RICH FRUITS	ripe mango, ripe papaya, and 100% fruit juice made from these + *other locally available vitamin A rich fruits*	
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these	
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg	
11	FISH AND SEAFOOD	fresh or dried fish or shellfish	
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. peanut butter)	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OIL AND FATS	Oil, fats or butter added to food or used for cooking	

Dietary Diversity Questionnaire – ***Child (3 years or older)*** *If child is younger than this, skip to the next section.*

Please describe the foods (meals and snacks) that your child ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.

Interviewer: Write down all foods and drinks mentioned. When mixed dishes are mentioned, ask for all items included. When the respondent has finished, probe for meals and snacks not mentioned.

Breakfast	Snack	Lunch	Snack	Dinner	Snack

When recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

	Food Group	Examples	*Yes = 1* No = 0
1	CEREALS	corn/maize, rice, wheat or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)	
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside	
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as amaranth, cassava leaves*	
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) + *other locally available vegetables*	
6	VITAMIN A RICH FRUITS	ripe mango, ripe papaya, and 100% fruit juice made from these + *other locally available vitamin A rich fruits*	
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these	
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg	
11	FISH AND SEAFOOD	fresh or dried fish or shellfish	
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. peanut butter)	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OILS AND FATS	Any oil, fats, or butter or foods made with these	

<u>Infant Feeding Practices Questionnaire</u> – *(Child 0-23 months)*

1	Did you ever breastfeed your child? If YES, for how many months? _____	1 = Yes 0 = No (Skip to Question 3)	
2	How long after birth did you first put your child to the breast?	000 = Immediately 1 = Hours (_____) 0 = Days (_____)	
3	Was your child breastfed yesterday during the day or at night?	1 = Yes 0 = No 8 = Don't Know	
4	Now I would like to ask you about some medicines and vitamins that are sometimes given to infants. Was your child given any vitamin drops or other medicines as drops yesterday during the day or at night?	1 = Yes 0 = No 8 = Don't Know	

*Read the questions below. Read the list of liquids one by one and mark **yes or no**. After you have completed the list, continue by asking "times" where the respondent replied 'yes' for questions:*

	Next I would like to ask you about some liquids that your child may have had yesterday during the day or night. Did your child have any_____?	Yes	No	DK	How many times yesterday during the day or night did your child consume…?
6	Plain Water	1	0	8	
7	Infant formula such as [insert local example]	1	0	8	Times: _____
8	Milk such as tinned, powdered, or fresh animal milk?	1	0	8	Times: _____
9	Juice or juice drinks?	1	0	8	
10	Clear broth?	1	0	8	
11	Yogurt?	1	0	8	Times: _____
12	Thin porridge?	1	0	8	
13	Any other liquids?	1	0	8	

Please describe the foods (meals and snacks) that your child ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.

Interviewer: Write down all foods and drinks mentioned. When mixed dishes are mentioned, ask for all items included. When the respondent has finished, probe for meals and snacks not mentioned.

Breakfast	Snack	Lunch	Snack	Dinner	Snack

When recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

Question Number	Food Group	Examples	1 = Yes 0 = No
1	CEREALS	corn/maize, rice, wheat or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)	
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots .	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + *other locally available vitamin A rich vegetables*	
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as amaranth, cassava leaves*	
5	OTHER VEGETABLES	other fruits and vegetables (e.g. tomato , onion, eggplant, wild fruits) + *other locally available vegetables*	
6	VITAMIN A RICH FRUITS	ripe mango, , ripe papaya, and 100% fruit juice made from these + *other locally available vitamin A rich fruits*	
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these	
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods	

9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg	
11	FISH AND SEAFOOD	fresh or dried fish or shellfish	
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. peanut butter)	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OILS AND FATS	Any oil, fats, or butter or foods made with these	
Check 1-14 Answers		If all NO (Proceed to Question 15) If at least one YES (Skip to Question 16)	
15	Did your child eat any solid, semi-solid, or soft foods yesterday during the day or night?	If Yes, list those foods here:	Yes = 1 No = 0 (Skip to Q 18)
16	How many times did your child eat solid, semi-solid, or soft foods (other than liquids) yesterday during the day or night?		Number of Times: _____
17	Did your child drink anything from a bottle with a nipple yesterday during the day or night?		Yes = 1 No = 0

Protein and mung bean specific questions:

1.	Do you consume lentils or beans in harvest season?	Yes or No
2.	If yes, how many times in the harvest season did you consumed lentils or beans?	Number of times: _____
3.	Do you consume Mung bean in the harvest season?	Yes or No
4.	If yes, how many times in the harvest season did you consume mung bean?	Number of Times: _____
5.	Do you consume animal meat in the harvest season?	Yes or No
6.	If yes, how many times in the harvest season did you consume animal meat?	Number of Times: _____
7.	Did you consume eggs in the harvest season?	Yes or No

8.	If yes, how many times in the harvest season did you consume eggs?	Number of Times: _____

Food Source

1.	Could you please detail your primary source for obtaining food?	Own Production, gathering, hunting, fishing =1 Purchased = 2 Borrowed, bartered, exchanged for labour, gift from friends or relatives = 3 Food aid = 4 Other =5 _____
2.	What are other sources of food in addition to the primary source already selected?	Own Production, gathering, hunting, fishing =1 Purchased = 2 Borrowed, bartered, exchanged for labour, gift from friends or relatives = 3 Food aid = 4 Other =5 _____

APPENDIX C: FOCUS GROUP QUESTIONS

1. What is your favorite food to eat?
2. How does your access to food change throughout the year?
   -During the dry and wet season what are your main sources of protein?
3. What do you or your household do if you don't have enough food?
4. What current activities or support systems exist in the community that help you obtain food?
5. What else would you like to see help people obtain food?
6. How has mung bean impacted you or your household's food?
7. When you have mung bean, do you prefer it to other legumes?