

THE IMPACT OF URBAN AGRICULTURE ON MALNUTRITION IN AFRICA

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Grace Powell

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Grace Powell

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Abstract

Africa currently has the highest number of people who are malnourished. This has to do with the growing inequalities in the country and the inadequate food supply. The upper class has access to most of the resources, and people in Africa are living in extreme poverty, 74 cents a day. This study seeks to back up the claim that urban agriculture does have a relationship with food insecurity. It specifically looks at the relationships between the prevalence of undernourished, average dietary energy supply adequacy, average value of food production, percentage of arable land equipped for irrigation, access to improved water source, access to improved sanitation and the value of agricultural production. Using data from the Food and Agriculture Organization in order to understand the impacts urban agriculture can have on food insecurity in Africa.

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED
UNAUTHORIZED AID ON THIS THESIS

A handwritten signature in cursive script, appearing to read "Grace Powell".

Grace Powell

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Introduction

Urban agriculture is the production of food within cities and towns (Zezza & Tasciotti, 2017). It is a recent phenomenon that plays an important role in ensuring food supply for urban residences. Urban agriculture has gained popularity all over the world because of the positive impacts it can have on the livelihoods of lower income households. Populations among developing countries will continue to increase and more people will migrate from rural to urban areas. Urbanization leads to changes in the demand for agricultural products and bring about major challenges for urban and rural food security (Satterthwaite, McGranahan & Tacoli, 2010). According to the Food and Agriculture Organization (FAO), food security is defined as having a reliable source of nutritious food, and the indicators can be broken down into four categories: availability, access, stability and utilization. Availability is the average dietary energy supply, average value of food production and the average protein supply. Access refers to GDP per capita, prevalence of undernourishment. Stability is the per capita food variability, and utilization is the access to improved water sources and to improved sanitation facilities (FAO, 2017). There is an issue of malnutrition around the world. Most people are failing to obtain the necessary amount of food to sustain their daily life. This study will analyze the relationship between malnutrition and urban agriculture.

Malnutrition contributes to 3.1 million under-five child deaths annually (United Nations International Children's Emergency Fund, 1995). Urban agriculture can have an impact on the nutrition of children and of adults. Malnutrition is defined as missing vital vitamins and nutrients needed to be living a healthy life. It is important to have a varied diet that includes a lot of vegetables and fruit. However, lower income families are not able to

afford the healthier food items. Vegetables and fruit prices have been increasing consistently. Current food policies support inexpensive mass processed meals because they are a high volume production and provide more profit per unit for the food industry (Satterthwaite, McGranahan & Tacoli, 2010). In Africa, profits from major retailers are too small and large supermarkets are not available in many parts of Africa. As a result, hundreds of millions of urban dwellers rely on urban agriculture for their food production (Satterthwaite, McGranahan & Tacoli, 2010). In order to ensure that everyone has access to nutritious food there needs to be more available and more affordable resources. Urban agriculture can provide more control over the quality of the produce and a more reliable supply of vegetables. It can lead to an increase in household food security, better maternal and childcare and an access to a healthier environment. Urban agriculture has been the main solution to decrease prevalence of undernourished adults and children (De Bon, Parrot & Moustier, 2010).

Not a lot of study as been done on analyzing the relationship between urban agriculture and malnutrition. This study seeks to determine whether there is a strong correlation between the four indicators of food insecurity and malnutrition in Africa. This is a relatively new topic and has been readily gaining more attention by policy makers. Learning more about the impact of urban agriculture can be very beneficial when the population among cities continues to increase. Poverty is a huge epidemic throughout the world and urban agriculture can help to end hunger globally. Urban agriculture will be seen as a necessity and will continue to gain attention worldwide. This study focuses on the impacts of urban agriculture in Africa. The next sections are on relevant literature, the theory and model, and data and results that provide evidence to the research question.

Literature Review

Food insecurity has been a concern throughout history and a really big problem today. It is an issue that needs to be a top priority for all countries. Households spend the majority of their income on food. The Food and Agriculture Organization of the United Nations found that 800 million people worldwide grow vegetables and fruits within a city (United Nations Development Program, 1996). Urban agriculture takes place in unused public land. This includes roadsides, riverbanks, railroads and unused parking lots. Typically, there are three types of people that rely on urban agriculture. People who are really poor that produce enough for their needs, those who rely on urban agriculture during times of crises and small-scale entrepreneurs that sell it and do not keep the produce for their own consumption (Crush & Frayne, 2010). The Agriculture sector has been so important for economic growth within developing countries. In Africa, the agriculture sector is known to be two or four times more effective than the other sectors in the economy. In Sub-Saharan Africa, food production needs to increase by sixty percent in order to sustain high levels of economic growth and urbanization. In Kenya, Egypt, Mali and Tanzania, poor urban households will spend 60 percent or more of their incomes on food (Crush & Frayne, 2010).

The Importance of Urban Agriculture

Urbanization has been increasing worldwide and there has been a decline in the ratio between food producers and food consumers. Urbanization refers to the increase of the population living in urban areas (Satterthwaite, McGranahan & Tacoli, 2010). The United Nations predicts that the urban population will increase by more than a billion between 2010 and 2025. There is a lot of concern on whether the demand for agriculture can be sustained. The production of perishables and small livestock is essential for city life. The 21st century

has experienced the greatest increase in the population size. With an increase in population come problems of poverty, employment and a lack of food supply. In Africa, more than half of the population now live in urban areas and it will go up to 60 percent by 2020 (Lynch, Kenny, Binns, James, Emmanuel, 2001). Cities will continue to increase in size and more people will migrate from rural areas to urban areas. Forty to forty five percent of the lower income household in Africa will be concentrated in towns and cities. Agriculture still provides employment for the majority of the population (World Bank, 2017). Urban agriculture can provide jobs when there is a lack of options in the industrial and service sectors (De Bon, Parrot & Moustier, 2010).

Urbanization can be a sign of economic growth. However, Africa has seen a consistent increase in the urban population with little to no economic growth. As a result, Africa is currently experiencing a food crisis. At the start of Africa's independence, all 45 states were self-sufficient in food. However, food production in Africa has been growing at the half the rate of growth of the population in Africa. Africa failed to develop economic systems that generate sufficient income for the poor and they cannot obtain an adequate diet. Urban dwellers in Africa have income so low that it is hard to meet basic nutritional needs (Satterthwaite, McGranahan & Tacoli, 2010). In the past food policies had failed to pay any attention to ensuring that everyone had access to "nutritionally vulnerable" food groups. Now many African nations have come up with food security plans in order to solve their food insecurity problem (Carl, Eicher & Staatz.1998).

The African Food Security Network conducted a survey on 11 cities in Africa: Biantyre, Cape Town, Gaborne, Harare, Johannesburg, Zusage, Maputa, Mazin, Maer, Msundazi, and Winhoek (Crush & Frayne, 2010). The survey asked where the households

normally obtain their food and how much of the household income comes from urban farm products. The survey found that twenty two percent of households grow their own food and that urban agriculture plays a more valuable role in the poorer African provinces. In Harare, 40 percent of lower income households rely on homegrown food at least once a week. Across the 11 cities, twenty two percent of households engage in some form of food production. Seventy seven percent of the people engaged in urban agriculture in these African Cities and food insecure (Crush & Frayne, 2010). According to the UNDP, 80% of families in Libreville (Gabon), 68% of urban dwellers in six Tanzanian cities, 45% in Lusaka (Zambia), 37% in Maputo (Mozambique), 36% in Ouagadougou (Burkina Faso) and 35% in Yaounde are involved in urban agriculture (De Bon, Parrot & Moustier, 2010). Therefore, the majority of their income came from urban farming.

Between 1972 and 1980, in Kampala, the largest city in Uganda, the wage income dropped by eighty percent (Maxwell, 1996). However, there was no evidence of malnutrition during this economic crisis. That had to do with the use of urban agriculture in the city. In order to survive, people had to figure out more creative ways to have a sustainable food source. People could not afford high priced food from the super market. Homegrown food was the solution to the decrease in wage income. It was more affordable and a more secure source of food. Urban agriculture can improve nutrition within children by improving household food security, dietary intake and the increased ability of mothers to care for their children (Maxwell, 1996). Urban agriculture is already improving the lives of poor urban dwellers in parts of Africa. Therefore, urban agriculture needs to be considered a valuable solution to problems of malnutrition in developing countries.

Past Evidence

Agriculture goes back to the Ancient Mayan civilization (Smit, Nasr & Ratta, 2011). Machu Picchu, the “lost” city in Peru, had an irrigation system and aqua terra systems. People in Peru were always walking distance to a food source. Indonesia has an urban agriculture tradition as old as China. Land and water crops are formed in former wetlands, and today, Indonesia uses Dutch hydroponics; Chinese raised beds and Malay fish cages (Smit, Nasr & Ratta, 2011). During economic crises, gardeners and farmers use up more land to help the poor. By 2030, food production systems will implement agricultural practices that will increase productivity in order to meet the goal of zero people hungry (FAO, 2017). It is important for government officials to get involved in order to implement policies. Urban agriculture has been around for many centuries. It can be the solution to our malnutrition problem.

In Havana, Cuba available space has been used for urban agriculture. Cuba uses hydroponics and permaculture methods to provide fresher food for the urban dwellers. They also manage wastewater for their food production. In St. Petersburg, Russia they have a rooftop gardening club. One rooftop produces 27 kg of radishes, 15 kg of onions and 9 kg of parsley. In Australia, there is small scale farming within the city of Brisbane. In 1997, Australia unused land was transformed into their first community garden. It has now celebrates its 40th anniversary (Levenston, 2017).

Wealth Gap in Africa

There are 160,000 people that are worth more than a million dollars in Africa. The number of poor people is increasing by 411.3 million in 2010 to 415.8 million in 2011 (Sedghi & Anderson, 2015). Extreme poverty continues to remain high throughout Africa.

South Africa has one of the highest income inequalities in the world and the highest number of individuals worth more than a million dollars. The top ten percent of the population owns ninety five percent of all the assets. That means the poorest individuals only earn about ten percent of the country's income. This high inequality can cause extreme political and economic consequences (Orthofer, 2016). Sub-Saharan Africa has the highest poverty levels and it has been relatively unchanged even though it has seen high economic growth over the past fifteen years. The reason for the current wealth gap has to do with Africa's current economic structure. The highest income is generated worker for large corporations. However, the number of jobs available at corporations is limited. Instead, the majority of Africa's population works in the informal sector where their income is a lot smaller. The United Nations Development Program conducted a study to figure out the best policy programs to address this inequality. The study found that by improving the distribution of human capital, increasing direct taxation, and by increasing productivity in the agricultural sector can lead to a reduction of the wealth gap in Africa (Bal, Cathro, & Bel, n.d).

Concerns About Urban Agriculture

However, there are a lot of disputes over the benefits of urban agriculture. There are mixed opinions on the effectiveness it actually has on people's livelihoods. Some critics feel that the benefits are exaggerated and that it really does not have as big of an impact as people claim. People perceive agriculture to have low economic benefits. As a result, this leads not having any support from Africa's legislation. Leaders see urban agriculture as a step backwards and will implement policies that would cripple the development. As a result, there is a loss of land available for agriculture because of policy changes (Jac, Joe & Annu, 2011). This is a problem because millions of urban dwellers rely on urban agriculture for part of

their food consumption. Malnutrition may be a result of political choices rather than lack of resources (Satterthwaite, McGranahan & Tacoli, 2010). There is also concern that urban agriculture will increase the amount of pollution in the cities. Urban agriculture uses ninety percent less water than conventional agriculture and recycles their resources. Today, vegetables travel 2,000 km to get to a grocery store. This is really inefficient and is the part of the reason food contributes to one third of our environmental footprint (Gause, 2017). However, urban agriculture has a lot of beneficial attributes that are often overlooked. Urban agriculture can turn urban waste into a more productive resource. Farmers can also use wastewater to irrigate the farms. Urban agriculture can also decrease run off from a flood, since farms can be constructed on flood plains (Magnussan, Bergmam, Katunguka-Burakilhaya, 2014).

Summary

More than fifty percent of the world's population lives in urban areas. This percentage will only increase as more people move to urban areas because of better economic opportunities. The total areas used for urban farming now exceed land cultivated for rural farming. For example, in Sub-Saharan Africa the production of maize was smaller than what was being cultivated in urban areas. In Ghana, 10 percent of household water is recycled back for the urban farms (Kinver, 2014). Urban sprawl is happening quickly and in order to keep up with the pace we need to integrate agriculture into the cities. The amount of food supplied worldwide needs to double in order to keep up with the growing population.

The central role of urban agriculture is in the supply of perishable goods like vegetables. It is expensive to buy imported fresh vegetables and hard to keep fresh for long. Everyone should have the access to healthy food. With urban agriculture, there is a more

direct producer involvement in retail sales when you are able to buy your vegetables from a local source. Dependency on an outside source for food is risky because of how vulnerable the country would be to natural disasters. Urban agriculture creates more job opportunities for people who move for more rural parts of the world. There is also easier quality control because of the proximity and farmers can earn a more regular cash flow. Vegetables can take as little as a few weeks to grow so cities are able to consistently have a supply of fresh produce. We should be growing food where the majority of the people live. In 2025, 70 percent of the world will be living in urban areas (Gause, 2017). It is an important movement of this century, and the contribution of urban agriculture to food security has benefited many economies all over the world. Urban agriculture has emerged as a solution to food insecurity problems in developing countries.

Theory and Methodology

The theory states that if countries engage in urban agriculture then the number of adults and children who are undernourished will decrease. However, most studies do not have a lot of data to back up this theory. It is important to conduct a study that has quantitative evidence to show that there is a relationship between urban agriculture and malnutrition. To fully understand that relationship, this analysis uses data from the Food and Agriculture Organization and the World Bank. The data consists of the population, the income from agriculture and food insecurity indicators in Africa.

Africa was chosen for this study because of its historic background in agriculture. Africa's urban growth rate is almost double the world average (Beach, 2013). Therefore, Africa sees urban agriculture as a "livelihood strategy", and urban residences are continuing to embrace their agricultural heritage through urban agriculture (Gordon & Lee-Smith, n.d). The main problem Africa faces is the lack of a sustainable food source for the poorer community. Urban agriculture resolves this problem by providing access to a wide variety of nutritious food as well as providing people with a more practical income. Cameroon, a country in central Africa, is considered the "garden city". The income generated from selling vegetables in Cameroon is higher than having a minimum wage job (Musa, 1996). The urban population uses agriculture as a way to decrease the cost of food for their families. As a result, in Zambia, half of the urban dwellers engage in urban agriculture (Beach, 2013).

The first set of data represents the population in South Africa and Sub-Saharan Africa. Table 1 and 2 show the population growth in South Africa and in Sub-Saharan Africa from 2009 to 2015. The number of women in South Africa has increased by 25,581,248 to 27,999,778 in the past seven years. In Sub-Saharan Africa, the population has increased by

millions of men and women each year. It is predicted that by 2060, Africa will have a population of 2.8 billion people (World Bank, 2017). I chose to look at population growth because it can cause a lot of food security problems. The population will continue to increase so in order to have a reliable food source, food production needs to increase at the same rate as the population.

Table 1: Population in South Africa

Year	Country	Population (Female)	Population (Male)
2009	South Africa	25,581,248	24,674,565
2010	South Africa	25,947,418	25,032,015
2011	South Africa	26,327,129	25,402,217
2012	South Africa	26,721,034	25,785,481
2013	South Africa	27,130,274	26,181,681
2014	South Africa	27,556,160	26,590,575
2015	South Africa	27,999,778	27,012,199

Source: World Bank

Table 2: Population in Sub-Saharan Africa

Year	Country	Population (Female)	Population (Male)
2009	Sub-Saharan Africa	428,435,012	424,803,640
2010	Sub-Saharan Africa	440,295,943	436,727,194
2011	Sub-Saharan Africa	452,461,294	448,994,462
2012	Sub-Saharan Africa	464,939,085	461,609,092
2013	Sub-Saharan Africa	477,724,704	474,553,927
2014	Sub-Saharan Africa	490,815,839	487,809,243
2015	Sub-Saharan Africa	504,210,701	501,360,100

Source: World Bank

To understand the magnitude of urban agriculture, it is important to see the statistics that show the impact urban agriculture can have on the number of people employed in Africa. Employment is one of the driving forces behind economic growth. Table 3 shows the percent of male and female employed in agriculture, in the industry sector and the service sector of the economy South Africa, Algeria, Ethiopia, Namibia, Tanzania, Uganda and Zimbabwe (World Bank, 2017). In Tanzania, Uganda, and Zimbabwe the majority of the men and women are employed in the agriculture sector. Specifically, in Zimbabwe, 71.6 percent of women are employed in agriculture. While only 2.2 percent of women are employed in the industry sector and 26.1 percent in the service sector of the economy. Agriculture plays an even more substantial role in Uganda where 66.5 percent of the men and 76.7 percent of the women are employed in agriculture. As a result, Tanzania, Uganda and Zimbabwe rely on urban agriculture for the employment of the majority of their population and agriculture is actively practiced in those countries.

Table 3: Percent of Employed in Agriculture, industry and Service Sector

Country	% Employed in Agriculture (Men)	% Employed in Agriculture (Women)	% Employed in Industry (Men)	% Employed in Industry (Men)	% Employed in Service (Men)	% Employed in Service (Women)
South Africa	6.6	4.3	33.3	11.7	60.1	84
Algeria	9.9	3.1	32.3	21.4	28.3	11.7
Ethiopia	10.3	6.6	28.7	18.3	61	75.2
Namibia	31.9	30.9	23.6	5.3	94.6	63.8
Tanzania	65.3	70.8	9.3	3.1	25.4	26
Uganda	66.5	76.7	10.5	3.6	22.8	19.3
Zimbabwe	62.8	71.8	12.6	2.2	24.6	26.1

Source: World Bank

Modifications

In order to see the correlation between food security and agriculture, this study is analyzing data on Africa from the Food and Agriculture Organization (FAO, 2016). Certain variables are specifically used to represent agriculture and to represent indicators of malnutrition. Agriculture was defined as the value of food production, percentage of arable land equipped for irrigation, value of food imports over total of merchandize exports, and improved water source and sanitation. Malnutrition was defined as the prevalence of undernourished; the number of people malnourished in Africa and the average dietary energy supply.

The dependent variables are the prevalence of undernourishment in the country and the number of people undernourished. The independent variables are the average dietary energy supply, average value of food production, percentage of arable land equipped for irrigation, value of food imports over total merchandise exports, access to improved water sources, access to improved sanitation facilities, value of agricultural production. The data is collected between the years 2000 and 2016 and the data is calculated in percent averages. I am using the year 2000 as the base and looking at how the variables have changed over those sixteen years. I will be using data from the years 2000 to 2016. The model will show the impact of the independent variables on the dependent variables by conducting an OLS regression. I am running a regression analysis since I believe the independent variables will predict the prevalence of undernourishment and the number of people malnourished in Africa. This model seeks to find results that would back up the claim that urban agriculture does have a relationship with food insecurity. I expect the data to show a strong relationship between malnutrition and urban agriculture.

The model: Prevalence of undernourished (%) = $B_0 + B_1 \text{adf} + B_2 \text{vfp} + B_3 \text{pal} + B_4 \text{sod} + B_5 \text{iws} + B_6 \text{iwsan} + u$

The prevalence of undernourished = the percentage of people malnourished in Africa from 2000-2016.

Adf= average dietary energy supply adequacy

Vfp= Average value of food production

Pal= Percentage of arable land equipped for irrigation

Sod= Share of Diet from cereals, Roots and Tubers

Iws= Access to improved water sources

Iwsan= Access to improved sanitation facilities

Urban agriculture is widely used throughout Africa. Africa relies on agriculture for a huge part of their economy. With the right policies, Africa can achieve economic growth. Their emphasis now should be on maintaining childhood health and making the right investment to better the poorer community. Urban agriculture can provide poorer households with a more reliable income and sustainable food source. In 2008, Africa suffered an economic crisis and relied on urban agriculture to overcome the economic loss. Imported goods can be very costly and vulnerable to economic crisis or a natural disaster (Gordon & Lee-Smith, n.d). Although, there are a lot of other factors that go into food insecurity, urban agriculture is a step in the right direction to finding sustainable solutions to the problem of malnourished adults and children in Africa.

Analysis and Results

To understand the relationship between poverty and urban agriculture, this paper evaluates a simple regression to show that poverty can depend on the five variables: the share of dietary energy supply derived from cereals, roots and tubers (%), average dietary protein supply (g/capita/day), percentage of arable land equipped for irrigation, access to improved water sources (%), and access to improved sanitation facilities. The hypothesis states that the regression analysis will show there is a strong relationship between the number of people undernourished and the independent variables stated above.

There are many different ways to measure food insecurity. The data was found from the Food and Agriculture Organization database. FAO measures food insecurity by collecting data on dietary diversity and food frequency as well as people's consumption behaviors. The data is analyzed on a country level from the years 2000 to 2014¹. The variables are taken from the list of food insecurity indicators and fall under the availability, stability and utilization sub topics, and it is considered a panel dataset. The data specifically look at the impacts of malnutrition in thirteen countries in Africa. This analysis will help better understand the causes of malnutrition in order to understand how to meet the World Bank's goal of halving the number of people who are malnourished by 2030.

¹ 3-year averages.

Summary Statistics

The summary statistics of the dependent and the independent variables are found on Table 4. The number of observations in this data set ranged from 384 to 234. The prevalence of undernourished ranged from 3.6 to 54.9 percent, and the number of people undernourished ranged from .2 million to 17.3 million. The access to improved water sources ranged from 23.5 to 95.7 percent. The access to improved sanitation facilities ranged from 9.3 to 98.4 percent. The share of dietary energy supply derived from cereals, roots and tubers ranged from 76 to 146 percent.

The χ^2 value was very high when I ran the Wald test for heteroskedasticity². The large chi-square value indicates that heteroskedasticity is present, and the null hypothesis cannot be rejected. In order to fix for heteroskedasticity, the regression was run with the robust standard errors. A Hausmann test was conducted and determined that the regression should be run under a fixed effects model. The error variance of the data set is represented on the scatterplot and histogram (Figure 1 &2). A correlation matrix of all the variables to check how strongly related they are to each other. The average dietary supply and the average value of food production are strongly related to one another³. Therefore, the average value of food production was removed when I ran the regression.

² The χ^2 value was 1250 which is more than the normal threshold value.

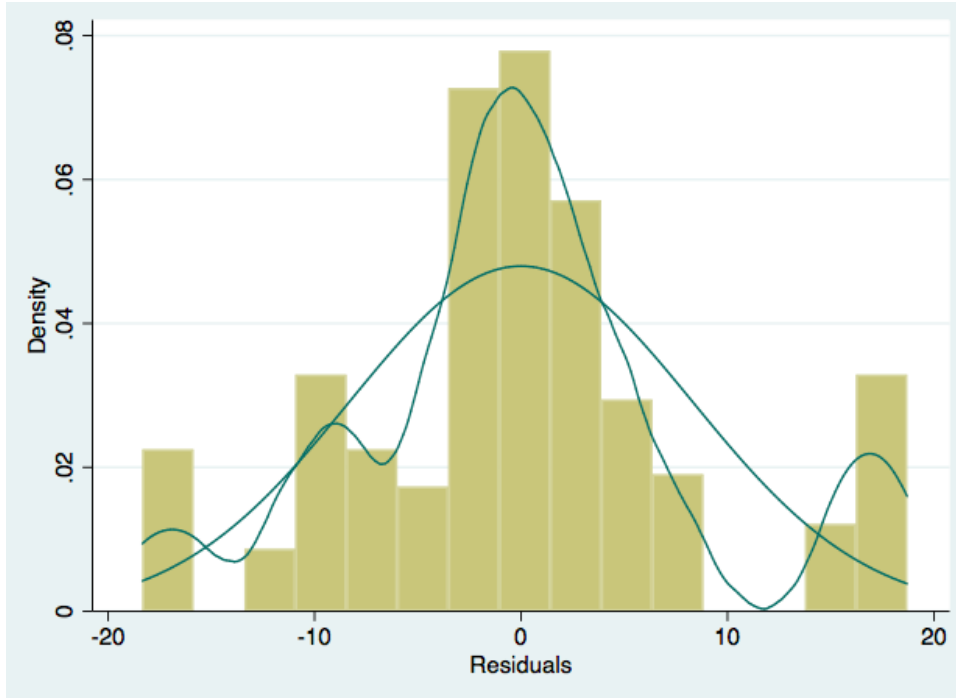
³ The average dietary energy supply has a high correlation of .9139 and the average value of food production has a high correlation of -.6167.

TABLE 4
COMPLETE SUMMARY STATISTICS

Variable	Count	Mean	Standard Deviation	Minimum	Maximum
Prevalence of Undernourished (%)	304	25.00921	12.50708	3.6	54.9
Average Dietary Energy Supply	335	104.3194	12.32674	76	147
Average share of Diet from Cereals, Roots and Tubers (%)	234	60.86325	8.403357	43	79
The Number of People Undernourished (million)	304	4.442434	4.154167	.2	17.3
Access to Improved water source	332	67.64448	15.21635	23.5	95.7
Access to Improved Sanitation Facilities	347	37.32882	23.83938	9.3	98.4
Percentage of Arable Land for Irrigation	294	7.664286	9.776285	.2	37.2
Average Value of Food Production	308	156.0162	51.39389	49	250

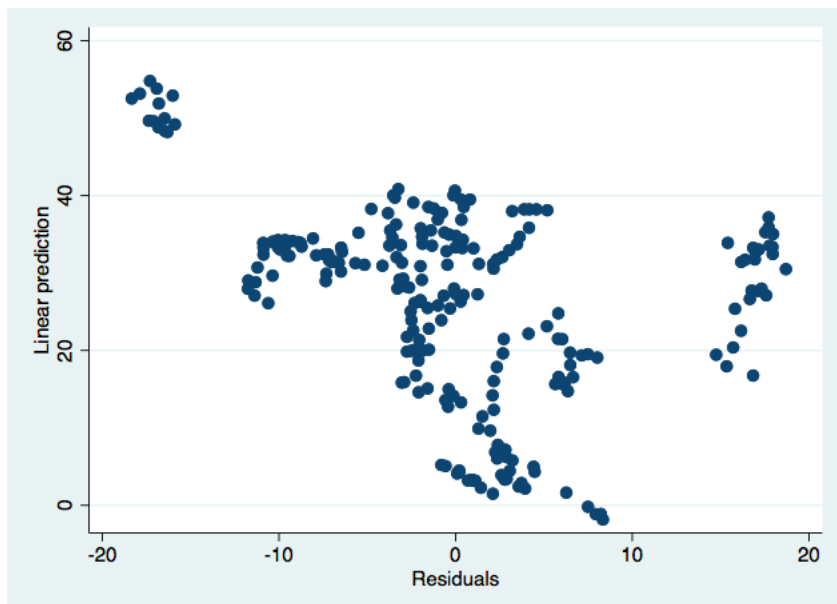
Source: author's calculations

Figure 1: Histogram of Variance



Source: author's calculation

Figure 2: Scatterplot of Residuals



Source: author's calculation

Results That Did Not Follow The Hypothesis

Most of the variables did not play a significant impact as originally predicted (Table 5). The model did not show a strong relationship between the independent variables and the dependent variables. The focus of the model was to see the relationship between the prevalence of people undernourished and the FAO defined indicators of food insecurity. I expect that the coefficients for share of dietary energy supply, the percentage of arable land for irrigation, access to improved water sources, and the share of data to roots, tubers and cereals to all have a significant p-values.

The assumption is that by increasing the land used for irrigation, having access to improved water sources and having an increase in the overall average dietary energy supply, the number of people suffering from malnourishment should decline. However, only one of the variables had a significant p-value and followed the predicted results. The share of dietary energy from roots, cereals and tubers, the percentage of arable land for irrigation, access to improved sanitation facility did not have significant p-values at the five percent level.⁴

The reason it may not have been significant is because having a high diet of roots, cereals and tubers is not a healthy lifestyle. It is more beneficial if people increase their intake of fruits and vegetables. However, it could also be that the majority of the people still need to increase cereals, roots, and tubers as well as fruits and vegetables. Since they lack the necessary amount of calories per day to live a healthy lifestyle. The access to improved

⁴ The share of diet from roots, tubers, and cereal had a negative coefficient of .2171051 and a p-value of .1444.

sanitation facilities also did not have a significant impact on the prevalence of people undernourished⁵.

The percentage of available land for irrigation also failed to be significant at the 95th percentile.⁶ It was originally predicted that if the percentage of land available increased then the prevalence of malnourished would decrease. More land available would lead to an increase in food production. It is heavily emphasized that increasing productivity is necessary for overcoming extreme hunger. Research done in Malaysia, India, and Africa by the Food Policy Research Institute (IFPRI) showed that there would be a strong relationship between food production and calorie consumption (Mellor, 1986). However, even with higher productivity rate through better technology, the population is growing too fast and the production of food is not keeping up. This is one of the reasons why percentage of arable land was not significant. Between 1961 and 1980, the per capita food production fell by 1.1 percent per year in Sub-Saharan Africa. This was the cause of poor crop years, low government investment in agriculture and unfavorable policies (Mellor, 1986). The consumption growth outpaced production.

The hypothesis states that by increasing the production of food through urban agriculture, the number of people undernourished will decrease. Other factors need to change in order for the independent variables to be a significant part of reducing malnourishment. In time it will increase as more government policies invest in agriculture and provide farmers with better technology and fertilizers. Even countries that have invested in better technology, cannot keep up with the growing population. Today, most developing countries still depend

⁵ The p-value for access to improved sanitation facilities was .286. This is above the significant value .05.

⁶ The p-value was .076

heavily on imports. The increase of productivity will help export more goods and increase the income of the lower class.

TABLE 5
RESULTS OF REGRESSION ANALYSIS

prevalenceofu~d	Coef.	Robust Std. Err.	t	P>t	95% Conf. Interval
averagedietar~a	-.932548	.1148916	8.12	0.000	-1.1749- .69701482
shareofdietar~e	-.217105	.1417658	-1.53	0.144	-.5162148 - .0819847
percentageofa~o	.5251456	.2775029	1.89	0.076	-.0603244- 1.110026
acesstoimpro~s	.1117847	.1009386	1.11	0.286	-.1011773- .324966
acesstoimpro~i	-.394283	.1716421	-2.30	0.035	-.7564183- -.03215
_cons	138.9256	21.41278	6.49	0.000	93.748602- 184.1026

Source: author's calculations

Limitations of the Data

Urban agriculture is a relatively new phenomenon that a lot more developing countries are turning as more people migrate from rural to urban areas. There are not a lot more studies done in recent years that connect food insecurity data with urban agriculture. The data used is from the Food and Agriculture Organization to represent agriculture and malnutrition rates in the Africa region.

It is difficult to control for specific factors that have a large impact on the nutritional status of individuals. This includes government policy, education, income inequalities, and climate change. Education is a major factor causing a high rate of malnutrition in Africa (Bain, Awah, Geraldine, Kindong, Sigal, Bernard & Tanjeko, 2013). A lot of women in Sub-Saharan Africa lack education on nutrition and as a result make poor food choices, and people know very little about the necessary vitamins and nutrients to live a healthy lifestyle. Even if healthier food is available, they may choose to not consume it. Women's education can have more of an effect on lowering malnutrition rates among children than in food availability (Bain et al, 2013). In East Africa, 48 percent of the children under the age of five are stunted and 36 percent of children are underweight. A study done in Nairobi on children by the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) found that 40 percent of the children in the study were stunted, and the study found that a strong predictor for that was based on maternal education. An increase in education can be a breakthrough for the poverty cycle in urban poor settings (Bain et al, 2013).

Africa is very vulnerable to climate change. The continent is warming faster than the global average (Hope, 2009) Climate change has a more drastic impact on countries that already face social and economic challenges. Climate change increases the frequency of

drought and excess flooding. In the past few years, Sub-Saharan Africa has seen a huge increase in temperatures. Farmers do not have good solutions put in place to overcome drought and excess rain and cannot predict the changing weather conditions. As a result, Africa's forests are shrinking at 1 percent per year and most of the continent is experiencing dry periods. This is one of the main causes of crop yields to be so low for the past few years. Many African policy makers do not see malnutrition as a top priority. With corruption being really high, most of the resources are in the hands of the elite. There also need to be improvements with transportation and the distribution channels (Bain et al, 2013).

Results That Did Follow The Hypothesis

The model had a high R-square value of .8686. The model explains 89 percent of the variability of the prevalence of people undernourished. The model does explain a lot of the variability. The average dietary energy supply had a significant p-value of 0.000, and had a negative coefficient of .9325483. For every one-unit change in the average energy from their diet, the prevalence of undernourished will decrease by .99325483 units. This result followed the original hypothesis. Increase in calorie intake will have substantial impact on the number of people malnourished in Africa.

The analysis did not prove to be as significant as originally projected. However, the data reinforces the need for a more adequate amount of energy from food. Too many people lack the adequate amount of calorie intake to sustain a healthy lifestyle. The distribution of resource and wealth in Africa is among the worst. In South Africa, the top 10 percent owns 90-95 percent of all the assets (Orthofer, 2016). Agriculture growth can be found to reduce poverty and can have a substantial impact on the incomes of the poor. However, there are a lot of other problems that need to be controlled.

Conclusion

This study seeks to fill the gap on how agriculture can lower the number of people in poverty in Africa. Previous research on food production and food insecurity rates helped shape my hypothesis, that urban agriculture will have a significant impact on malnutrition in Africa. With so many people still suffering from inadequate dietary needs, Africa needs to increase food production internally. More investment in the agriculture sector can help increase employment and income for the lower class. As agriculture grows, the rest of the economy can benefit.

Urbanization is inevitable and urban poverty continues to be a major problem, especially in Africa and in developing countries. An increased population in the cities causes people to be more dependent on commercially processed foods. Between 1980 and 1990, food prices rose to more than the average income of the people living in Africa (Armar-Kumuse, n.d). In 1988, the entire monthly minimum wage purchased enough food to last just four to five days. As a result, poor families will spend 60 to 80 percent of their income on food. In urban areas, people are more focused on purchasing their own food instead of also selling food for an income (Armar-Kumuse, n.d). Food prices depend on the efficiency of the food market and the distribution system. We do have enough resources and land to supply the growing population, however we are not utilizing it in a sustainable way. Africa is in a “poverty trap” (Kates & Dasgupta, 2007). The country has little savings that leads to little capital investment and ultimately causes an increase the problems of malnourishment. The government is constrained on how to promotes growth and distribute resources equally (Kates et al, 2007).

Agriculture is the most feasible sector to increase food production. There is already a high rate of participation in agriculture in Africa, especially among the poor. The general consensus is that agriculture will lower poverty but there is an ongoing debate on what type of agriculture would work best and what policies should be implemented. More people are migrating to urban areas because of the harsh inequalities and the lack of access to resources in the rural areas. To make matters worse, the population continues to increase in the cities and the food production cannot meet the demands of the people (Kates et al, 2007). Urban agriculture can be the solution to reducing urban poor throughout Africa.

A study by Paul Okwi in 2007 found that physical qualities such as land use, soil type, slope, elevation and distance to public resources explain more than half of the variation in the poverty numbers. However, African governments fail to get sufficient public investment and aid to make resources more accessible for the lower income individuals. Lack of modern technology in Africa is another reason it fails to keep up with the growing population. Developing countries goal is to focus on implementing programs that support increasing food production. In Kenya, the government is investing in more modern machinery in order to increase production, employment, and improve the income of the poor (Food and Agriculture Organization, 2017). For the first time in more than two and half decades, Ethiopia adopted an agriculture plan: the Sustainable Development and Poverty Reduction Program (SDPRP). This program promotes agricultural research, water harvesting and small- scale irrigation (Kates et al, 2007).

The regression model showed that the explanatory variables were responsible for 87 percent of the variation of the response variable. The implications of my model show that agriculture and diet have a substantial impact on malnutrition rates in Africa. This follows

the hypothesis that there is a strong relationship among agriculture and food insecurity.

Although many of the variables were not as significant as predicted, the model suggests that having an adequate energy supply can drastically lower the number of people malnourished.

The model did not control for certain factors that can drastically change malnutrition rates.

Those factors include climate change, education and government policies.

The model could have been improved by including transportation, production of vegetables and education among the lower income families. If these variables were included in the model could possibly show a more significant relationship between these variables and malnutrition rates in Africa. The model also did not take into account the landscape of each African country and their access to local resources. Countries in Africa have distinct climate and can be affected by climate change in different ways. It also would have been valuable to look at the type of local government put into place in each country. The chi² test came out to be high so a better data set could have had more accurate results.

Although there has been some progress in government investment in Agriculture, there is still a gap in government policies that support the development of urban agriculture. In Kenya and Nairobi, agriculture is not recognized as land use under permit certification laws so it is hard to get zoning permits approved (Armar-Kumuse, n.d.). Policies need to pivot their focus on increasing food production in order to half the number of people living in poverty by 2030. South Africa has been focusing on the importing of food as well as increasing the country's food production internally. The government has implemented a new policy called The Integrated Food Security Strategy (IFSS). The goal of this policy is to ensure a sustainable access to a level of safe and nutritious food for a healthier lifestyle (FAO, 2017). These policies represent steps in the right direction. The government has also

started the Food Security Production Intervention Program that helps farmers increase production of basic foods. A better collaboration between the nutrition, health and agricultural sectors would help increase the health of the urban community. Currently, the agricultural sector just focuses on producing more food and does not consider diversifying the crops to ensure an increase in the population's wellbeing. In order to diversify the crop production, farmers' income should increase. Farmers need to be able to afford fertilizers, seeds and better technology in order to speed up the process.

A solution to fixing food distribution is starting a community supported agriculture program. A group of consumers pay a fixed price in exchange for a weekly vegetable box or the permission to harvest a certain amount to produce and sell to the public (United States Department of Agriculture, 2018). Governments are noticing that local food production is a survival technique for the poor and policies are focusing more on producing local goods. Communities are working together in order to make sure there is equal share of food for everyone and that the farmers' can access loans in order to start their own farm plot in the urban areas. Twenty to forty percent of agricultural goods are lost to transportation. A more local source of food would be a lot more sustainable for the urban communities (Sangwe, 2016).

Urban agriculture is a solution to increasing their access to a sustainable food source. Today, 40 percent of the populations in African cities are involved in urban agriculture. Ninety percent of the city's fresh vegetable consumption is from within the cities. Urban agriculture can provide 20 to 30 percent more of the household's food supply (Armar-Kumesu, n.d). Having a local source of food allows people to be able to purchase more perishable vegetables and poultry products. Urban agriculture can increase the quality of the

diet and increase the nutritional status of the poor. It also can link to a higher nutritional status of their children. A lower proportion of children who are malnourished come from a household that engages in farming. However, limited access to land and water is a significant constraint (Armar-Kumesu, n.d).

As more governments invests in the agriculture sector it will become easier to access more land and have less restrictions to produce food in the urban areas. The model showed that the relationships between the food insecurity variables and the prevalence of malnourishment are a lot more complicated than originally hypothesized. Climate change, education and the government's role also need to be considered when understanding the trend of food insecurity in Africa. With better research and energy spent on this issue, the right policies will be implemented to lower the number of people who are food insecure all over the world.

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APPENDIX A

TABLE 6

VARIABLE CORRELATION MATRIX

	preval~d	averag~a	averag~s	shareo~e	number~l	percen~o	access~s
prevalence~d	1.0000						
averagedie~a	-0.9139	1.0000					
averageval~s	-0.6167	0.5857	1.0000				
shareofdie~e	0.1259	-0.079	-0.3731	1.0000			
numberofpe~l	0.2464	-0.1489	-0.2279	-0.0678	1.0000		
percentage~o	-0.0331	-0.076	0.1951	0.3587	-0.1808	1.0000	
accesstoim~s	-0.2766	0.1877	0.2481	-0.4189	-0.3835	-0.3105	1.0000
accesstoim~i	-0.1716	0.0555	0.2817	-0.2830	-0.2880	0.0336	0.5871
year1	-0.1625	0.1717	0.2144	-0.0546	0.0118	-0.0141	0.3229
country1	0.3104	-0.2322	-0.2251	-0.1810	0.2439	0.0357	0.1136

Source: author's calculations

