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Zambia, Sustainable Agriculture  
Solving malnutrition in rural Zambia with sustainable agriculture

There is a way for Zambia to help reduce malnutrition for the rural population. Zambia has improved the quality of life in many ways, but one problem that hasn't improved is the level of malnutrition from 1992-2013 as shown by the level of stunting, wasting, and underweight people. 48% of the children have had their growth stunted from lack of nutrients, 25% are underweight, 6% are severely malnourished, and 12% of infants are born underweight (WFP/Rein Skullerud.). Most families eat cereals, predominantly maize and starchy roots. While cereals provide two-thirds of the energy in the diet, these foods do not have enough nutrients for a growing child, causing malnutrition. Many of the adults are not able to work to their full potential because of nutrient deficiencies ("Zambian Cuisine."). There are many solutions Zambia has implemented to combat malnutrition, but the most important of these include implementing education about food and animal nutrition at schools, repurposing food in Zambia, and increasing drone usage in Zambia. The solutions proposed in this paper align directly with Zambia's 7th national development plan 2017-2021 ("7th National Development Plan 2017-2021 - Zambia."). The main goal is to decrease the dependence on copper and increase the importance of agriculture to Zambia's economy.

The population in Zambia was 17.09 million in 2017 with 58.62% living in rural areas ("Climate."). The typical family size is 5.8 people. From 2010 to 2017, the population increased by seven million, leading to a shortage of jobs for the working class (Arcgis.com). Moving to a more sustainable agriculture system will improve food supplies and increase the need for labor. ("Unemployment Rate in Zambia averaged 12.88 percent from 1986 until 2017.")

Geographically, Zambia is a high plateau with few hills and mountains, which denies the country access to services and markets. Zambia's economy is heavily dependent on copper mining and volatile copper prices. For example, copper reached an all-time high in 2011 of \$4.58 per pound and fell to an all-time low in 2016 of \$1.94. China was one of the largest buyers of Zambian copper accounting for 45% of all sales ("Tag - Copper Price."). During China's industrial boom, much copper was needed. A recent slow down in China's economic growth has decreased the need for copper, causing volatility in the Zambian economy.

With the copper prices going down, the agricultural aspect of Zambia needs to be boosted. "Once at the forefront of the 'Green Revolution', with hybrid maize yields breaking record charts in the 1960s, Zambia has vast agricultural potential. Yet despite a favorable climate, fertile land and 40 percent of the water resources in the entire southern African region, that potential is yet to be fully tapped. Of the 58 percent of land suitable for agricultural production, only 14 percent is currently under cultivation. And despite bumper maize harvests, agriculture makes up only 20 percent of GDP while employing roughly 85 percent of the population ("New Agriculturist.>"). The copper prices were the main profit of Zambia but with prices dropping, the agriculture sector needs a boost. "The government recognizes that increasing agriculture and agribusiness are

critical for improving incomes and food security, reducing poverty, and creating a more diversified and resilient economy(“Zambia: Harvesting Agricultural Potential.”).”

Zambia has two main seasons, rainy and dry. The average annual rainfall is 50 inches overall, with 47.2 inches in the rainy season and 2.8 inches in the dry season. Fifty-eight percent of land in Zambia is classified as a medium to a high potential for agricultural production. So far, only 14% of this agricultural land is currently utilized, which leaves another 44% of the medium to high potential agricultural land to be used to grow food(“Climate”). Only 6% of the land that is being utilized is irrigated. “The usual practice amongst most farmers, especially those in the rural areas, is to hang up their farming tools during the dry season as they impatiently wait for the next raindrop from high heaven in the following rainy season(Stoddard, Ed).” These farmers only grow during the wet season and make less profit.

In many countries with nutrient deficiencies, faith can restrict diets, but that is not a dominating factor in Zambia. Zambia's main religion is Christianity and does not prohibit the consumption of any foods. There is a food cycle that is from livestock, vegetables, and finally to the animals. The humans eat much of the vegetables but the scraps go to the animals. The livestock eats the vegetable scraps and produces manure for the vegetables to grow. If this cycle is employed in a balanced manner, the Zambia diet would be more nutrient-dense and sustainable.

Working adults make approximately two dollars a day. Of the students that attend school, females in Zambia are more likely to drop out than males and get married at a young age. Twenty-eight percent of the girls from the age of 15-19 are mothers or have been pregnant and only 50 percent of those girls go back to school. Zambia is one of the lowest academic regions in Africa with 35% of people ages 15-24 classified as illiterate(“Literacy: United Nations Educational, Scientific and Cultural Organization.”).

Education is a broad subject and should not just be thought of as workers obtaining a college degree. Rather, increasing education opportunities would contribute more to economic growth.

A proven solution in fighting nutritional deficiencies is to start vegetable gardens in schools partnered with education regarding nutritional facts. This means changing generations of thinking over the course of 10-20 years. The lack of movement in malnutrition statistics suggests if a change is to occur, it needs to be with young people. Some people have gardens in their backyard for fresh produce, but some look down upon eating vegetables. Many people believe vegetables are for the poor and will not contribute anything to their diets. Many schools are growing gardens and feeding students, but most aren't teaching students the nutritional value in each of the food groups. Some projects have been funding similar gardens such as the Garden-based Agriculture for Toledo's Environment or GATE, program in Belize. The GATE project uses a model utilizing measures ranging from organic gardens to food processing with solar dryers(“GATE School Gardens Program.”). While this program is not in Africa, it demonstrates how small amounts of funding can grow into big cooperative ventures which help many people.

Increasing the availability of technology can bridge the gap from the gardens at the school to the parents at home. Kids can help their parents by showing parents how to use the information provided by electronic devices. “As a Kiva Fellow in Southern Africa, I get to pursue that interest in my work with a company called iSchool that develops educational technology for primary school students and teachers in Zambia(“iSchool Zambia”)

iSchool produces pre-loaded Mwabu tablets with educational resources for students and teachers. Their materials cover the entire Zambian primary school curriculum, from Grades 1 through 7, and early grade material is available in 8 local languages in addition to English. Entirely local examples from the Zambian context are used in iSchool's curricula, and students are encouraged to engage in active inquiry-based learning." ("iSchool Zambia") In Africa, some projects are helping out students with technology. The kids can document what helps the garden and teach their parents what the nutritional rewards of a garden are. With the help of these projects, there will be a growth in education, particularly the rural population.

The second solution is increasing the utilization of food waste for animal feed. Today in the United States, the trend is to use products that are better for the environment, such as metal straws and buying from a company that uses environmentally safe products. The youth are trending towards more environmentally sound practices and will support the second solution. When table scraps are thrown away they go into a landfill and when they decompose in a landfill they release a gas that is 28 times more potent than carbon dioxide. This will help the reduction of greenhouse gasses and feed animals in Zambia.

The United States and other developed countries waste much of the food that is produced and throw away food with slight imperfections. "In the United States, food waste is estimated at between 30-40 percent of the food supply. This estimate, based on estimates from USDA's Economic Research Service of 31 percent food loss at the retail and consumer levels, corresponded to approximately 133 billion pounds and \$161 billion worth of food in 2010("Food Waste FAQs.')." This food waste could have a big impact on the way of living in Zambia. Food waste from developed countries could be processed for use in Zambian agriculture. The food waste is dried and ground, so it has a long shelf life and is easy to ship for use as livestock feed. "Having your feed tested is a way of ensuring your livestock are consuming the adequate nutrients they need in their diet. Poor nutrition can affect not only the productivity of the animal but also its health and behavior. Forage and feed sampling is an essential tool in determining your animal feed quality("Feed Analysis.')." The feed quality has to be good to produce the best results from your animal. In the USA, farmers often buy expired foods (including candy) at very low costs, crush it up, check to see what kinds of nutrients are needed to be added and feed it to their livestock. Much of the food that is thrown out is not old or has anything wrong with it; it just does not meet the standards that consumers expect. In exchange for implementing programs to convert food waste to animal feed, large corporations would benefit from positive public relations and reduce landfill costs.

The population of Zambia livestock has grown in the past years dramatically, but Zambian farmers are still in need of help with the proper ways to raise livestock. One of the main issues with Zambian livestock production is poor pasture management and feeding practices. From the year 2004 and 2015, the population of cattle grew from 2,392,893 to 4,319,277. Goats, pigs, sheep, and poultry have grown significantly as well. This supplemental food could help grow the animal population further. With the help of the schools, students can learn improved methods to meet animal needs with the repurposed foods for animal feeds. Integrated education incorporating agriculture practices and nutritional information will permeate through communities starting with students.

The nutrient cycle based on livestock, humans, and vegetable production starts with the animals that are fed vegetable scraps. The animals then produce manure that can be used as manure for gardening, and finally, people complete the cycle by eating all of the vegetables except for the scraps that go to the animal. Fertilizer has been increasing in prices for many years. “The cost of fuel and fertilizer, which tripled from around US\$400 per tonne in 2005 to US\$1,300 per tonne in 2008, is having a significant impact on smallholder production(“New Agriculturist.”).”

“Animal manure fertilizer offers short- and long-term benefits if you use and apply it correctly. Animal manures provide essential nutrients required to grow healthy plants. Also, animal manure adds organic matter to the soil, improving microbial activity, water drainage and overall soil structure(Delp, Rachel. “The Best Animal Manure Fertilizers.”).” Manure has many uses for growing crops, and not just for the organic matter back into the soil. Many of the nutrients that are needed to grow the crops come from the animals raised there. “Animal manure from cows, horses, and chickens are commonly available and used as fertilizers, along with manure from sheep, goats, and rabbits. The nutrient content is not the same for all livestock and farm animals, however. For example, chicken manure has a high nitrogen content, whereas dairy cow and horse manures provide a more balanced boost of soil nutrients. Sheep and goat manures also provide needed nitrogen to the soil, but they also add more potassium than dairy or horse manure (Delp, Rachel. “The Best Animal Manure Fertilizers.”).” The increased cattle population will contribute to an increase availability of manure to be used in Zambia. The nutrient profile is different for all animals and must be appropriately used depending on the available nutrients in the manure. The animals would then eat the table scraps that the humans do not eat. The farmers could collect food waste from the people around them, leading to improved sanitation.

The final solution would be for Zambia to implement drones to combat the infrastructure challenges. Companies in developed nations are testing drones for delivery today, but are struggling with the strict regulations. “Drones could be used for soil and field analysis. They can be used to produce accurate 3-D maps that can be used to conduct soil analysis on soil property, moisture content, and soil erosion. This is very important in planning seed planting patterns. Even after planting, such information is useful for both irrigation and the management of the nitrogen level in the soil(Kipkemoi, Peter, et al. ).” This technology has the potential to greatly benefit the farmers of Zambia.By implementing drones farmers can check fields by taking pictures of the crops to see if there are problems with pests, irrigation, or nutrient deficient crops. “Though not quite prevalent just yet, some manufacturers have come up with systems able to shoot pods containing seeds and plant nutrients into the already prepared soil. This profoundly reduces the planting costs (Kipkemoi, Peter, et al. ).” Planting the seeds by drone will dramatically decrease the price of planting in the near future. “One of the largest obstacles in farming is inefficient crop monitoring of vast fields. This challenge is made worse by the rise of unpredictable weather patterns which lead to increased risks and maintenance costs. Drones can be used to develop time-series animations to show precise crop development which reveals production inefficiencies hence better crop management (Kipkemoi, Peter, et al. ).” With this technology, the farmers could have more time to work on other projects around the farm. “Using ultrasonic echoing and lasers, drones can adjust altitude with a change in topography and geography. Their ability to scan and modulate its distance from the ground enables them to spray the correct amount of the desired liquid evenly in real-time. This results in increased efficiency since the amount of water penetrating groundwater is minimized. Spraying using drones has also proven to be faster than other traditional methods (Kipkemoi, Peter, et al. ).”

Drones can accomplish amazing feats and one of the main ones is spraying. Spraying the field correctly has a big impact on how well your crops grow. This spray is more effective by hitting only the weeds that are needed and uses fewer pesticides which are better for the environment. “Drones equipped with thermal, hyperspectral, or thermal sensors can identify the parts of the field have become dry. This way the identified areas can be attended to promptly making irrigation precise and timely.” The weather in Zambia is not reliable and causes struggles in Zambia for the farmers and with the help of drones, the farms can have proper irrigation. “Some drones are capable of scanning crops using visible and near-infrared light. On-board light processing devices are then able to identify the amount of green and near-infrared light reflected by the plants. This data is then used to develop multi-spectral images which depict the plant health. These images can be used to track crop health and to monitor remedied administered if any sickness is discovered.” The plants' health could be monitored every day by the farmers.

If Zambian farmers were able to work with the developed countries or the Zambian government to distribute surplus food, even food distribution could be achieved using drones. Cell phones could be used to show the drones where the supplies are needed the most. In Rwanda, there is a project that uses drones to deliver blood or medical supplies. This could be implemented in Zambia for food and supplies. If Zambia allowed looser regulations for drone deliveries, this could help close the gaps in a lacking infrastructure. Zambia would be seen as a testing place for large corporations and drone delivery. The companies that are supplying the drops will have a way of advertising and positive publicity.

While implementing education about food and animal nutrition in schools, increasing the utilization of food waste for animal feed, and increasing drone usage to combat infrastructure challenges may seem like simple solutions for Zambia, Dr. Borlaug had a simple idea that fed over a billion people. The schools will start to teach children how to sustain agriculture in small quantities, and hopefully later in life those children will use that knowledge on a large scale. The food waste in the world now is a great waste of food that needs to be utilized to help out Zambia's struggling economy. Drones are a new technology that will be used, it is not an ‘if’ but a ‘when’. With these solutions, I hope to start something small that grows over time and possibly mirror the US production abilities.

## Works Cited

- WFP/Rein Skullerud. "UN World Food Programme." WFP, 3 Mar. 2015, [www.wfp.org/stories/10-facts-about-hunger-zambia](http://www.wfp.org/stories/10-facts-about-hunger-zambia) .
- "Cattle & Crop Farming in Zambia." Farmer's Weekly, 31 May 2017, [www.farmersweekly.co.za/rural-insight/cattle-crop-farming-in-zambia/](http://www.farmersweekly.co.za/rural-insight/cattle-crop-farming-in-zambia/) .
- "Chapter 2 Food for Living." Zambian Basic Education Course, NUTRITION EDUCATION, Supplementary Material - Teachers Book Grade 2, [www.fao.org/3/ag066e/ag066e05.htm](http://www.fao.org/3/ag066e/ag066e05.htm)
- "Climate." Zambia Tourism, [www.zambiatourism.com/about-zambia/climate/](http://www.zambiatourism.com/about-zambia/climate/)
- "Open Knowledge Repository." Open Knowledge Repository, <https://openknowledge.worldbank.org/>
- "Purchase for Progress." World Food Programme, [www.wfp.org/purchase-progress/news/blog/5-facts-about-connecting-farmers-markets-zambia](http://www.wfp.org/purchase-progress/news/blog/5-facts-about-connecting-farmers-markets-zambia) . Reports, Staff.
- "The Top Five of the Largest Causes of Poverty in Zambia." BORGEM, 4 Dec. 2017, [www.borgenmagazine.com/causes-of-poverty-in-zambia/](http://www.borgenmagazine.com/causes-of-poverty-in-zambia/) . Sitko, Nicholas, and Jordan Chamberlin.
- "The Anatomy of Medium-Scale Farm Growth in Zambia: What Are the Implications for the Future of Smallholder Agriculture?" MDPI, Multidisciplinary Digital Publishing Institute, 18 Sept. 2015, [www.mdpi.com/2073-445X/4/3/869/htm](http://www.mdpi.com/2073-445X/4/3/869/htm) .
- "Working Conditions and Wages of Informal Sector Workers in Domestic Service in Zambia By Grayson Koyi." ALREI.org, 28 Apr. 2017, <https://alrei.org/education/working-conditions-and-wages-of-informal-sector-workers-in-domestic-service-in-zambia-by-grayson-koyi> .
- "Zambia - Agricultural Land (% of Land Area)." Zambia Agricultural Land Percent Of Land Area, <https://tradingeconomics.com/zambia/agricultural-land-percent-of-land-area-wb-data.html>
- "Zambia - Population 2017." Countryeconomy.com, Follow Us, 18 July 2018, <https://countryeconomy.com/demography/population/zambia>
- "Tag - Copper Price." Zambia Daily Mail, [www.daily-mail.co.zm/tag/copper-price/](http://www.daily-mail.co.zm/tag/copper-price/).
- "Literacy: United Nations Educational, Scientific and Cultural Organization." Literacy | United Nations Educational, Scientific and Cultural Organization, <http://www.unesco.org/new/en/dakar/education/literacy/> /
- "GATE School Gardens Program." Plenty International, <https://plenty.org/programs/plenty-belize/school-gardens/>
- Delp, Rachel. "The Best Animal Manure Fertilizers." Home Guides | SF Gate, 7 Oct. 2016, <https://homeguides.sfgate.com/animal-manure-fertilizers-73720.html>.
- "Food Waste FAQs." USDA, <https://www.usda.gov/foodwaste/faqs> .

“Feed Analysis.” Water Agricultural Laboratories, INC., <https://watersag.com/service/feed-analysis/>

Kipkemoi, Peter, et al. “News.” DroneGuru, 27 Jan. 2019, <http://www.droneguru.net/the-pros-and-cons-of-drones-in-agriculture/>

“New Agriculturist.” New Agriculturist: Country Profile - Zambia, <http://www.new-ag.info/en/country/profile.php?a=2621>

“7th National Development Plan 2017-2021 - Zambia.” Global CRRF, [http://www.globalcrrf.org/crrf\\_document/7th-national-development-plan-2017-2021-zambia/](http://www.globalcrrf.org/crrf_document/7th-national-development-plan-2017-2021-zambia/)

“Zambia Unemployment Rate.” Zambia Unemployment Rate | 2019 | Data | Chart | Calendar | Forecast | News, <https://tradingeconomics.com/zambia/unemployment-rate>

“Zambian Cuisine.” Recipes Wiki, recipes.fandom.com/wiki/Zambian\_Cuisine.Arcgis.com, <http://www.arcgis.com/home/item.html?id=0265098>

“Zambia: Harvesting Agricultural Potential.” World Bank, <https://www.worldbank.org/en/about/partners/brief/zambia-harvesting-agricultural-potential>

“iSchool Zambia.” Kiva, <https://www.kiva.org/blog/spreading-education-technology-in-zambia-with-ischool>

Stoddard, Ed. “Drought Threatens Small-Scale Zambian Maize Farmers.” Reuters, Thomson Reuters, 19 Nov. 2013, <https://www.reuters.com/article/us-zambia-drought/drought-threatens-small-scale-zambian-maize-farmers-idUSBRE9AI0ET20131119>