Meeting Donors in the Middle: Repurposing Production Data to Quantify Meals Produced

By: Benjamin D. K. Wood, Kirby Richardson and Jessica Lyons

Keywords: agricultural production, calories, food, meals, corporate social responsibility, philanthropy

Heifer International, an agricultural production focused implementer, has partnered with households for over 80 years to increase food security. As Heifer's model evolved, we understood better the need to work within food systems to increase the opportunities of households to escape poverty and achieve food security. With Heifer's expanded scope, we are reviewing alternative funding streams, including corporations, to account for the scaling of our projects. In these efforts, we initially encountered issues with corporations understanding how they would be able to quantify and market potential corporate social responsibility (CSR) donations to us.

In this case, science met reality through our need to find a creative fundraising solution for an agriculturally focused implementing organization. While CSR might logically help fill this hole, a gap exists between agricultural production focused implementers and food consumption focused corporate donors. We designed the meals produced calculation to help close that gap. From the implementer side, the calculation uses agricultural production data, which we already capture to understand the productivity of project participants, to quantify production into a more easily understood concept for a general audience. From the corporate donor perspective, they can market their donation to fit their organizational CSR focus with defensible numbers.

The calculation transforms agricultural production into an approximation of the number of meals that production produced. The transformation begins with production data, which we standardize through a series of unit of measurement conversions. Then, using a USDA food caloric calculator, we convert all the production into calories. Once we determine a total number of calories produced, we discount the calories based on production source and convert into meals produced with a calories per meal assumption. The assumption is based on a localized caloric burden calculation, endogenously accounting for differences in need depending on profession.

Calculating caloric meals produced is a justifiable proxy for number of meals produced because of the context of our work. While calories alone do not create a nutritious meal, they represent the basic need of humans to sustain themselves. As Heifer strives to work with the poorest of the poor households, being able to assess how Heifer's programming contributed to increasing the ability of these households to meet their basic caloric requirements is a valuable measure of progress.

We believe that this calculation might help other organizations quantify and market their implementation work. The USDA food caloric calculator is incredibly diverse, even allowing for the conversation of non-traditional crops like spices and agave. We also developed a unit conversion guidance, to allow others to conduct the calculation even if the production data are reported in non-standard measurements. Ultimately, we see this calculation as a low-cost innovation to align the interests of implementers and corporations with the goal of helping more people escape hunger and poverty.

Introduction

Agriculture serves as the primary income-generating activity for approximately 59 percent of the households living in low-income countries and approximately 38 percent of the households living in middle-income countries (UC Davis, 2023). Many non-governmental organizations (NGOs) focus on supporting these farmers through, for example, by helping them increase their productivity, access markets, plant high value crops and care for the land. NGOs work with governmental and commercial farmers to partner with farmers to increase their knowledge, capacity and ultimately well-being.

As global societies generally move farther away from agriculture, explaining the importance of working with farmers is sometimes difficult for the general population. Funding for agriculturally-focused NGOs is relatively low, with Giving USA noting that "animals/environment" consistently ranks as one of their lowest sub-categories of focus area for donations (GivingUSA, 2024). And agriculturally focused NGOs are perpetually searching for new donors to engage.

Agriculturally focused NGOs are not the only organizations to see decreases in their funding. Public funding for agricultural research is also decreasing. Nelson and Fuglie (2022) detail a steady decline in public sector research funding over the last two decades.

Corporate Social Responsibility (CSR) is a promising area of potential funding to fill these funding gaps. Corporate commitments have generally increased over time. The Giving USA report noted an upward trend in corporate gifts over the last two years, with corporations engaging with NGOs through channels varying from in-kind staff time donations to employee match programs (Social Trendspotter, 2024) and NGO implementers are logical partners for these funders. However, CSR funding, like most funding streams, oftentimes comes with string or preferred areas of work.

We designed the caloric meals produced indicator to help bridge the gap between production and donor interest. The calculation is a practical, low-cost, approximate quantification of meals produced. Through this quantification, we hope to connect donors more closely with the farmers who produce the food that feeds the world.

Literature Review

To determine how caloric meals produced fits within the wider international development literature, our literature review focused on three areas:

1. Food insecurity and its relationship to caloric needs
2. Discount factors for translating agricultural production into human consumption
3. Standardizing non-standard units of agricultural production.

Food insecurity and its relationship to caloric needs

Researchers attempt to quantify hunger using a prevalence of undernutrition indicator. As measuring undernutrition typically proves difficult, caloric intake oftentimes serves as a standard proxy (Iversen et al., 2023). Calories are used as a common indicator of food insecurity across the literature, especially in severe food insecurity environments. Khan and Ali discuss how food insecurity is associated with malnutrition and emphasize the importance of removing barriers for the delivery of healthy and wholesome foods (2023).

We only focus on calories when estimating the number of caloric meals produced using our calculation. There are obvious limitations to our approach, we discuss in detail within the limitations section below. From a literature perspective, while caloric need is oftentimes used as a proxy for malnutrition, the overlap is incomplete. Bocoum et al. (2014) discuss the connection between household financial poverty and food security, noting that households do not always prioritize the most affordable calories when making their food purchasing decisions. Hossain et al. (2019) test alternative approaches to caloric based food security measurement techniques, suggesting that adding subjective measurements of food insecurity increases the predictive accuracy of their measurements. Ibok et al. (2019) outline a new index for measuring food insecurity that focuses on long term food vulnerability in relation to shocks.

Discount factors for translating agricultural production into human consumption

To translate agricultural production data into number of caloric meals produced, we must account for food not used for human consumption, lost and wasted. The research by Mottet et al. (2017) on food versus feed provided us with initial guidance on our discount factors. We initially suggested a 15 percent livestock discount factor and a 25 percent crop discount factor to account for these situations.

We conducted a more extensive literature review to determine more accurate discount factors food livestock and crop production. We looked at the research on food waste, post-harvest loss, crop wastage and livestock wastage. While these are relatively under-researched areas, we identified recent literature related to all these topics.

Food wastage and loss is a major area of concern for the transformation from production to caloric meals produced. The Food and Agriculture Organization (FAO) differentiates between food loss and waste and describes that while both decrease the amount of food available throughout the overall food supply chain, food loss takes place during harvest and continues up until right before the retail level while food waste takes place during the retail and consumption levels of the food supply chain (FAO, 2019). Buzby, Wells and Hyman (2014) discuss that food loss refers to post-harvest food that is available for human consumption but is not consumed and explains that this could include losses from cooking foods, contamination, insects and other animals, spoilage and unconsumed foods. Abass et al. (2014) describe how post-harvest management and infrastructure impact post-harvest losses. While Crisendo et al. (2023) explore the relationship between food loss and socioeconomic factors during the different stages of the food supply chain including farm, harvest, storage and transporting crops

We use average discount factors to transform production into caloric meals produced. To estimate how much food loss and wastage occurs; to incorporate into our discount factors, we reviewed a wide range of literature. Unfortunately, the literature fails to identify a global standard around food wastage averages. Kitinoja et al. (2018) note the need for more standardization of food loss and food waste measurements at different points in the food supply chain in order for more accurate reporting. Delgado (2021) emphasizes how food loss has many ways of being defined and that there is no standardization on measurement.

The United States Department of Agriculture's (USDA) Economic Research Service (ERS) provides extensive United States specific documentation of average food loss and wastage. The USDA-ERS (2025) food loss guidelines focused on loss-adjusted food availability which considers loss from retail and consumer and provides a total percentage for each type of livestock and crop commodity. The USDA-ERS food loss estimates as a percentage of total production vary from a low of 15 percent for tree nuts and peanuts to a high of 41 percent for added sugars and sweeteners. Loss categories of particular interest to us for transforming Heifer's agricultural production data are included in the Figure 1.

Unfortunately, the USDA-ERS (2025) loss percentages in Figure 1 focuses specifically on food loss in the United States, which may not be very applicable to some of the areas that Heifer International serves. Hodges, Buzby and Bennett (2011) compare post-harvest food loss in more developed countries to less developed countries and discussed how less developed countries have more financial incentive to reduce food wastes than countries like the United States. The Food and Agriculture Organization (FAO) report on food loss percentages for different commodities in their 2019 State of Food and Agriculture. They estimate food loss percentages for cereals and pulses at around eight to nine percent, fruits and vegetables at around twenty-one to twenty-two percent, meat and animal products at around eleven to twelve percent and roots, tubers and oil-bearing crops at around twenty-five percent (FAO, 2019).

FIGURE 1:

U.S. Percentage of Food Waste in 2010 (USDA-ERS, 2025)

TYPE OF COMMODITY	PERCENT OF **RETAIL LOSSES**	PERCENT OF **CONSUMER LOSSES**	**TOTAL PERCENT OF LOSSES**
Grain Products	12	19	31
Fruit	9	19	29
Fresh Fruit	12	25	37
Vegetables	8	22	30
Fresh Vegetables	10	24	34
Dairy Products	11	20	31
Milk	12	20	32
Meat, Poultry and Fish	5	22	26
Meat	4	23	27
Poultry	4	18	22
Fish and Seafood	8	31	39
Eggs	7	21	28
Tree Nuts and Peanuts	6	9	15

Research literature estimates varying amounts of global average food loss and wastage for crops. Crisendo et al. (2023) examine global food loss data and estimate average on-farm losses from fruits and vegetables at around 40 percent, while on-farm maize losses average closer to 25 percent. Kansanga et al. (2023) focuses specifically on the African region, finding average of 22 percent of household harvested food loss. Omotagjo (2018) looks at East Africa and determines cereal crops food losses of between 10 and 20 percent. Many sources examine specific countries. For example, Ridolfi et al. (2018) look at food loss within Ghana, noting maize at fourteen percent, rice at thirteen percent, cassava at thirty-three percent, ground nuts at seven percent, fish at twenty-one percent, tomatoes at thirty-seven percent, okra at twenty-four percent, mango at forty-six percent and oranges at five percent. The Ugandan Bureau of Statistics (2020) estimated annual commodity loss percentages across a range of crops. When focusing on Bangladesh, Alam et al. (2018) discover pest related food losses in maize to vary from ten to 25 percent. Delgado et al. (2017) examine food losses along the food chain in Peru, Guatemala, Honduras and Ethiopia used four different methods to calculate loss including self-reported, category method, attribute method and price method. They average the four methods and determine varying crop losses including 17 percent for Honduran beans, 19 percent for Honduran maize, 16 percent for Guatemalan maize, 18 percent for Guatemalan beans, 20 percent for Peruvian potatoes, 14 percent for Ecuadorian potatoes and8 percent for Ethiopian teff. Salihoglu et al. (2017) gathers crop loss percentages from three different sources, ultimately estimating Turkish crop loss percentages for 15 cereals, one roots and tubers, one oilseeds and pulses, 107 fruits and vegetables, nine meats, five fish and seafood, 35 dairy products and two eggs.

While Heifer projects support households working in crop production, the organization was founded on partnering with households to rear livestock. We found a wide range of livestock loss percentages in the literature focusing on Heifer supporting animals, including beef, poultry, small ruminants and rodents.

We found a few references to beef food loss percentages. Smil (2004) recommends determining the percentage of livestock that is consumed by taking the retail weight of an animal and subtracting cooking and table waste. He estimates that only 34 percent of a US beef carcass is consumed after removing bones, fat and cooking and table waste. According to South Dakota State University (SDSU) Extension, the edible percentage of a beef carcass would be about 63 percent, which would be around only 40 percent of the steer's live weight, once you remove bones, fat, muscle, etc. (SDSU Extension, 2022).

There were also a few sources that focused on poultry. Malher et al. (2015) look at food loss and waste in poultry production in France and note that around 70 percent from the carcasses of spent hens is used for human consumption. They also determine that around 31.15 percent of broiler poultry are removed due to loss, removal of by products and food waste. Miller (1964) focuses specifically on the edible yield of turkeys, explaining that the loss from cooking small turkeys was around 24 percent and from cooking large turkeys was around 32.3 percent. Miller also states that the edible meat yield for turkeys was around 54-56.7 percent depending on turkey size.

Small ruminants are a major source of agricultural production for households within Heifer projects and therefore of particular interest to us for this study. According to Washington State University Extension, about 65 percent of the pork carcass will be consumed after removing fats and bones (Kuber & Smith, n.d.). For sheep, the University of Wisconsin-Madison Livestock Division of Extension notes that an average carcass cutting yield of meat is 43-50 percent for boneless cuts and 65-75 percent for bone-in (U of W, n.d.). Wingett et al. (2018) determine that for sheep meat in Australia around 6 percent of total domestic production accounted for loss and uses beyond human consumption. Webb (2014) explains that for four different kinds of goats, Boer, Nubian X Florida, Spanish X Florida and Florida Native, the total meat yield ranged from 68 percent to 76.5 percent. Taking an average of all four different types of goats, the total meat yield for a goat on average would be around 70.45 percent with around 29.55 percent accounting for wasted and uses not for human consumption.

Finally, we focused on literature related to food loss and waste percentages for rodents, specifically guinea pigs, since these are also found within Heifer Internationals livestock commodities. Sánchez-Macías et al. (2018) note that the head and feet make up around 11 percent of the weight of a guinea pig, the carcass is made up of about 15 to 20 percent of bone and1 to 2 percent of carcass remainders that are not consumed. Considering all three factors, we assume that around 30 percent of the overall guinea pig does not go to human consumption. De Figueiredo et al. (2020) compare meat yields of male and female guinea pigs and their results showed the meat yield from female guinea pigs was around 55.40 percent of carcass weight, while the meat yield from male guinea pigs was 60.34 percent of carcass weight. Since guinea pigs in Heifer's agricultural data are not separated by sex, we take an average of those two percentages and then subtract that amount from 100 to get the discount percentage of 42.13 percent.

FIGURE 2: Comparison of Food Loss and Waste Percentages by Source and Region

SOURCE BY REGION	FRUIT & VEGETABLE	LEGUME/ CEREAL	DAIRY	FISH	POULTRY	SMALL RUMINANT & SWINE	LARGE RUMINANT	RODENT
United States								
USDA (2010), food loss	Fruit: 29% Veg: 30%	Grain: 31% Nuts: 15%	Dairy: 31%	Fish & seafood: 39%	Poultry: 22% Eggs: 28%	Meat: 27%	Meat: 27%	Meat: 27%
WSU Extension						Pig: 35%		
SDSU Extension							Cow: 60%	
University of Wisconsin- Madison Extension						Lamb: 25%-57%		
Smil (2004)							Cow: 62%	
Miller (1964)					Turkey: 24%-32%			
Webb (2014)						Goat: 29.55%		
Global								
FAO (2019)	Fruit: 21.6% Veg: 21.6%	Cereal & Pulse: 8.6%			Meat: 11.9%	Meat: 11.9%	Meat: 11.9%	Meat: 11.9%
Crisendo et al. (2023)	Fruit: 40% Vegetable: 40%	Maize: 25% Cereal & Pulse : 15%-23%						
Njie (2012)			Dairy: 20%	Fish: 30%				
Hodges et al., (2011)		Grain: 9.9%-17.5%						
Africa								
Kansanga et al. (2023)	Sweet Potato: 26%	Maize: 22% Beans: 22%						
Uganda BoS (2020)	Banana: 15% Other Fruit: 10% Potato: 20% Other Veg: 10%	Millet: 10% Wheat: 3% Rice: 5% Maize: 8.2%	Cow Milk: 5%		Eggs: 5%			
Ridolfi et al. (2018)	Tomato: 37% Mango: 46% Orange: 5% Cassava: 33% Okra 24%	Maize: 14% Rice: 13% Nuts: 7%						
Omotagjo (2018)		Cereal: 10%-20%		Fish: 21%				
Asia								
Alam et al. (2018)		Maize: 10%-25%						
Salihoglu et al. (2017)	Fruit: 38%-69% Veg: 38%-69%	Cereals 7%-8% Oilseed & Pulse: 1%	Dairy: 8%-27%	Fish & Seafood: 5%	Meat: 8%	Meat: 8%	Meat: 8%	Meat: 8%
Central America								
Delgado et al. (2017)	Potato: 14%-20%	Maize:16%-19% Teff: 8% Beans: 17%-18%						
Sánchez-Macías et al. (2018)								Guinea Pig: 30%
De Figueiredo et al. (2020)								Guinea Pig: 42%
Europe								
Malher et al. (2015)					Spent hen: 30% Broiler: 31%			
Oceania								
Wingett et al. (2018)						Sheep: 6%		

Considering the large amount of information available on food loss and waste and the large number of commodities included in Heifer International's datasets, we group individual commodities into commodity categories to create standard discount rate by commodity. The commodity categories include fruits, vegetables which also contain tubers, legumes and cereals grouped together, sweeteners and oils grouped together including honey, dairy products, fish, poultry and poultry eggs, small ruminants including sheep, goats, swine, large ruminants including buffalo and cows and rodents to account for guinea pigs and rabbits. We outline these discount factors by commodity in Figure 2.

Standardizing non-standard units of agricultural production

Another critical part of this project involves standardizing units of measurements in order to calculate agricultural production totals across the different crop and livestock production categories. While food consumption and agricultural production are frequently used methods of measurement, Oseni et al. (2017) note that converting non-standard units of measurement is a relatively recent focus within the literature. They reference discuss how survey respondents often find it easier to report agricultural production in local units instead of international standard units of measurement and that recording production in local units might increase accuracy of the reporting. Heifer International's standard survey allows respondents to use nonstandard units when necessary, so the datasets include nonstandard units of measurements like handfuls, boxes, bags, basins, bundles, bunches, number of specific crop commodities, etc.

Given the variety of measurement types within Heifer's data, we prioritized creating a conversion factor for non-standard units of measure. To increase our confidence in these conversions, we looked for research support for converting these nonstandard measures into kilograms. We summarize our findings from the literature in Figure 3. The conversions listed in Figure 3 are some of the nonstandard units of measurement conversions currently being used by Heifer, which have been supported through internal assessment and a general review of the literature.

FIGURE 3:

Nonstandard units of measurements conversion to KG

UNITS OF MEASUREMENT	KG PER UNIT OF MEASUREMENT
Basin	15
Basket	30.30
Box	7
Handful	0.23
Unit of Banana	7
Unit of Lemon	4
Unit of Orange	6

During the literature review, we found a few sources that discuss weights of nonstandard units of measurements for this project and can be added to Figure 3 to be used when standardizing the datasets for this project and future projects. The nonstandard units we searched for were ones that we came across in Heifer's datasets. Specifically, we wanted to convert bags, banana bunches, specific fresh fruits and vegetables (e.g. okra, pineapple, pepper, avocados, etc.), goat milk and country specific units of measure (e.g. Haitian, Ecuadorian, Nepalese).

When examining Heifer's data, bags is a commonly mentioned non-standard unit of measurement. Ndegwa et al. (2016) focus on bags as a measurement for maize in Kenya and noted that each bag held 90 KG of maize, which they note is a Kenyan standard size. Fintrac Inc. (2015) determines the average weight of a bag of potatoes Kenya to be 110 KG. When searching for standard bagging weight, we found that David et al. (2015) describe standard seeds and nuts bags in Uganda having an average bagging weight of 42 KG. Kilimo (2012) describes the average size of bags for legumes and cassava in Uganda as 100 KG bags. Bhore (2021) finds the average weight of avocados to be 120 KG bags. For bags of tomatoes in Ecuador, we assume that they used standard 12-pound bags, which weigh around 5.63 KG when used for tomatoes according to the International Trade Administration (2021). For bags of onions in the Americas, the University of Georgia Extension (2022) lists that the standard bag of onions weighs 40 pounds or 18 KG.

Along with bags, another highly used non-standard unit of measure within the Heifer data are bunches. These bunches typically refer to banana crops, so understanding weights of bananas bunches is essential for accurate data standardization. Ndabamenye et al. (2012) research bunches of East African highland bananas and notes that a medium sized bunch is 14.7 to 15.5 KG. Based on this study, we establish an average and assumed that a bunch of bananas would be around 15 kilograms for the Rwanda and Uganda datasets.

Bananas are reported by *régimes* in Haiti and the Ministry of Agriculture lists the three banana types commonly produced with average weights of 14 KG, 16 KG and18 KG (Kass, 2018, p. 1). For the dataset with responses collected from participants in Haiti, we use an average of these three to banana types and assumed each *régime* of bananas weighed around 16 KH. We also assume that the average weight of plantains is like that of bananas.

Within the Heifer data, several non-standard units of measure are reported within the Ugandan data, especially around fruits and vegetables. Dijkxhoorn et al. (2019) provide estimates for Ugandan fruit and vegetable measurement types, noting the average weight for fresh pineapples ranges from 800 grams to 2,750 grams depending on classification. Based on this estimate, we assume that the average weight on an individual pineapple is 1,775 grams or 1.78 KG. They also describe wooden crates of Ugandan tomatoes as weighting around 230-250 KG and that a box of peppers is usually around 6-7 KG. Additionally, they determine avocados to range from 123 to more than 500 grams per fruit, so using this source, we assumed that avocados weigh around 311 grams or .31 KG. Heifer also records okra and common beans within the Ugandan data, but we were unable to find an average weight within the Ugandan literature. As a proxy for okra weights, we look to Aluko et al. (2020). They discuss okra in western Africa with an average weight of .10 to .18 KG depending on fertilizers use. We take an average from the range to get .14 kg per okra. When trying to find the weight of individual bean pods, we use Karavidas et al. (2023) as a proxy, where they record Rwanda common bean pod to weight on average around 10 grams.

Haiti is another country that includes many non-standard measurements within their data. Mintz (1961) describes marmite as number 10 cans typically used to measure grains and other crops for market and can hold approximately 110.7 ounces or around 3 KG. A report from the Ministry of Agriculture in Haiti also listed a marmite of coffee as 3 KG, a marmite of maize as 2.7 KG, a marmite of groundnuts as 3 KG, a marmite of peppers as 1 KG and a marmite of rice as 2.7 KG (Kass, 2018). For legumes and cereals, we round up to 3 KG. Since marmite averages around 3 KG for most commodities listed and Kass Does not list out a marmite of fruits and vegetables, we assume that those are also both around 3 KG. Kass also lists a "sac" of as weighing between 22.7 KG to 25 KG and a parquet weighing 15 KG. We average the weights listed for a "sac" and rounded up to 24 KG per sac.

A few crop commodities were listed by individual number in the sets from Bangladesh, so we looked for location specific average weights for betel leaves, lemons, pumpkins, gourds and cabbage. Vernekar & Vijayalaxmi (2019) note that the average weight of two different kinds of betel leaves is around 3.3 grams and 1.83 grams. Using an average of the two weights, we use 2.57 grams per leaf (.0025 KG). Another crop reported by individual unit in Bangladesh was lemons, which average around 260 grams (.26 kg) per fruit according to the Bangladesh Agricultural Research Institute (National Encyclopedia of Bangladesh, 2021). For pumpkins, Ahamed et al. (2011) finds the average weight of Bangladeshi pumpkins to weigh between 1.5 KG to 4.2 KG depending on the different types of pumpkin. Using an average from this source, we use 2.85 KG per pumpkin.

In the datasets from Nepal, there were a few households that reported fruit by number of items without the type of fruit listed. For these, Shrestha (2022) looks at Nepali fruits and finds bananas between 12-30 KG per fruit depending on type, guava listed between 60-230 g, citrus fruits listed between 35-50 g, apples listed between 140-155 g and mangoes listed between 170-175 g. To determine weight per unit of fruit, we average each type of fruit listed in this source and then averaged those totals to get 4.3 KG per unit of fruit.

In the datasets from Ecuador, some commodities reported by the individual number of crops included lettuce, broccoli, radish, beets and corncob. Cabilovski (2011) finds the average head of lettuce weighed between 396 and 415 grams. Kayesh et al. (2019) notes that the average head weight of broccoli is around 425 grams. For radishes, Rotunno (1924) discusses how beets range from 1.72 grams to 2.89 grams, so we take an average of 2.3 grams per beet. Eren et al. (2016) finds average corncob weights of 269 grams per corncob. For entries listed as garden vegetables, we look at the most common vegetables grown in Ecuador, noting that onions are at the top of that list and assumed that it would be reasonable to use standard weights for onions for these vegetable data entries. According to the National Onion Association (n.d.), the average weight for an onion is 12 ounces or .34 kg.

Some crops were listed by unit that we could not find sources focused on average weights for Ecuador specifically but could find weights for the item in other regions and assumed would be around the same. For melons, Ahrolovich (2019) notes that the average of melon fruits is 3-11.5 KG. For papayas, Meena et al. (2012) lists a variety of papayas and their average weights, which average out to .51 KG. Ayala Silva and Ledesma (2014) explain that avocados range from 3 to 10 ounces each. Gourds were also listed by unit and one source compared a variety of gourd characteristics and noted that the average weight was 1.25 kg (Kandasamy et al., 2019). For oranges, Shravan and Shere (2018) list the average weight as 198.5 grams. The FDA (2017) determines the weight of cauliflower as 594 grams, the average weight of a tomato as 148 grams and the average weight of a cucumber as 297 grams.

For livestock, we needed to establish an average milk production for dairy goats. We found an article from the USDA site that notes that a goat produces an average of 1,399 pounds of milk annually, which converts to 634.6 KG (USDA, 2012). For ease of reference, we consolidate all these averages in Appendix A at the end of this paper.

Methodology

We begin by defining a meal within a local context. As part of Heifer's core monitoring and evaluation process, each of our projects which are aimed at supporting farmers toward closing the living income gap for themselves and their families must establish a Living Income Benchmark. This benchmark provides a guideline for the localized cost of living associated with minimum acceptable diet, housing, other components of dignified living—such as clothing, education and healthcare—and savings to withstand financial shocks and stresses. The minimum acceptable diet component highlights the recommended calories per capita, their ideal nutritional source and their associated cost. With this information, specifically the first piece, we can determine what the minimum viable standard is for a single meal in each of our project demographic areas.

FIGURE 4:

Heifer's Living Income Benchmark Components

Each year, we collect data from program participants across the world through household surveys, accumulating information on household demographics, crop and livestock production quantities and financials related to agricultural activities. Each household reports on the types of crops produced, including the amount of each crop grown, consumed, given away, sold and that went to waste. Similarly, we also report on livestock quantities birthed, given away, sold and deceased within that reporting year. Heifer International uses these data within our "meals produced" calculation to report on total meals produced through specific programs.

To provide accurate reporting, we must first standardize the units of measurement used within all agricultural data collected on projects supported by funding partners before running calculations. The chosen unit for the calculation is kilograms, which, in many cases, requires a set of conversions from either local units, in the case of crops, or from individual head of animals, by relying on average weights. After standardizing the unit to kilograms, we take the number of kilograms for each type of crop produced and subtract out the amount reported as wasted. Similarly, for livestock, we take the total produced each year subtracted by the total that died that year for each type of animal.

After the total number of relevant (non-wasted) kilograms is calculated for each commodity, we then refer to the U.S. Department of Agriculture's Food Data Central (USDA, 2024) to pull caloric data for each commodity to convert total kilograms produced of each commodity into total calories produced for that commodity. Common calorie conversions are included in Appendix C. Once we have total calories produced for each type of commodity, we then total up all calories from crops and all calories from livestock for the project and then remove a percentage to account for waste and other uses beyond human consumption, such as animal feed, tithing, cultural practices, utilizing animals for farm labor, etc. The discount factor used is fifteen percent for crops and twenty-five percent for livestock. These percentages were determined from previous research including an article analyzing food versus feed (Mottet et al, 2017).

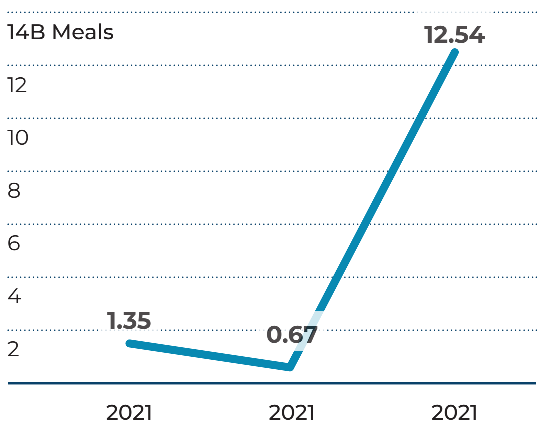
Post-discount, we extrapolate the caloric production values from sample population to full project population to arrive at an estimated total caloric production. Once we have estimated the total calories produced for both crops and livestock, we then convert this total into "meals produced" based on the minimum caloric definition of a meal established in our Living Income Benchmark process.

Results

After finalizing data analysis, we aggregate results by contributing project, establishing a post-discount number of meals produced total for each implementation year, as well as working to apportion estimated meal production according to the value of CSR investment we received. Over the past three years, we have been able to calculate meals produced from a number of our projects across our portfolio. Each year, we had a different number of projects from which we were able to conduct these analyses, which helped to contribute to a large degree of variation that we see in the number of calories and meals produced.

Additionally, caloric production is a function of farm yield, which is not consistent across time due to both on-farm and other environmental factors. With that in mind, Chart A outlines the year-on-year extrapolated meal production values.

CHART A:
Number of Meals Produced, 2021-2023



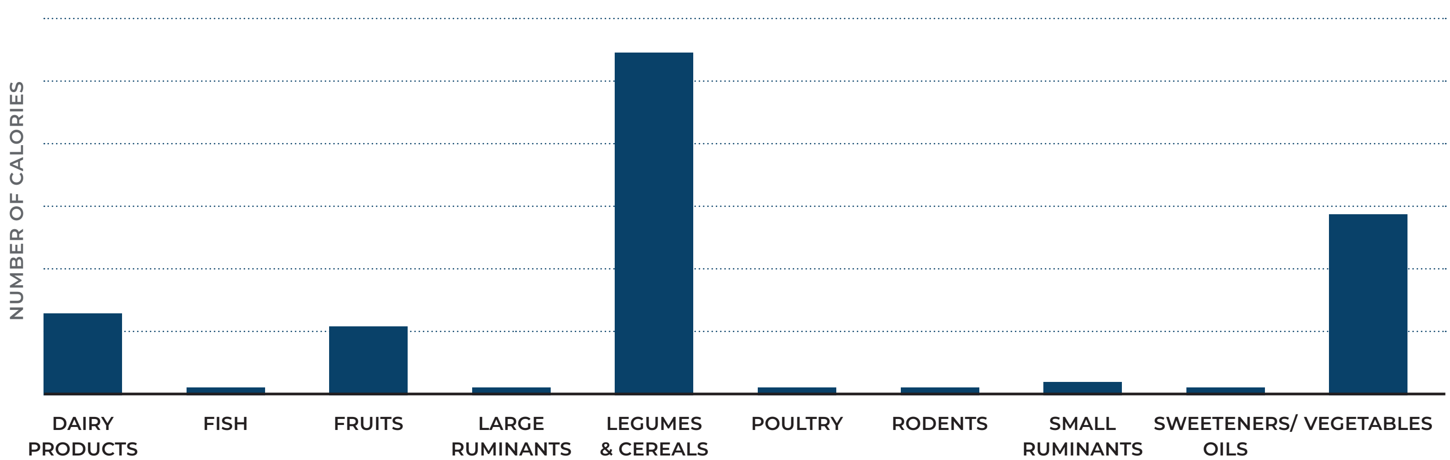
In the 2023 fiscal period, running from July 2022 to June 2023, we analyzed production data from 15 projects across the globe in order to establish a meal production quantity, representing nine countries from across our three geographic portfolios and a combined participant population of over 450,000 smallholder farmers.

Within these projects, sampled households reported producing a wide array of commodities, which we have consolidated into the following food groups:

- Dairy Products
- Legumes & Cereals
- Sweeteners & Oils
- Fish
- Poultry
- Vegetables
- Fruits
- Rodents
- Large Ruminants
- Small Ruminants

Within these categories, our participating projects reported approximately 229 million meals-worth of calories produced. When extrapolated beyond the sample and to the full project population, the reporting projects' farmers produced an estimated 12.5 billion meals worth of calories. Most of these calories came from high-yield, calorically dense crops such as cereals and legumes, starchy vegetables, dairy products and fruits. The lowest contribution to total caloric production came from culturally specific commodities like guinea pig, situationally relevant commodities such as fish raising and commodities with higher processing requirements such as sweeteners and oils.

CHART B: Quantity of Calories Produced by Commodity Type

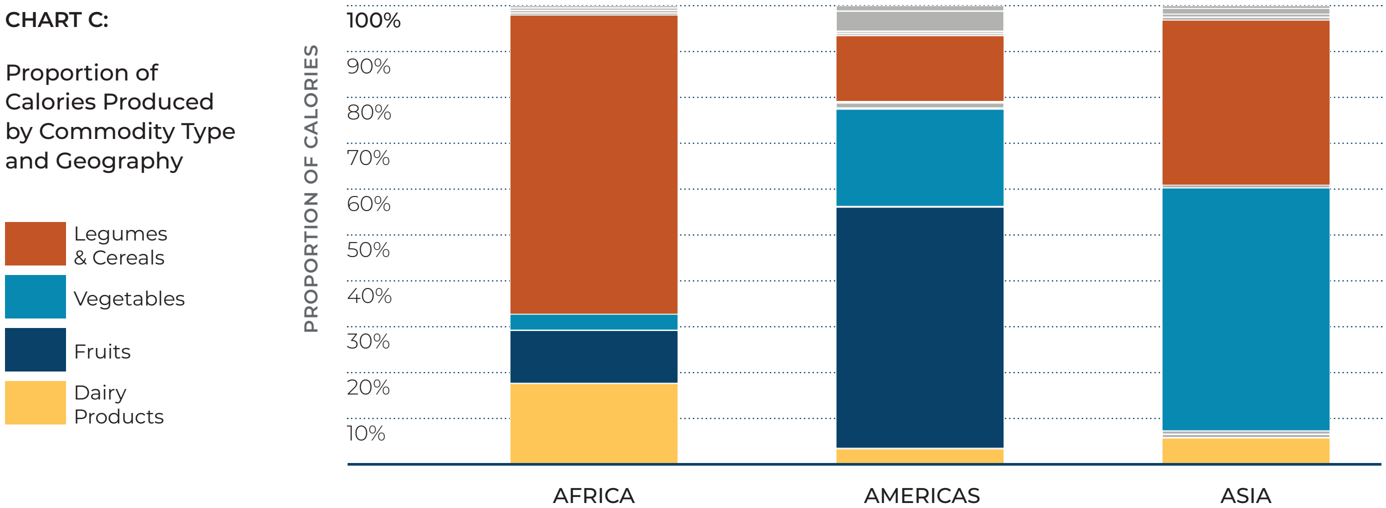


It is important to note that, while Heifer International began as a livestock-focused organization, at least a significant portion of our projects aimed at helping establish more sustainable and dignified livelihoods for smallholder farmers are not reporting much in the way of animal production. Calories produced from animal sources, with a few notable exceptions (dairy), are quite low. It is also important to note, however, that this sample of projects is not representative of Heifer's work as a whole and is not intended to be used as a general roadmap of Heifer's value chain interventions; however, the fact that animal sourced calories make up such a minority of the calories produced is indicative of the wide variety of local contexts within which Heifer works, as well as the degree to which Heifer's work has diversified from its initial mandate of placing animals as a form of financial stimulus.

As is to be expected from a diverse portfolio attempting to work with farmers to develop locally relevant and sustainable value chains, the sources of calorie production from each of our geographic regions are distinct and illustrate the differences in crop prioritization within the projects in those areas.

CHART C:

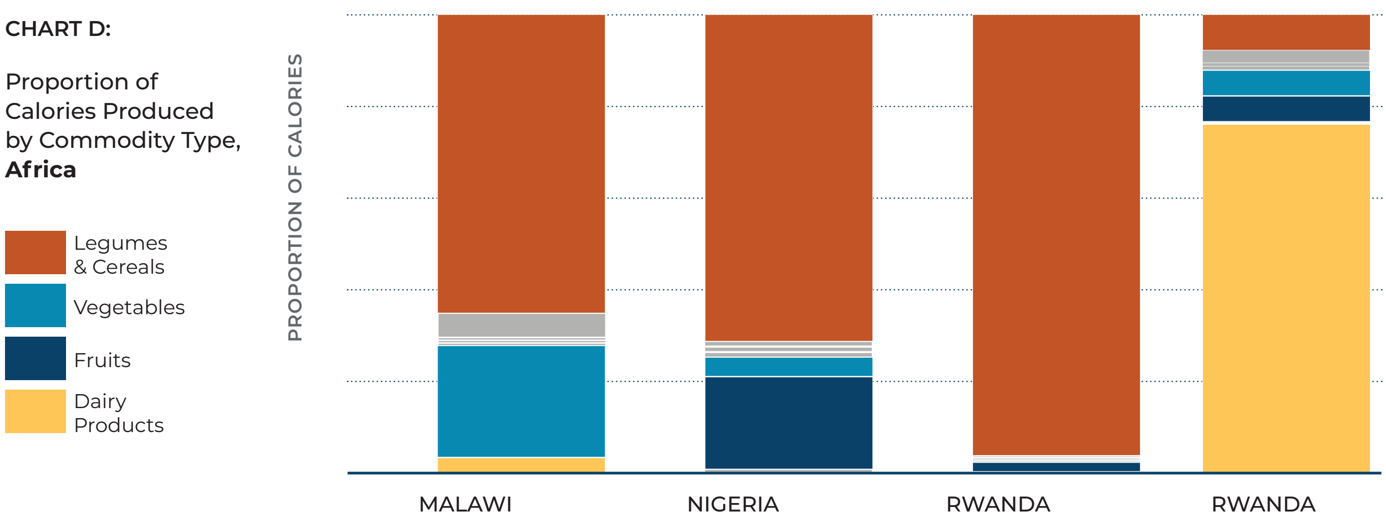
Proportion of Calories Produced by Commodity Type and Geography



If we look at Africa in Chart C, we can see that legumes and dairy are the largest contributors to calorie production for FY23. As is illustrated below, our projects in Uganda have a strong focus on dairy production and processing, while our projects in Rwanda, Malawi and Nigeria reported large amounts of maize and rice being produced, lending itself to the large contribution of legumes and cereals to the overall Africa caloric distribution above. Our reporting project in Nigeria also reported many calories from tomato production, lending itself to the sizeable fruit calorie contribution as compared to Asia, for instance.

CHART D:

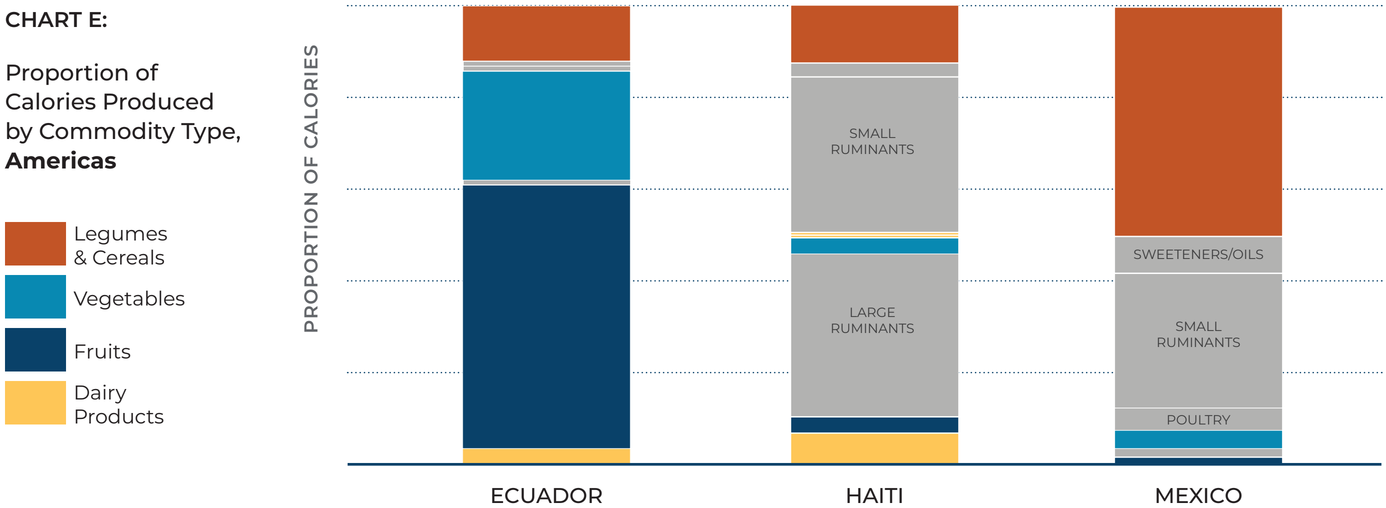
Proportion of Calories Produced by Commodity Type, **Africa**



In our projects in the Americas, we saw a wider differentiation within project focus and caloric production. In Ecuador, where our projects work extensively in the coffee and cacao value chains, both of which are fruits, we see a large contribution to overall calories produced from the fruit category, with vegetables and legumes making up most of the remaining calories reported.
In Haiti, we see one of the few projects in our meal production portfolio where most calories reported did come from animal-based protein sources, with the majority coming from large ruminants like cows and slightly fewer being sourced from small ruminants like sheep and goats. In Mexico, we saw most reported calories came from the legumes and cereals category, because our projects in Mexico all have a significant sub-focus on traditional *milpa* grain farming.

CHART E:

Proportion of Calories Produced by Commodity Type, **Americas**

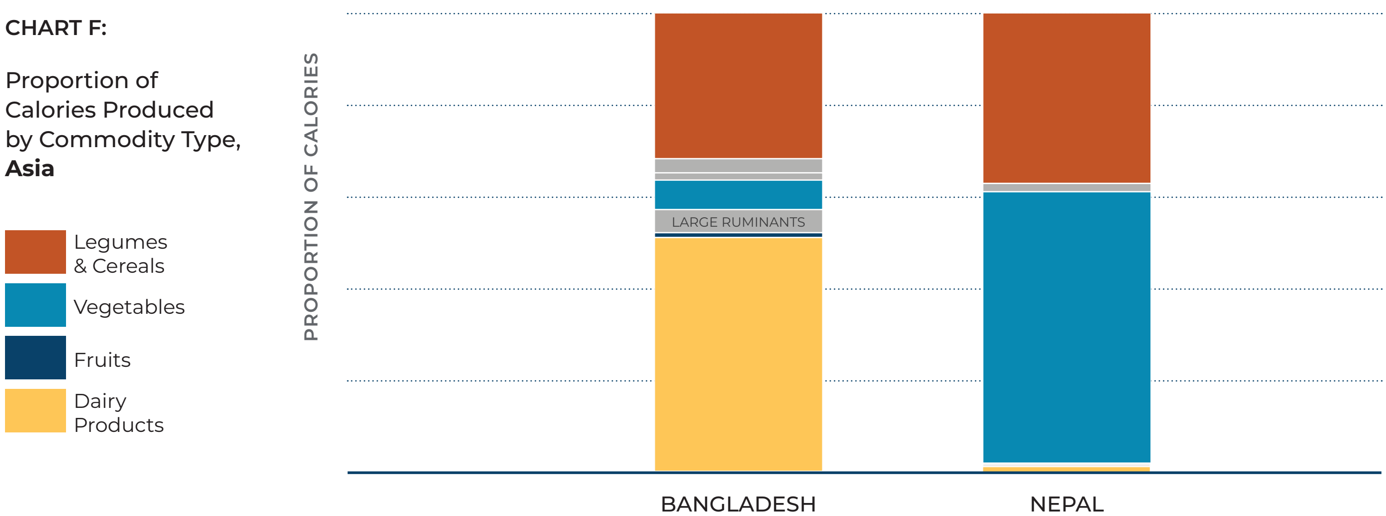


Though we have a smaller number of contributing projects from our Asian portfolio, we can see that most calories reported from our Asian project offices were legumes and cereals, vegetables, or dairy. Our projects in both Bangladesh and Nepal grow a large quantity of rice, contributing to the large prevalence of cereals. As you can see in Chart F, Bangladesh's primary cash commodity within our project structure is small ruminants, namely goats. These calorie counts, however, indicate that the ruminants are not being bred for the purpose of meat consumption, but rather to be used for dairy production.

In our Nepal projects, we see a large quantity of both garden and commercial vegetables reported. Of these vegetables, the most reported were cauliflower, potatoes, spinach and mustard greens and an indigenous leafy plant called gundruk, a common staple in Nepalese cooking. However, Nepal's primary value chain within our project structure is also small ruminants, but that does not appear to emerge from the production data, with only a very small sliver of the total calorie production associated with ruminants. One explanation could be that projects are highlighting the potential of ruminant raising as an income diversification strategy and marketing said strategy to farmers who predominately work in vegetable and cereal production.

CHART F:

Proportion of Calories Produced by Commodity Type, **Asia**



Our research included running all of the reported commodities through the USDA Food Data Central database, which contains a comprehensive macronutrient profile for each large array of commodities. To streamline the conversion process, we designed a calculator that would use the nutritional information from the USDA tool to convert post-discount caloric production into commodity-specific meal production. The process of developing the tool was insightful, as it gave us a view into the types of commodities that generate the largest number of calories, as well as those that are not as calorically dense.

To be expected, oils and fat sources in one's diet generate the largest number of edible calories at 8800 kcal per KG produced, contrasted against leafy greens and other garden vegetables which are nearly calorie negative (in the case of lettuce, cucumber, coffee and chard, all ranging between 150 and 200 kcal per KG) or calorie negative and requiring more calories for the body to process than the food itself actually contains (celery and chayote, both less than 100 kcal per KG).

The largest contributor to Heifer's caloric production is cereals. Maize, rice and other cereals make up nearly 37 percent of all calories reported and cereals as a category contribute an average of nearly 4000 edible kcal per KG produced. Dairy sources, while representing only 7 percent of our annual caloric contribution from on-farm production, universally contribute over 1000 edible kcal per KG produced, ranging depending upon the dairy source.

The purpose of this calculation, by design, was to establish a process by which we could respond to interdisciplinary CSR donors looking for investment opportunities by using available data in a creative way. Thus, our final step in our analysis was determining, of the total calories (and by extension, meals) we estimate based on our production data, how many can we say that a CSR donor contributed to with their investment? Arriving at a defensible and equitable number of meals requires us to make a few additional assumptions. First, we have to assume that estimated total crop and livestock production values are associated with the full cost of our project. Second, we have to assume that production values would not have reached reported levels without our project's intervention. Third, we have to assume that a proportion of the project budget would yield a proportion of total caloric production.

Thus, we arrive at a simple principle: if a CSR donor provides us with capital equal to 10 percent of the total cost of delivery of a project for the given year, they are entitled to say that they contributed to 10 percent of the total estimated meals produced by a project each year. As previously stated, we are very clear about what can and cannot be said regarding the data and analysis we are conducting. We are not able to make claims about nutrition, about food security, about meal consumption, about hunger rates, etc. with these data. However, our analysis and reporting has been extremely well-received by our CSR donors with whom we have partnered to establish this methodology, predominately because the methodology is a creative solution with limited additional lift requirement that allows the CSR donor to meet (and exceed) enumerated targets related to food production.

As we move forward, our plan is to continue developing the methodology, expanding our analysis so that we can substantiate a greater number of impact statements, develop a more holistic and granular understanding of the food systems in which we work and appeal to a larger population of CSR donors who are looking to invest in creative solutions. We will, additionally, continue to pursue publication of this method and look for opportunities to integrate into communities of practice that can either benefit from this methodology or contribute to strengthening it.

Limitations

Calories alone do not equal meals (e.g. rice)

The methodology revolves around establishing a meal-equivalent calorie value to establish the number of meals produced based on caloric value of total production. The methodology does not allow us to make any claims regarding the nutritional value, as 750 calories worth of rice may be the caloric equivalent of a meal, but it contains no dietary diversity.

Discount factor

Our discount factor is based on some prior research regarding the proportion of on-farm production that is dedicated to non-consumptive uses such as animal feed and religious ceremony; however, the research into these phenomena is limited in scope to certain geographies and is limited in quantity.

USDA Calorie Converter based on United States averages

When converting from production quantities to calories, we use the USDA Food Data Central to identify the average caloric value of one KG of each commodity. These averages are based on ideal circumstances, such as the average size and weight of livestock and average composition of edible crops. These averages, as such, are based on a Global North ideal that is unlikely to be replicated in a developing context. The average meat animal in a developing context is not as likely to have the same body composition as the average meat animal in a high-income nation, thus leading to variations in nutritional value that may or may not lead to a skewed number of calories produced.

Conclusion

Caloric meals produced are a useful transformation of existing agricultural production data to allow for an easy interpretation of the value of project support. The conversion of these data into caloric meals produced allows major donors to support international development projects while simultaneously fulfilling their CSR needs. The ease with which this measure can be produced allows other development focused organizations to generate caloric meals produced numbers and explain their work to a lay audience.

In terms of next steps, we plan to transform Heifer's fiscal year 2024 agricultural production data into caloric meals produced, continue to partner with our corporate sponsor to fund Heifer International programming and begin to explore opportunities to use this measure with a general audience. We see caloric meals produced as a valuable tool that allows us to simplify and explain how our projects benefit households.

Bibliography

Abass, A. B., Ndunguru, G., Mamiro, P., Alenkhe, B., Mlingi, N., & Bekunda, M. (2014). Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. Journal of Stored Products Research, 57, 49–57. https://doi.org/10.1016/j.jspr.2013.12.004

Ahamed, K., Akhter, B., Islam, M., Ara, N., & Humauan, M. (2011). An Assessment of Morphology and Yield Characteristics of Pumpkin (Cucurbita Moschata) Genotypes in Northern Bangladesh. Tropical Agricultural Research & Extension. 14(1).

Ahrolovich, R. N., Urinbaevana, M. H., & Madiyarovich, S. S. (2020). Melon and its environmental characteristics.Journal of Critical Reviews,7(2), 480-490.

Alam, M. J., Ahmed, K. S., Sultana, A., Firoj, S. M., & Hasan, I. M. (2018). Ensure food security of Bangladesh: Analysis of post-harvest losses of maize and its pest management in stored condition. Journal of Agricultural Engineering and food technology, 5(1), 26-32.

Aluko, M., Kehinde-Fadare, A., Oluwole, O. (2020). Growth and Yield of Okra (Abelmoschus esculentus (L.) Moench) Under the Influence of Different Organic Fertilizers. International Journal of Research and Innovation in Applied Science.

Aulakh, J., Regmi, A., Fulton, J., & Alexander, C. (2013). Estimating Post-Harvest Food Losses: Developing a Consistent Global Estimation Framework. https://ageconsearch.umn.edu/record/150363/files/AAEA_Poster_Post-harvest.pdf

Ayala Silva, T., & Ledesma, N. (2014). Avocado history, biodiversity and production.Sustainable horticultural systems: Issues, technology and innovation, 157-205.

Banglapedia: National Encyclopedia of Bangladesh. (2021). Lemon. https://en.banglapedia.org/index.php?title=Lemon#

Bhore, S., Ochoa, D., Al Houssari, A., Zelaya, A., Yang, R., Chen, Z., Deeya, S., Sens, S., Schumann, M., Zhang, Z., & Eltantawy, E. (2021). The Avocado (Persea americana Mill.): A Review and Sustainability Perspectives.

Buzby, J. C., Wells, H. F., & Hyman, J. (2014). The Estimated Amount, Value andCalories of Post-harvest Food Losses at the Retail and Consumer Levels in the United States.

Cabilovski, R., Manojlović, M., Bogdanovic, D., Rodic, V., & Bavec, M. (2011). Fertilization Economy in Organic Lettuce Production. Journal of Sustainable Agriculture. 35. 745-756. 10.1080/10440046.2011.606491.

Cafiero, C., Viviani, S., & Nord, M. (2018). Food Security Measurement in a Global Context: The Food Insecurity Experience Scale. Measurement,116, 146-152.

Cassidy, E. S., West, P. C., Gerber, J. S., & Foley, J. A. (2013). Redefining agricultural yields: From tonnes to people nourished per hectare. Environmental Research Letters, 8(3). https://doi.org/10.1088/1748-9326/8/3/034015

Clements, P. (2012). Evaluating the Cost Effectiveness of Heifer International Country Programs. Journal of MultiDisciplinary Evaluation, 8(18), 16–28.

Clinton, Bill. (2007). Giving: How Each of Us Can Change the World. Alfred A. Knope.

Creswell, J. W., & Creswell, D. J. (2018). Research Design, Qualitative, Quantitative andMixed Methods Approaches (5th ed.). SAGE Publications Inc.

Crisendo, D., Piiponen, J., Heino, M., & Kummo, M. (2023). Socioeconomic Factors of Global Food Loss. 12, 23. Agriculture & Food Security. https://doi.org/10.1186/s40066-023-00426-4

David, K., Patrick, O., Puppala, N., Ureta, B., Michael, D., Jane, I., Paul, A., Moses, B., Cresencia, A. (2015). Groundnut Seed Production Manual for Uganda. National Agricultural Research Organisation: Entebbe, Uganda.

De Figueiredo, L. B. F., Rodrigues, R. T. D. S., Leite, M. F. S., Gois, G. C., Araújo, D. H. D. S., de Alencar, M. G., & Queiroz, M. A. Á. (2020). Effect of sex on carcass yield and meat quality of guinea pig.Journal of Food Science and Technology,57, 3024-3030.

Dépigny, S., Delrieu Wils, S., Tixier, P., Keng, M., Cilas, C., Lescot, T., Jagoret, P. (2019).

Plantain productivity: Insights from Cameroonian cropping systems. Agricultural Systems, 168.https://doi.org/10.1016/j.agsy.2018.10.001.

Dierolf, T. S., Kern, R., Ogborn, T., Protti, M., & Schwartz, M. (n.d.). Heifer International: growing a learning organisation. Retrieved November 6, 2023, from https://developmentinpractice.org/readers/Learning%20Org/Dierolf.pdf

Dijkxhoorn, Y., van Galen, M., Barungi, J., Okiira, J., Gema, J., & Janssen, V. (2019).The vegetables and fruit sector in Uganda: Competitiveness, investment and trade options. (Wageningen Economic Research report; No. 2019-117). Wageningen Economic Research.https://doi.org/10.18174/505785

Eren, B., Keskin, B., Yilmaz, I., & Karakus, B (2016). Determination of Yield and Some Plant Features of Grain Corn Varieties. Igdir University, Faculty of Agriculture, Department of Agronomy.

FAO, IFAD, UNICEF, WFP, & WHO. (2022). The State of Food Security and Nutrition in the World: Repurposing Food and Agricultural Policies to Make Healthy Diets More Affordable. In The State of Food Security and Nutrition in the World 2022. FAO. https://doi.org/10.4060/cc0639en

FDA. (2017). Nutrition Information for Raw Vegetables. https://www.fda.gov/food/food-labeling-nutrition/nutrition-information-raw-vegetables

Fintrac Inc. (2015). USAID-KAVES: Potato Value Chain Analysis. USAID From the American People.

Food and Agriculture Organization of the United Nations (FAO). (2019). The State of Food and Agriculture: Moving Forward on Food Loss and Waste Reduction. Rome. Licence: CC BY-NC-SA 3.0 IGO.

GivingUSA, 2024. https://givingusa.org/giving-usa-limited-data-tableau-visualization/

Hodges, R. J., Buzby, J. C., & Bennett, B. (2011). Post-harvest losses and waste in developed and less developed countries: Opportunities to improve resource use. Journal of Agricultural Science, 149(S1), 37–45. https://doi.org/10.1017/S0021859610000936

Hossain, M. Mullally, C., & Asadullah, M. N. (2019) Alternatives to calorie-based indicators of food security: An application of machine learning methods. Food Policy, 84, 77-91. https://doi.org/10.1016/j.foodpol.2019.03.001

Ibok, O. W., Osbahr, H., & Srinivasan, C. (2019). Advancing a new index for measuring household vulnerability to food insecurity. Food Policy, 84, 10-20. https://doi.org/10.1016/j.foodpol.2019.01.011

International Trade Administration. (2021). Interim Box Weight Charts. https://www.trade.gov/tomatoes-box-weight-charts

Kandasamy, R., Arivazhagan, E., & Bharathi, S. S. (2019). Evaluation of growth and yield characters in bottle gourd (Lagenaria siceraria (Mol.) Standl.).Journal of Pharmacognosy and Phytochemistry,8(3), 4653-4655.

Kansanga, M. M., Mohammed, K., Batung, E., Ansumah Saaka, S., & Luginaah, I. (2023). Lost harvest: examining the association between post-harvest food loss and food insecurity in semi-arid Ghana. International Journal of Sustainable Development & World Ecology, 30(7), 776–791. https://doi.org/10.1080/13504509.2023.2198507

Karavidas I., Ntatsi G., Marka S., Ntanasi T., Consentino B., Sabatino L., Iannetta P/, Savvas D. (2022). Fresh Pod Yield, Physical and Nutritional Quality Attributes of Common Bean as Influenced by Conventional or Organic Farming Practices. Plants (Basel). 12(1):32. doi: 10.3390/plants12010032. PMID: 36616159; PMCID: PMC9824475.

Kass, Marché. (2018). Unité Statistique Agricole et Informatique: Système d'Information sur les Marchés Agricoles (SIMA). Ministere De L' Agriculture Des Ressources Natureles Et Du Development Rural. https://agriculture.gouv.ht/statistiques_agricoles/wp-content/uploads/2018/05/Rapport_Prix-March%C3%A9-Kass-pour-le-21-mai-2018.pdf

Kayesh, E., Sharker, M. S., Roni, M. S., & Sarker, U. (2019). Integrated nutrient management for growth, yield and profitability of broccoli.Bangladesh Journal of Agricultural Research,44(1), 13-26.

Khan, Z., & Ali, A. (2023). Global Food Insecurity and its Association with Malnutrition. 2.Emerging Challenges in Agriculture and Food Science.

Kilimo Trust. (2012). Development of Inclusive Markets in Agriculture and Trade (DIMAT): The Nature and Markets of Bean Value Chains in Uganda.

Kilimo Trust. (2012). Development of Inclusive Markets in Agriculture and Trade (DIMAT): The Nature and Markets of Cassava Value Chains in Uganda.

Kitinoja, L., Tokala, V. Y., & Brondy, A. (2018). Challenges and opportunities for improved post-harvest loss measurements in plant-based food crops. Journal of Post-harvest Technology (Vol. 06, Issue 4). http://www.jpht.info

Kuber, P. & Smith, S. M. (n.d.). From Pig to Pork Chop: How Much Meat to Expect from a Butcher Hog. Washington State University Extension.

Lal Shrestha, S., Dhakal, M., Gautam, I., & Pandey, S. (2022). Research Status on Fruit Research and Future Strategy under Nepal Agricultural Research Council. National Horticulture Research Center, Khumaltar, Lalitpur.

Lucantoni, D., & Domarle, J. (2023). Unlocking food security and livelihoods: the transformative power of agroecology among vulnerable smallholder farmers in Kembata Tembaro, Ethiopia. Agroecology and Sustainable Food Systems, 47(9), 1341–1371. https://doi.org/10.1080/21683565.2023.2230931

Malher, X., Coudurier, B., & Redlingshöfer, B. (2015). Food Losses and Waste in the Poultry Production Chain: From Farm to Retail. 16. European Symposium on the Quality of Eggs and Egg Products.

Meena, B. S., Varma, L. R., & Mehta, R. S. (2012). Evaluation of papaya varieties under North Gujarat conditions.

Miller, B. F. (1965). Edible yield of turkey parts.Poultry Science,44(3), 848-853.

Mintz, S. W. (1961). Standards of Value and Units of Measure in the Fond-des-Negres Market Place, Haiti. The Journal of the Royal Anthropological Institute of Great Britain and Ireland, 91(1), 23–38. https://doi.org/10.2307/2844466

Mottet, A., de Haan, C., Falcucci, A., Tempio, G., Opio, C., & Gerber, P. (2017). Livestock: On Our Plates or Eating at Our Table? A New Analysis of the Feed/Food Debate.Global Food Security,14, 1-8.

National Onion Association. (n.d.). Cutting, Preparation Tips and More. https://www.onions-usa.org/chefs-educators/foodservice/cutting-preparation-tips-and-more/

Ndabamenye, T., Van Asten, P.J.A., Vanhoudt, N., Blomme, G., Swennen, R., Annandale, J.G., Barnard, R.O. (2012). Ecological characteristics influence farmer selection of on-farm plant density and bunch mass of low input East African highland banana (Musa spp.) cropping systems. 135. Field Crops Research. https://doi.org/10.1016/j.fcr.2012.06.018.

Ndegwa, M. K., De Groote, H., Gitonga, Z. M., & Bruce, A. Y. (2016). Effectiveness and economics of hermetic bags for maize storage: results of a randomized controlled trial in Kenya.Crop Protection,90, 17-26.

Nelson and Fuglie, 2022. https://www.ers.usda.gov/amber-waves/2022/june/investment-in-u-s-public-agricultural-research-and-development-has-fallen-by-a-third-over-past-two-decades-lags-major-trade-competitors/

Njie, D. (2012). Global Initiative on Food Losses and Waste Reduction. Food and Agriculture Organization of the United States.

Omotajo, O. R., Olaniyan, O., & Mudahunga, J. C. (2018).Effects of Agribusiness Investments on Post-harvest Losses and Food Security in Sub-Saharan Africa: Evidence from Maize and Beans Value Chains in Nyagatare District, Rwanda(pp. 1-16). IFAD Working Papers: Rome, Italy.

Pelant, R. K., Chandra, B., Pu, J. B., Lohani, M., Suknaphasawat, N., Xu, G. (1999). Small Ruminants in Development: The Heifer Project International Experience in Asia. Small Ruminant Research,34(3), 249-257.

Rawlins, R., Pimkina, S., Barrett, C., Pedersen, S., & Wydick, B. (2013). Got Milk? The Impact of Heifer International's Livestock Donation Programs in Rwanda on Nutritional Outcomes. Food Policy, 44, 202-213.

Ridolfi, C., Hoffmann, V., Baral, S. (2018). Post-Harvest Losses: Global Scale, Solutions andRelevance to Ghana. International Food Policy Research Institute.

Rotunno, N. A. (1924). Effect of size of seed on plant production with special reference to radish. Botanical Gazette, 78(4), 397-413.

Salihoglu, G., Salihoglu, N. K., Ucaroglu, S., & Banar, M. (2018). Food loss and waste management in Turkey.Bioresource technology,248, 88-99.

Sánchez-Macías, D., Barba-Maggi, L., Morales-delaNuez, A., & Palmay-Paredes, J. (2018). Guinea pig for meat production: a systematic review of factors affecting the production, carcass and meat quality.Meat science,143, 165-176.

SDSU Extension. (2022). How Much Meat Can You Expect from a Fed Steer? https://extension.sdstate.edu/how-much-meat-can-you-expect-fed-steer

Shravan, R., & Shere, D. M. (2018). Study of physico-chemical characteristics of sweet orange (Citrus sinensis) fruit.Journal of Pharmacognosy and Phytochemistry,7(6), 1687-1689.

Smil, V. (2004). Eating Meat: Evolution, Patterns andConsequences. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1728-4457.2002.00599.x

Social Trendspotter, 2024. https://socialtrendspot.medium.com/charitable-giving-key-trends-from-giving-usa-2024-and-what-they-mean-for-your-nonprofit-528248eb0560

Uganda Bureau of Statistics. (2020). Uganda Food Balance Sheets Report 2013-2018. African Development Bank Group. https://www.ubos.org/wp-content/uploads/publications/10_2020Uganda_Food_Balance_Sheets_Report_2013-2018_Final_08Oct2020-1.pdf

University of Georgia Extension. (2022). Weights and Processed Yields of Fruits and Vegetables. https://extension.uga.edu/publications/detail.html?number=C780

University of Wisconsin-Madison. (N.D.). How Much Meat Should a Lamb Yield? https://livestock.extension.wisc.edu/files/2020/10/how-much-meat-should-a-lamb-yield.pdf

USDA. (2012). U.S. Dairy Goat Operations. https://www.aphis.usda.gov/animal_health/nahms/goats/downloads/goat09/Goat09_is_DairyGoatOps_1.pdf#:~:text=For%20milk-producing%20operations%20with%2010%20or%20more%20goats%2C,yield%20of%201%2C500%20pounds%20per%20doe%20or%20more.

USDA-ERS. (2020). Dietary Guidelines for Americans: 2020-2025. https://www.dietaryguidelines.

gov/sites/default/files/2021-03/Dietary_Guidelines_for_Americans-2020-2025.pdf

USDA. (2020, November 12). Loss-Adjusted Food Availability Documentation. https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system/loss-adjusted-food-availability-documentation/#usefulness

USDA. (2020). Milk Production. https://www.nass.usda.gov/Publications/Todays_

Reports/reports/mkpr0220.pdf

USDA, 2024. https://fdc.nal.usda.gov/

Vernekar, A. and Vijayalaxmi, K. (2019). Nutritional Composition of Fresh and Dehydrated Betel Leaves. The Pharma Innovation Journal. 8(4).

Webb, E.C. (2014). Goat Meat Production, Composition andQuality. Animal Frontiers. Volume 4, Issue 4. https://doi.org/10.2527/af.2014-0031

Wingett, K., Allman-Farinelli, M., & Alders, R. (2019). Food loss and nutrition security: reviewing pre-consumer loss in Australian sheep meat value chains using a planetary health framework.CABI Reviews, 1-12.

World Food Programme. (2023). A Global Food Crisis. https://www.wfp.org/global-hunger-crisis

Appendix A

Commodity Conversion Charts: Calories per Gram Based on Commodity

COMMODITY	CALORIES PER GRAM	CATEGORY
Alpaca	1.500	Small Ruminants
Aman (Star Fruit)	0.310	Fruit
Amaranth	1.030	Cereals
Apple	0.520	Fruit
Avocado	1.600	Fruit
Banana	1.000	Fruit
Barley	3.670	Legumes & Pulses
Beans/Kalogonda Beans	0.450	Legumes & Pulses
Beetroot	0.430	Vegetable
Blackberry	0.430	Fruit
Boro Fruit (Jujube)	0.780	Fruit
Broccoli	0.340	Vegetable
Buckwheat	3.400	Cereals
Buffalo	1.430	Large Ruminants
Buffalo	1.430	Large Ruminants
Buffalo Milk	0.970	Livestock & Animal Products
Butter	7.170	Livestock & Animal Products
Cabbage	0.250	Vegetable
Cacao	2.000	Fruit
Calf	3.000	Large Ruminants
Carob	2.220	Spices
Carrot	0.480	Vegetable
Cassava	1.590	Vegetable
Cattle (Bulls)	3.000	Large Ruminants
Cattle (Heifer)	3.000	Large Ruminants
Cauliflower	0.290	Vegetable
Celery	0.080	Vegetable
Cereals	3.790	Cereals
Chard	0.190	Vegetable
Chayote	0.045	Fruit
Cheese	4.020	Livestock & Animal Products
Chick	2.000	Poultry
Chillis	0.400	Vegetable
Cocoa Yams	1.320	Vegetable
Coffee	0.178	Legumes
Cooking Oils	8.840	Livestock & Animal Products
Coriander	0.310	Spices
Cow	3.000	Large Ruminants
Cow milk	0.420	Livestock & Animal Products
Cowpeas	1.000	Legumes & Pulses
Cucumber	0.150	Vegetable
Donkey		Large Ruminants
Duck Eggs	1.850	Egg
Eggplant	0.240	Vegetable
Fish	2.000	Fish
Fruits	1.000	Fruit
Garden Vegetables	1.000	Vegetable
Garlic	3.200	Vegetable
Ghee	9.000	Livestock & Animal Products
Goat	1.000	Small Ruminants
Goat (Doe)	1.000	Small Ruminants
Goat milk	1.000	Livestock & Animal Products
Goat (Buck)	1.000	Small Ruminants
Gourd	0.200	Fruit
Grains	3.000	Cereals
Guinea Pig	1.000	Rodent
Honey	3.000	Livestock & Animal Products

COMMODITY	CALORIES PER GRAM	CATEGORY
Jam	2.780	Livestock & Animal Products
Lady Finger (Okra)	0.440	Vegetable
Lamb	1.930	Small Ruminants
Legumes	1.000	Legumes & Pulses
Lemon	2.900	Fruit
Lettuce	0.150	Vegetable
Maize	0.960	Cereals
Mango	0.600	Fruit
Maschua	0.460	Vegetable
Milk (Buffalo)	0.970	Livestock & Animal Products
Millet	1.180	Cereals
Onions	0.400	Vegetable
Orange	4.700	Fruit
Papaya	0.430	Fruit
Passion Fruit	0.970	Fruit
Pawpaw	0.430	Fruit
Peas	0.800	Legumes & Pulses
Pelibuey		Small Ruminants
Peppers	0.300	Vegetable
Pigeon	2.130	Poultry
Pigeon Pea	3.400	Legumes & Pulses
Piglet	2.000	Small Ruminants
Pineapple	0.600	Fruit
Plantain	1.520	Fruit
Potatoes	0.740	Vegetable
Poultry (chicken)	2.000	Poultry
Poultry (duck)	2.000	Poultry
Poultry (fowl)	1.190	Poultry
Poultry (goose)	1.300	Poultry
Poultry (turkey)	2.000	Poultry
Poultry Eggs	2.000	Egg
Pulses	3.300	Legumes & Pulses
Pumpkin	0.420	Fruit
Quinoa	3.850	Legumes & Pulses
Rabbit	2.000	Rodent
Rhubarb	0.710	Vegetable
Rice	1.000	Cereals
Seeds / Nuts	6.000	Legumes & Pulses
Sheep	3.000	Small Ruminants
Sorghum	3.200	Cereals
Soybean	1.400	Legumes & Pulses
Spices	3.000	Spices
Spinach	0.210	Vegetable
Strawberries	0.360	Fruits
Sugarcane	4.000	Cereals
Sunflower/Sesame	8.840	Legumes & Pulses
Sweet Potato	0.860	Vegetable
Swine	2.000	Small Ruminants
Tangerine	0.530	Fruit
Tilapia	2.000	Fish
Tomatoes	0.220	Fruit
Turnip	.280	Vegetable
Watermelon	0.300	Fruit
Wheat	3.400	Cereals
Yogurt	0.780	Livestock & Animal Products
Yuca	1.600	Vegetable
Zebu		Large Ruminants

HEIFER INTERNATIONAL

For more information on Heifer International MEL, contact:

MERL@heifer.org

FEBRUARY 2025