

Tanzania National Panel Survey**Living Standards Measurement Study - Integrated Surveys on Agriculture****LEGUMES**Professor Leigh Anderson, *Principal Investigator*Associate Professor Mary Kay Gugerty, *Principal Investigator*

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Tanzania National Panel Survey

LSMS-ISA: Legumes

Over Half of Tanzanian Households Grew at Least One Legume Crop

Tanzanian farmers reported growing eight different varieties of food legumes: beans, groundnuts, cowpeas, mung beans, chickpeas, bambara nuts, field peas, soya beans, and pigeon peas. Fifty-seven percent of households in Tanzania grew at least one of these crops during the long and/or short rainy seasons. *Table 1* shows the proportion of households cultivating each legume crop. Priority legumes (beans, groundnuts, and cowpeas) were the most commonly cultivated legumes.¹ The only legumes cultivated by more than 10% of households were beans (34% of households) and groundnuts (22% of households).

Table 1: Proportion of Households Cultivating Legumes

| Crop | Proportion |
|----------------|------------|
| Legumes | 57% |
| Beans | 34% |
| Groundnuts | 22% |
| Cowpeas | 8% |
| Bambara Nuts | 4% |
| Pigeon Peas | 4% |
| Mung Beans | 3% |
| Chickpeas | 1% |
| Fieldpeas | 1% |
| Soya Beans | 0% |

¹ Priority crops include maize, paddy, cassava, sorghum, millet, beans, groundnuts, sweet potatoes, yams, cowpeas, and mangoes.

KEY FINDINGS

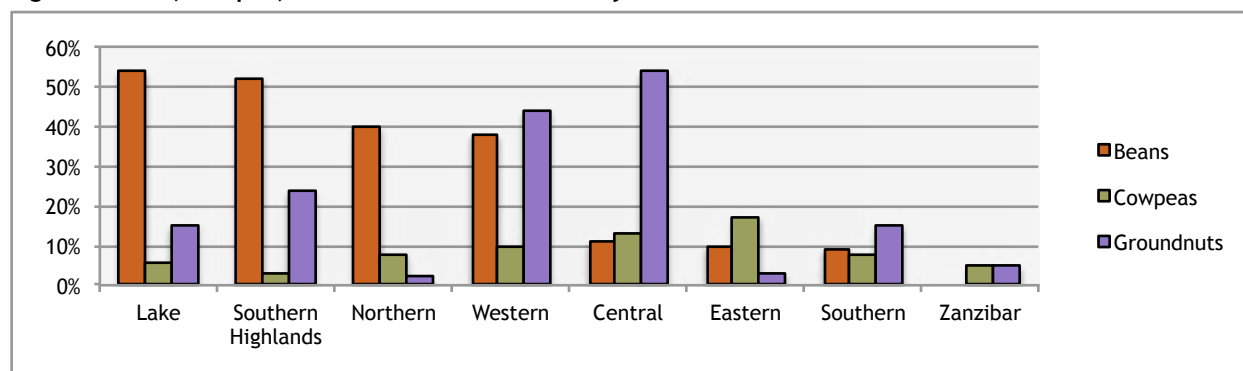
- 57% of Tanzanian households grew legumes in the long and/or short rainy seasons.
- Households that cultivated legumes consumed twice the quantity of beans, peas, lentils, and groundnuts as households that purchased them (in the seven days prior to their interview).
- Eighty-one percent of long rainy season legume plots and 91% of short rainy season legume plots were intercropped.
- Maize is the most common intercrop: 77% of intercropped legume plots in the long rainy season were intercropped with maize.
- A relatively high proportion of legume-producing households sold groundnuts (42%) and beans (34%).
- Beans received the highest price by weight of all priority crops.

Legume Cultivation Varied by Zone

Cultivation of legumes was widespread with at least 45% of households growing one or more legume crops in all zones except Zanzibar (12%) and the Eastern Zone (34%). As shown in *Map 1*, cultivation was not evenly distributed throughout the regions within each zone. For example, while 93% of households grew legumes in the Kagera region of the Lake Zone, only 16% cultivated legumes in the Mara region. However, sample size limitations preclude reliable statistics at the regional level.

The cultivation rates of individual priority legumes also varied geographically (see *Figure 1*). At least 38% of households in the Southern Highlands, Lake, Northern, and Western zones cultivated beans, while 11% or fewer households cultivated beans in the other zones (see *Map 2*). *Map 3* shows that a higher proportion of households cultivated groundnuts in the Western (44%) and Central (54%) zones than in other zones (24% or less). Fewer than 10% of households in each zone cultivated cowpeas except in the Eastern (17%) and Central (13%) zones. Among non-priority legumes, only bambara nuts and pigeon peas were cultivated by more than 10% of households within any individual zone; nationally only 4% of households grew each of these two crops.

Figure 1: Bean, Cowpea, and Groundnut Cultivation by Zone



Producing Households Consumed Twice the Legumes as Purchasing Households

An estimated 72% of all agricultural households consumed beans, peas, or lentils (identified as “pulses” in the TZNPS consumption survey) in the seven days preceding their survey interview.² Of these, 56% consumed pulses from purchase and 41% consumed pulses from their own production. The mean quantity of pulses consumed by producing households in the previous seven days was double the quantity consumed by households that purchased pulses. Groundnuts were consumed by 37% of households in the week preceding their interview, and producing households consumed twice the quantity as purchasing households (see Figure 2).

The only foods Tanzanian farming households reported consuming more frequently than pulses in the seven days prior to their interview were vegetables and maize. Whereas maize ugali has about 120 calories and 2.7 grams of protein per 100 gram portion, bean relish has nearly the same calorie content but 6.4 grams of protein. One hundred grams of groundnuts, or about 2/3 cup, has 567 calories and 25.8 grams of protein.³ Increased legume consumption, especially of groundnuts, would likely increase total calorie and protein intake.

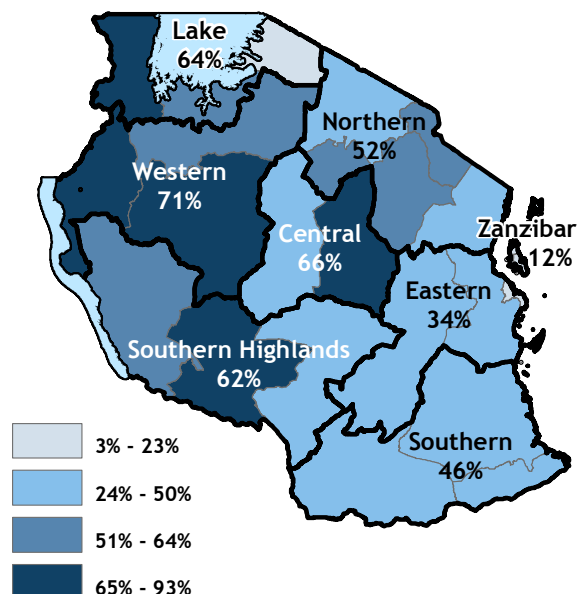
90th Percentile Yields were More than Double Median Yields

Twenty-six percent of plots were planted with legumes in the long rainy season. As shown in Figure 3, 90th percentile yields were more than double the median yields for groundnuts and more than triple the median yields for beans and cowpeas. While insufficient observations were collected to definitively compare zonal yields, the Lake Zone (95 plots) had higher bean yields and the Central Zone (85 plots) had higher groundnut yields than the other zones for which there were sufficient observations for comparison. Female- and male-headed household plots had no significant differences in yields.

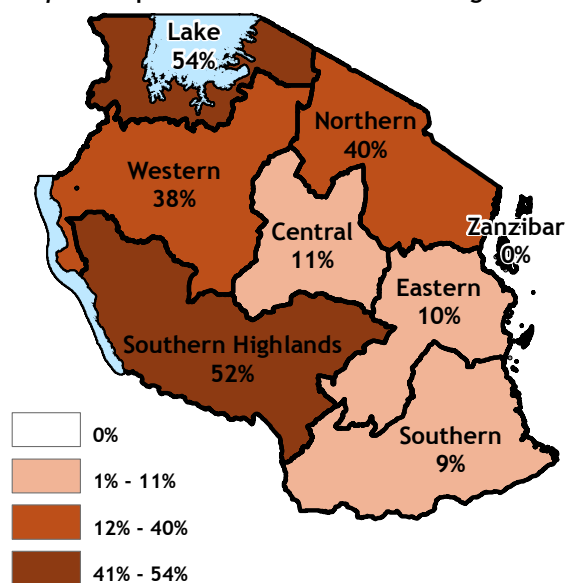
² Because TZNPS interviews were conducted by zone throughout the growing seasons, the consumption statistics focus on the seven days prior to the survey interview and may not represent average household consumption that occurs throughout the year.

³ Lukmanji, Z., E. Hertzmark, N. Mlingi, V. Assey, G. Ndossi, & W. Fawzi. (2008). “Tanzania Food Composition Tables.” MUHAS- TFNC, HSPH, Dar es Salaam, Tanzania.

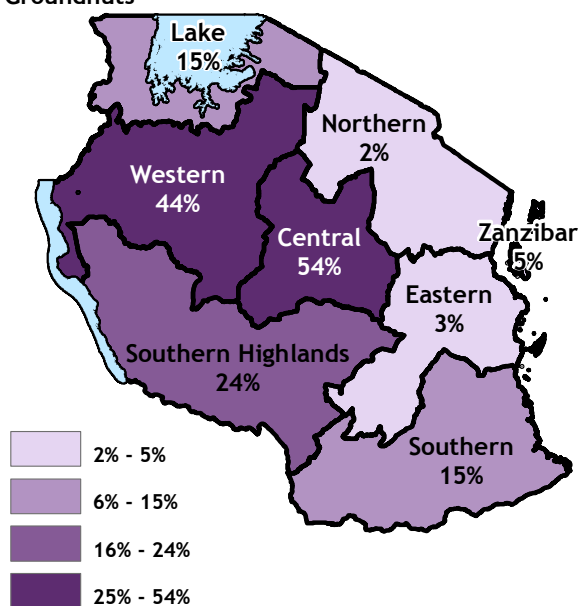
Map 1: Proportion of Households Growing Legumes



Map 2: Proportion of Households Growing Beans



Map 3: Proportion of Households Growing Groundnuts



High Producing Plots had Few Significant Differences from Other Plots

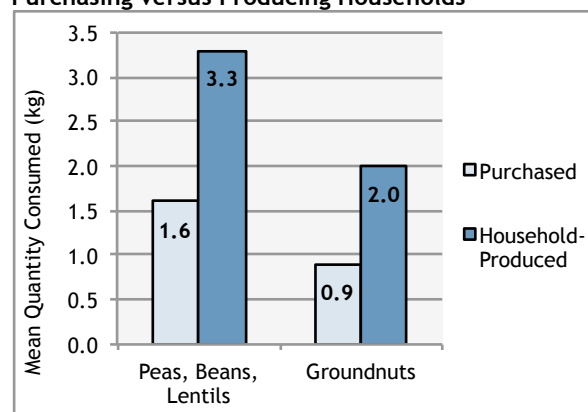
Characteristics of long rainy season high producing legume plots (90th percentile yields or higher) and all other plots did not differ significantly in most cases. High producing bean plots and other bean plots were equally likely to use inorganic fertilizer; high producing plots were less likely to use organic fertilizer, though this difference was not statistically significant. On average, high producing bean plots were significantly farther from markets (10.5 km) than other bean plots (7.6 km).⁴ More long rainy season bean plots were cultivated in loam soil than in sand, clay, or other soils, regardless of whether the plot yielded above or below the 90th percentile.⁵

High producing bean and groundnut plots were both significantly less likely to be intercropped than other plots, though this difference does not account for the additional yield of the intercropped crop (primarily maize).⁶ There were no significant differences between high producing groundnut plots and other groundnut plots when comparing fertilizer or fungicide/pesticide/herbicide use, or distance from plot to market.

Most Legume Plots were Intercropped

Eighty-one percent of all legume plots were intercropped in the long rainy season, and 91% were intercropped during the short rainy season (see *Table 2*). Farmers reported intercropping with one or multiple other crops, but the TZNPS did not report

Figure 2: Mean Quantity of Legume Consumption by Purchasing versus Producing Households

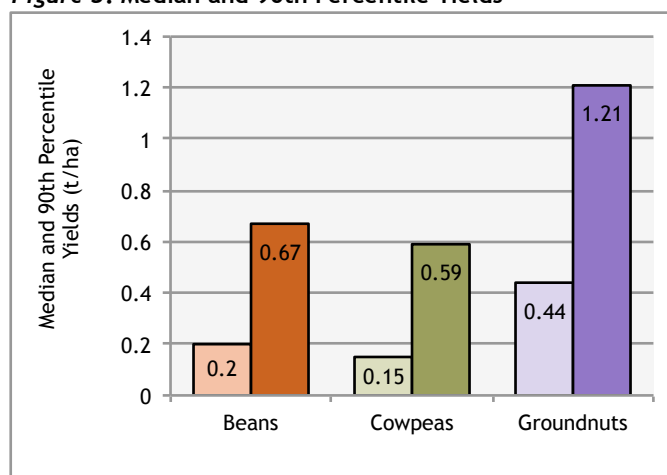


on intercropping plant populations, patterns, or management strategies. Of the legume plots that were intercropped in the long rainy season, over three-fourths were intercropped with maize. Legumes were also intercropped with sorghum (7%), sweet potatoes (6%), or at least one other legume (17%), among other crops.

On 83% of long rainy season intercropped plots, farmers reported their reasons for intercropping as a “substitute if either crop fails.” Farmers reported “more fertile soil” as the reason for intercropping for only 9% of plots, despite the potential for legumes to improve soil fertility for other crops, such as maize intercrops, through nitrogen fixing.

For both beans and groundnuts in the long rainy season, the mean plot area was significantly larger for intercropped legume plots than for pure crop stands. Intercropped and non-intercropped bean plots averaged 1.09 and 0.74 hectares, respectively. Intercropped groundnut plots averaged 1.43 hectares while non-intercropped plots averaged 0.98 hectares.⁷

Figure 3: Median and 90th Percentile Yields



⁴ Significant at $p < 0.0007$.

⁵ $P < 0.0000$.

⁶ Bean plots $p < 0.0666$; groundnut plots $p < 0.0210$.

⁷ The plot size for intercropped and non-intercropped plots was significant at $p < 0.0622$ for beans and $p < 0.0136$ for groundnuts.

Legume Yields were Lower on Intercropped Plots

Without controlling for plant population, median yields on intercropped bean and groundnut plots were significantly lower than non-intercropped plot yields, as shown in *Table 3*.⁸ Median maize yields were also lower on plots intercropped with legumes (0.66 t/ha compared to 0.79 t/ha on pure maize plots). Surveyed farmers reported the proportion of the plot planted with each crop, but did not report plant density or intercropping patterns; lower yields for individual crops on intercropped plots could therefore be a result of lower plant population. The literature suggests that particular intercropping patterns may improve soil fertility and yields.⁹

Table 3: Long Rainy Season Bean, Cowpea, and Groundnut Yields

| Crop | Median Intercropped Yields (t/ha) | Median Non-Intercropped Yields (t/ha) |
|------------|-----------------------------------|---------------------------------------|
| Beans | 0.2 | 0.35 |
| Cowpeas | 0.12 | Insufficient Observations |
| Groundnuts | 0.4 | 0.52 |

Improved Variety Seed Use was Low; Fertilizer Use was Relatively High

During the long rainy season, just 2% of bean and groundnut plots (11 observations each) and 5% of cowpeas (9 observations) were sown with improved variety seed. Fertilizer use was relatively high compared to cassava and paddy, with farmers using organic fertilizer on 14% of bean plots and inorganic fertilizer on 18%. The rate of fertilizer use on all legume plots was 13% for organic fertilizer and 12% for inorganic fertilizer. Groundnut plots had nearly equal rates of inorganic fertilizer use on intercropped and non-intercropped plots (about 10%), but intercropped bean plots had fertilizer use rates of 21% and non-intercropped bean plots had fertilizer rates of only 6%.

⁸ Mean intercropped and non-intercropped bean yields were 0.30 t/ha and 0.39 t/ha, respectively, ($p < 0.0724$). Mean intercropped and non-intercropped groundnut yields were 0.52 t/ha and 0.76 t/ha, respectively, ($p < 0.0099$).

⁹ For example, Mucheru-Muna et al. (2010) showed that a modified two-by-two intercropping strategy (two bean rows rather than one in between maize rows) significantly increased maize and legume yields, though it did not always result in a positive nitrogen balance. Mucheru-Muna, Monica, Pieter Pypers, Daniel Mugendi, James Kung'u, Jayne Mugwe, Roel Merckx, & Bernard Vanlauwe. (2010). "A staggered maize-legume intercrop arrangement robustly increases crop yields and economic returns in the highlands of Central Kenya." *Field Crops Research*, 115, 132-139. doi:10.1016/j.fcr.2009.10.013

Table 2: Proportion of Legume Plots Intercropped During Long and Short Rainy Seasons

| Crop | % Intercropped in the long rainy season | % Intercropped in the short rainy season | % Intercropped plots intercropped with maize in the long rainy season |
|------------|---|--|---|
| Legumes | 81% | 91% | 77% |
| Beans | 85% | 92% | 82% |
| Cowpeas | 91% | 93% | 78% |
| Groundnuts | 74% | 98% | 72% |

This suggests that the fertilizer may have been applied and intended for the intercropped crop.

Pre-Harvest Losses were Relatively High, but Post-Harvest Losses were Low

Farmers reported not fully planting bean, cowpea, and groundnut plots due to constraints more frequently than any other priority crop in the long rainy season. Of the 26% of bean plots that were not fully planted, farmers reported the causes as lack of equipment (63%), lack of seed (34%), and drought (3%).

Between 30-40% of long rainy season bean, cowpea, and groundnut plots experienced pre-harvest losses. The main reported causes for bean losses were insects (48%), animals (16%), and disease (15%). Insects and animals were the cause of about 85% of cowpea and groundnut pre-harvest losses. Drought and insects were the main reasons farmers reported harvesting less area than they planted for all three of the priority legumes.¹⁰ Post-harvest losses were relatively low for legumes, and bean post-harvest losses were lowest of all priority crops (5% in the long rainy season).¹¹ In the long rainy season groundnut post-harvest losses were 9%, and cowpea losses were somewhat higher at 11%. There were insufficient observations to determine the primary cause of legume post-harvest losses.

Beans and Groundnuts were Frequently Sold and Sale Prices were Relatively High

Groundnut cultivation was concentrated within the Western and Central zones, with 70% of households in Dodoma growing groundnuts, 48% in Shinyanga, 41% in Tabora and Kigoma, and less than 35% in all other Tanzanian regions. More households (46%) sold groundnuts in the long rainy season than any other priority crop except paddy (52%). Median groundnut prices per kilo were relatively high compared to other priority crops (see *Figure 4*). While the proportion of households selling groundnuts was relatively high, the median household value of

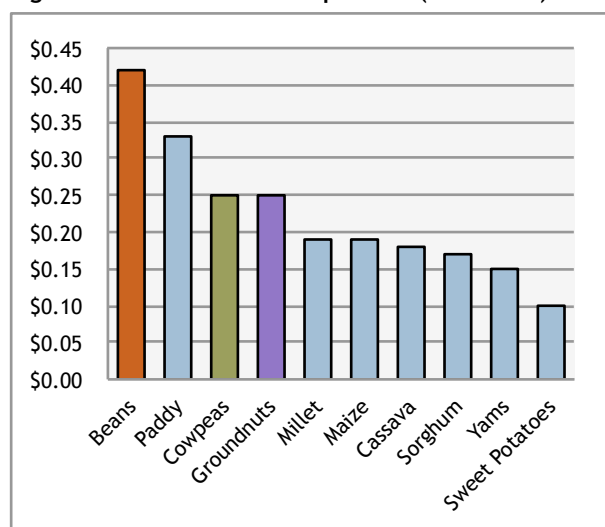
¹⁰ Farmers were asked two separate questions: *Was the area harvested less than the area planted?* and *Were there any losses of crops before the harvest?* Some farmers reported losses for both questions and it is possible that some farmers reported the same losses twice.

¹¹ Fifteen percent of paddy and 14% of maize households experienced post-harvest losses in the long rainy season.

groundnut sales (\$33.37) and the median quantity sold (120 kg) were lower than maize, paddy, yams, and cassava.

Thirty-four percent of households sold beans in the long rainy season, making bean sales less frequent than groundnut sales but more frequent than maize sales. Zonally, the proportion of households selling beans in the long or short rainy season ranged from 16% in the Western Zone to 41% in the Lake Zone.¹² The median sale price per kilo of beans was the highest of all priority crops (see *Figure 4*). However, the median value generated from bean sales by households that sold them was just \$25.03 and the median quantity sold (60 kg) was the second lowest of all priority crops. Fewer households sold cowpeas (26%), than any priority crop except cassava, sorghum, and mangoes. Although the median sale price was relatively high, households that sold cowpeas sold the smallest median quantity of all priority crops (30 kg).

Figure 4: Median Sale Price per Kilo (US Dollars)



Female-headed households appeared to sell legumes less frequently than male-headed households, though the difference was not statistically significant. Thirty-six percent of male-headed households sold beans in the long rainy season, compared to 29% of female-headed households. The rate of short rainy season bean sales was also higher for male-headed households (24% compared to 18% for female-headed households). Long rainy season groundnut sales were similar, with 48% of male-headed and 39% of female-headed households selling, though this difference was not significant.

High Sale Values Contribute to High Legume Plot Productivity

High sale prices contributed to relatively high legume land and labor productivity, measured as dollar value produced per hectare. Average long rainy season land productivity for non-intercropped groundnut plots was \$167.19/ha, higher than

all other priority crops except maize and paddy. Intercropped groundnut plot productivity was lower at \$141.94/ha. Similarly, non-intercropped bean plots had a relatively high average land productivity (\$152.41/ha), but lower productivity on intercropped plots (\$114.01/ha). Average labor productivity on intercropped bean plots (\$1.57 per work day) was highest after maize and paddy crops. Non-intercropped bean plots had lower rates of labor productivity, though not significantly. Conversely, pure groundnut plots had higher labor productivity (\$1.43 per work day) than intercropped groundnut plots.¹³ This may indicate that farmers had different crop management strategies for beans and groundnuts.

Strategic Implications and Outstanding Questions

Legume cultivation in Tanzania was widespread and was particularly dense in some regions in the western and central parts of the country. Fifty-seven percent of households cultivated at least one type of legume; the only priority crop more widely cultivated was maize. Beans and groundnuts make up most of the legume cultivation in the country. Production strategies appeared to vary for different legume crops. For example, the Western Zone had relatively high rates of both bean and groundnut cultivation, but only 16% of households sold beans compared to 48% who sold groundnuts. In all zones except Northern and Lake, households sold groundnuts at a higher rate than beans. Variation in cultivation and sales rates suggests a need to better understand household cropping and sales strategies.

Both the sale prices and the nutritional benefits of legume consumption are high, suggesting that increasing legume cultivation and yields could benefit farming households nutritionally and financially. Household sales volumes are low in spite of relatively high legume prices, underlining the need to better understand the constraints to increased production. As with many priority crops, the wide gap between high-producing and median-producing plots indicates the potential for yield gains for many farmers. Increased legume cultivation may also have nutritional benefits: legume-producing agricultural households reported consuming twice the quantity of protein-rich legumes as legume-purchasing farmers in the seven days prior to their interview.

Given the high rates of legume intercropping, a better understanding of the constraints and potential for legume cultivation may require additional information on plot management strategies, particularly for legume-maize intercrops. Though literature suggests that legume intercrops may improve soil fertility and increase yields through nitrogen fixing, TZNP data presented several questions about the

¹³ Productivity values were calculated by summing the estimated value of harvest for each crop on a given plot. If the respondent had not finished the harvest, the value of the crop not yet harvested was projected by assigning the same value/kilogram to the amount left to be harvested. Comparison excludes yams and cowpeas due to insufficient observations.

¹² Excluding the Eastern and Central zones and Zanzibar for insufficient observations (less than 30).

efficacy of intercropping. Intercropped yields were lower for both the legume and the intercropped crop (primarily maize), but TZNPS farmers did not report plant population, intercropping patterns, or crop management strategies, making it difficult to interpret overall yields and productivity for intercropped plots. In addition, yield differential across legume plots are not fully explained by input use; other plot management strategies may account for yield differentials.

Please direct comments or questions about this research to Leigh Anderson and Mary Kay Gugerty, at eparx@u.washington.edu.

This brief presents summary statistics from the Tanzania National Panel Survey (TZNPS), which was implemented by the Tanzania National Bureau of Statistics, with support from the World Bank Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) team. The LSMS-ISA data were collected over a twelve-month period from October 2008 through September 2009. The sample design was constructed to produce nationally representative estimates, and it consists of 3,265 households from eight administrative zones, each with a rural/urban cluster, for a total of sixteen sampling strata. The resulting data can produce nationally representative estimates at the national and zonal level. Sample size limitations preclude reliable statistics at the regional or district level. Agricultural households completed an additional farm questionnaire, resulting in 2,474 respondents who report involvement in any crop, fishing or livestock cultivation.

In 2011 EPAR completed the Tanzania LSMS-ISA Reference Report, a document consisting of eight sections that highlights specific areas such as crops and productivity, livestock, and inputs. The Reference Report provides summary statistics, detailed information on EPAR's methodology for analysis, and the opportunities and challenges that the LSMS-ISA survey data present. Please refer to the Section A: Introduction and Overview and Section D: Crops and Productivity of the Reference Report for more information on the data and analytical methodology used in this brief.

An appendix with confidence intervals and number of observations for all data in this brief is available upon request. While LSMS-ISA data was collected in kilograms and acres, we have converted units to metric tons (t) and hectares (ha) for this brief. One hectare = 2.47 acres and 1 t = 1000 kg.