

**LSMS - INTEGRATED SURVEYS ON AGRICULTURE
UNITED REPUBLIC OF TANZANIA: INTERCROPPING**Professor Leigh Anderson, *Principal Investigator*Associate Professor Mary Kay Gugerty, *Principal Investigator**Alice Golenko, Claire Kpaka, Caitlin McKee, C. Leigh Anderson & Mary Kay Gugerty**Prepared for the Agricultural Policy Team of the Bill & Melinda Gates Foundation*

LSMS - Integrated Surveys on Agriculture, United Republic of Tanzania: Intercropping

Introduction

In this brief we analyze patterns of intercropping and differences between intercropped and monocropped plots among smallholder farmers in Tanzania using the Tanzania National Panel Survey (TZNPS) as part of the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA). Intercropping is a planting strategy in which farmers cultivate at least two crops simultaneously on the same plot of land.

Potential benefits of intercropping may include increased yields, reduced production constraints from weeds or pests, and higher crop diversity per unit of land. Oswald et al. (2002) found that intercropping maize with different legume varieties increased total crop output in Kenya by between 40% and 120% compared to monocropped maize. Planting maize and beans together in Kenya has been shown to increase yields and control common parasitic weeds like *Striga hermonthica* and reduce the prevalence of stemborers (Skovgård & Peeter 1997; Odhiambo et al. 2001). Farmers may also choose to intercrop to improve soil fertility. Adu-Gyamfi et al (2007) reported that maize-legume intercropping in Tanzania and Malawi had higher biological nitrogen fixation than monocropped maize plots. Additionally, farmers may choose to intercrop as a way to reduce the risk of single crop failure (Lithourgidis et al. 2011).

The decision to intercrop annual crops with fruit trees may be distinct from the decision to intercrop a variety of annual crops. Intercropping annual crops with fruit trees can be a strategy to increase food security and income before the trees mature, or to maximize the efficiency of resources on smallholder plots (Ouma & Jeruto, 2010). However, Chamshama

KEY FINDINGS

- Eighty-one percent of households intercropped at least one plot at some point during the year.
- Maize was the most commonly grown priority¹ crop in Tanzania, and also the most frequently cultivated crop on intercropped plots.
- Some crops were frequently intercropped; farmers intercropped on over 85% of plots on which cowpeas, beans and sweet potatoes were present.
- The greatest proportions of intercropped plots were in the Lake and Northern zones, estimated at 75% and 74% of plots, respectively.
- Larger plots were more likely to be intercropped and households with more land were more likely to intercrop.
- Plots with a female decision-maker or shared decision-making were more likely to intercrop than plots with a male-decision maker.
- The most cited reason for intercropping across all seasons was as a substitute if the principle crop failed.
- Plots for which the respondent cited soil fertility as a reason for intercropping (7%) were more likely to use organic fertilizer than plots for which soil fertility was not cited.
- Intercropped plots planted with legumes had higher land and labor productivity than monocropped plots.

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

et al. (1998) suggest that intercropping with fruit trees leads to a decline in annual crop yields over time due to competition for soil moisture and nutrients.

In this brief we define intercropped plots as those for which respondents answered “yes” to the question “Was cultivation intercropped?” This question asked about long rainy season crops, short rainy season crops, fruit crops, and permanent

BOX 1: INTERCROPPING DEFINITIONS IN THE LITERATURE VERSUS LSMS-ISA INTERPRETATIONS

According to the literature, intercropping includes five distinct planting patterns (Ouma & Jeruto, 2010):

- **Row** intercropping is defined as growing two or more crops together with at least one crop planted in rows.
- **Strip** intercropping involves planting two or more crops in wide strips close enough for crop interaction.
- **Mixed** intercropping involves two or more crops planted in no distinct row arrangement.
- **Relay** intercropping is defined as planting a second crop into an established crop before the harvest of the initial crop.
- **Hedgerow** intercropping (or alley cropping) involves planting rows of annual crops between rows of trees, which are periodically pruned to minimize the effects of shading (Kang et al., 1985).

Seasonal crops are often intercropped with fruit and permanent crops (as shown in the photo below). As a result, our analysis considers both the long and short rainy seasons¹ together with fruit and permanent crops to give a full calendar year analysis of plot cultivation.

Picture 1: Intercropped banana trees and annual crops in Northern Tanzania



Photo credit: Mary Kay Gugerty

¹ The majority of Tanzania has one long rainy season that typically lasts from December through April. The North and Northeastern parts of the country have a long rainy season lasting from March through May and a short rainy season with lighter rainfall from October to December [Minot, N. (2010). Staple food prices in Tanzania. Washington, D.C. International Food Policy Research Institute].

crops.¹ According to the literature, intercropping can include various planting strategies (see Box 1). The survey did not distinguish among different planting patterns for intercropped plots. Respondents were asked simply if a plot was intercropped, so for the purposes of this brief all intercropped plots are considered together, irrespective of the specific planting strategy.

We discuss intercropping at the plot level and at the household level. At the plot level, if *any* crop on the plot (seasonal, fruit, or permanent) at *any* point in the year was reported as being intercropped, then the plot is designated as an “intercropped plot”. We do not distinguish if specific crops were intercropped, but rather if crops were *present on an intercropped plot*. For example, if maize and beans were intercropped on a plot where cowpeas were also present, cowpeas are considered *present on the intercropped plot* whether or not their cultivation was intercropped.

We define “intercropping households” as those households that intercropped at least one plot at any point during the year in comparison to households that did not intercrop any plots. The average number of plots across all agricultural households was 2.3.

INTERCROPPING PATTERNS IN TANZANIA

Intercropping is a prevalent farming strategy throughout most of Tanzania. Eighty-one percent of households intercropped at least one plot at some point during the long or short rainy season, which includes intercropping seasonal crops with their fruit or permanent crops. Sixty-three percent of plots were intercropped during the long or short rainy season, or with fruit or permanent crops.

Commonly Intercropped Crop Patterns

Maize was the most commonly grown priority crop in Tanzania, and also the most commonly cultivated crop on intercropped plots. Seventy-three percent of intercropped plots in either season were planted with maize. *Figure 1* displays the crops most frequently present on intercropped plots with maize.

Figure 1: Frequent Intercropping Combinations with Maize, All Seasons

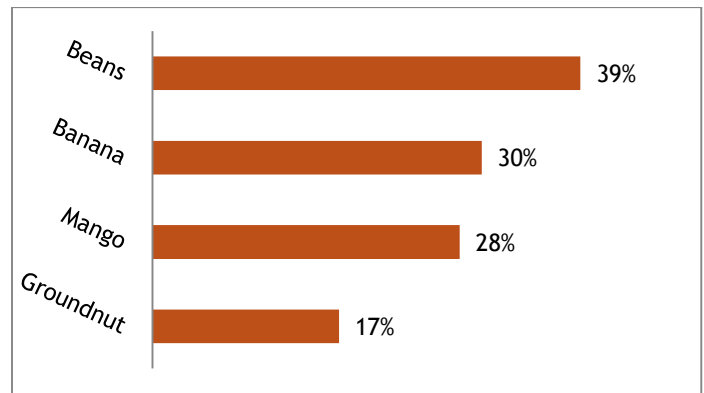
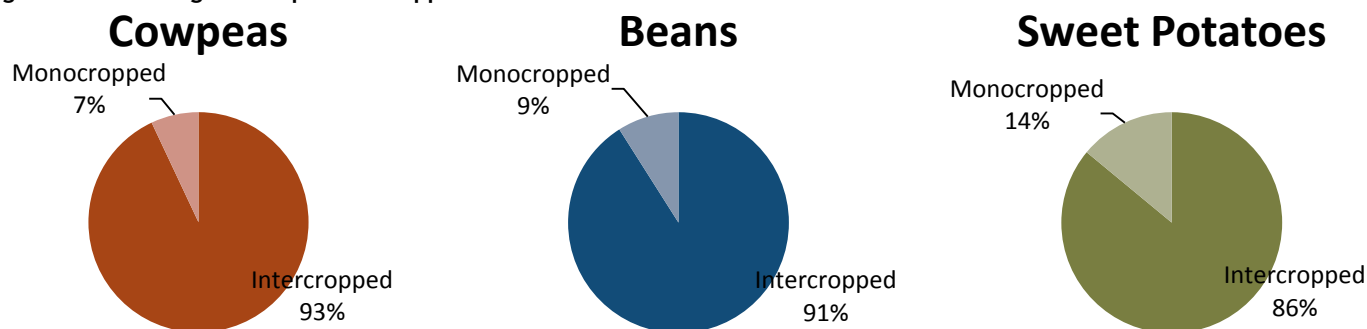


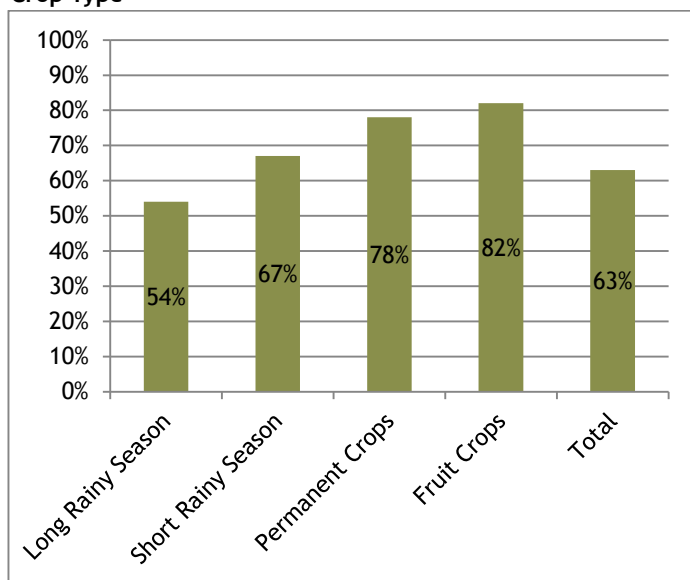
Figure 2: Percentage of Crops Intercropped



Following maize, the next most commonly cultivated crops on intercropped plots were beans (32%), groundnuts (16%), and sweet potatoes (11%).² Sorghum, cowpeas, rice, millet, cassava, and yams were planted on 10% or fewer of the intercropped plots, implying that these crops are more likely to be monocropped. Some crops were very frequently intercropped. Of the eleven priority crops, farmers used intercropping mostly frequently on plots on which cowpeas, beans and sweet potatoes were present. For example 93% of plots where cowpeas were planted were intercropped (see Figure 2).

Long and short rainy season crops are planted annually, while fruit and permanent crops are not necessarily replanted each year. In plots planted with annual crops, 57% of plots were intercropped on average, with intercropping more frequent in the short rainy season (67% of plots intercropped), compared to the long rainy season (54%). Permanent crops and fruit crops were more likely than annual crops to be intercropped at 78% and 82%, respectively (see Figure 3)

Figure 3: Percentage of Plots Intercropped by Season and Crop Type



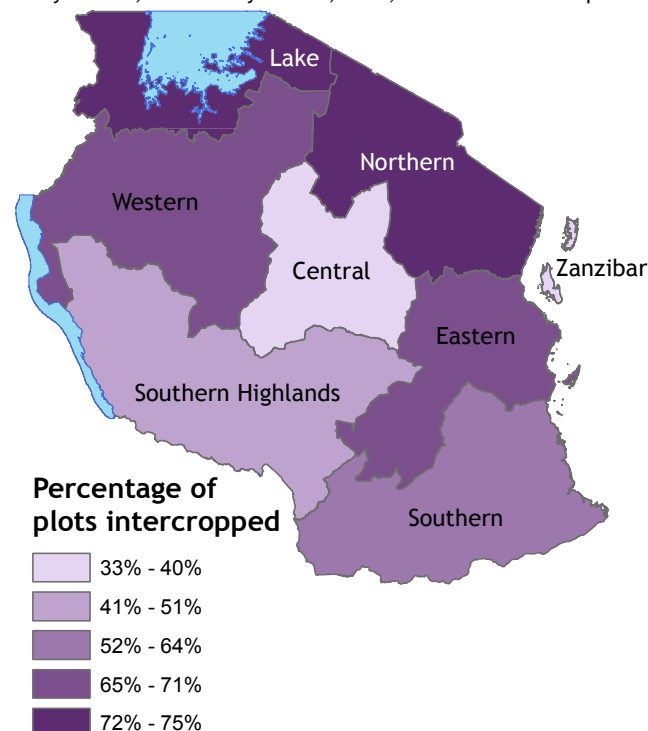
Prevalence of intercropping varied widely by zone

The greatest proportions of intercropped plots were in the Lake and Northern zones, estimated at 75% and 74% respectively (see Map 1). Zanzibar and Central were the zones with the fewest intercropped plots, with intercropping reported on only 33% and 40% of plots respectively. Maize was the most commonly cultivated crop on intercropped plots across all zones, except Zanzibar where cassava was the most commonly grown crop on intercropped plots.

At the household level intercropping was also a relatively widespread practice, At least 60% of households in all zones intercropped at least one plot during either the long or short rainy season or with fruit or permanent crops, with the exception of Zanzibar. Ninety percent of households in the Lake zone intercropped at least one plot, representing the highest proportion across zones.

² These portions are not mutually exclusive as each intercropped plot has at least two crops.

Map 1: Percentage of Plots Intercropped by Zone Including Long Rainy Season, Short Rainy Season, Fruit, and Permanent Crops



CHARACTERISTICS OF INTERCROPPING HOUSEHOLDS AND PLOT DECISION-MAKERS

The TZNP gathered data on the socioeconomic characteristics of households and household heads and asked who decided what to plant on each plot. We analyze intercropping patterns by household head and by plot decision-maker, including male household head, female household head, male plot decision-maker, female plot decision-maker, and shared plot decision-making.

The head of household and plot decision-makers were slightly older in intercropping households compared to monocropping households. While these findings are statistically significant, the magnitude of difference in age was only two years: 48 for intercropping households and 46 for monocropping households.³ Similarly, the average age of the decision-maker for intercropped plots was 49 and for monocropped plots was 47.⁴

Intercropping households and intercropped plots are larger

Intercropping is more prevalent among households with more household members and more land than monocropping households. Intercropping households averaged 5.5 household members; monocropping households averaged 5.⁵ Average total landholding size for intercropping households was 2.5 hectares compared to 1.7 hectares for monocropping households.⁶

Intercropped plots were typically slightly larger than monocropped plots. On average, intercropped plots were 1.0 hectares compared with 0.8 for monocropped plots.⁷ Intercropped plots were likely to be larger when the principle crop was maize, groundnuts, cassava, rice, or millet. No significant differences in plot size between intercropped and monocropped plots were found for beans, cowpeas, sweet potatoes, yams (few observations), or sorghum.

Table 1: Plot Size (hectares) for Male and Female Decision-Makers on Intercropped and Monocropped Plots

Gender of Plot Decision-Maker	Intercropped	Monocropped
Male***	1.3	0.9
Female**	0.6	0.5

***Statistically significant at the .01 level

As shown in *Table 1*, intercropped plots with male decision-makers were 1.3 hectares on average, compared to 0.9 hectares for monocropped plots with male decision-makers.⁸ Intercropped plots with female decision-makers were 0.6 hectares on average, compared to 0.5 hectares for

3 p-value: .0370
4 p-value: .0302
5 p-value: .0039
6 p-value: .0038
7 p-value: .0068
8 p-value: .0022

monocropped plots with female decision-makers.⁹ Plots with male decision-makers were larger than plots with female decision-makers, regardless of intercropping status.

Female plot decision-makers are more likely to intercrop than male

Plots with a female decision-maker or shared decision-making between a male and female were more likely to intercrop than plots where a male makes the decision alone (see *Table 2*).¹⁰ At the household level, gender of the household head was not significantly related to the use of intercropping.

Table 2: Gender of Decision-Maker on Intercropped Plots

Gender of Plot Decision-Maker	Percent of Plots Intercropped
Male	57%
Female	64%
Shared	67%

Intercropping households headed by females were located 5km closer to a road than monocropping female headed households¹¹

Female headed households with at least one intercropped plot were located about 5 km closer to a road than female headed households that did not intercrop (17km compared to 22km).¹² Among all households, intercropping households were located no closer to or further from a market, nearest road, or nearest population center of +20,000 people than households that did not intercrop any plots.

REASONS FOR INTERCROPPING

Insurance against crop failure was the most common reported reason for intercropping

Respondents were asked to choose from among three reasons they chose to intercrop on a given plot: substitute if one crop fails, increased soil fertility, or 'other.' Eighty-seven percent of respondents across all seasons cited that intercropping served as a substitute if the principle crop failed. Twelve percent of respondents listed "other." Only 7% of respondents listed "more fertile for soil."

9 p-value: .0123

10 Female decision-maker compared to male decision-maker p-value: .0221; Shared decision-making compared to male decision-maker p-value: .0003

11 Geospatial data provided by the World Bank. Data was originally referenced to household GPS coordinates. See World Bank Appendix A: Confidential Information, Geospatial Variables for more information.

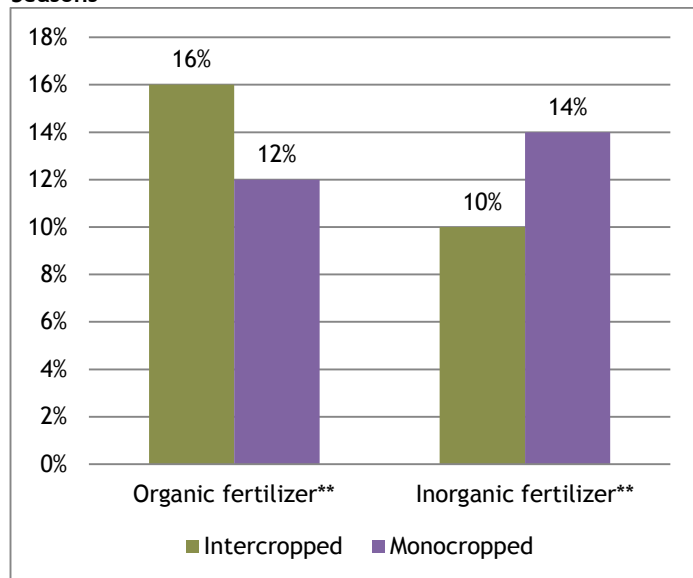
12 p-value: .0211

Although only 7% of plots were reportedly intercropped for the purpose of improving soil fertility, the top three intercropped crops (cowpeas, beans, and groundnuts) are nitrogen-fixing and may improve soil health. The survey limited responses to these three options, though as discussed in the introduction, there may be other benefits that are not reflected such as pest control, weed control, and increased plot output compared to monocropped plots.

Intercropped plots were more likely to use organic fertilizer and less likely to use inorganic fertilizer

Of plots planted in either the long or short rainy seasons, intercropped plots were slightly more likely to use organic fertilizer than monocropped plots (see *Figure 4*).¹³ Of plots planted in the long or short rainy seasons, intercropped plots were slightly less likely to use inorganic fertilizer than monocropped plots (see *Figure 4*). These results are statistically significant.¹⁴

Figure 4: Plot Fertilizer Use in Both Long and Short Rainy Seasons



**Statistically significant at the .05 level

These patterns are driven largely by long rainy season intercropping patterns. Of plots planted in the long rainy season, intercropped plots were slightly more likely to use organic fertilizer than monocropped plots: 15% compared to 11%.¹⁵ Intercropped and monocropped plots planted in the short rainy season were equally as likely to use organic fertilizer, both at 17%. Of plots planted in the long rainy season, there is no significant difference in inorganic fertilizer use between intercropped and monocropped plots, 12% compared to 14%. The sample size of inorganic fertilizer use in the short rainy season was too small to analyze.

13 p-value: .0353

14 p-value: .0398

15 p-value: .0799

On average, intercropped plots received slightly more organic fertilizer in the long rainy season, although the difference was not significant (see *Table 3*). On average, intercropped plots used approximately half as much inorganic fertilizer than monocropped plots in the long rainy seasons, although again the differences were not significant¹⁶.

Table 3: Quantity of Fertilizer Use in Long Rainy Seasons (kg/hectare)

	Intercropped	Monocropped
Organic fertilizer	7339	5958
Inorganic fertilizer	1211	2816

Plots for which the respondent cited soil fertility as a reason for intercropping were more likely to use organic fertilizer than plots for which soil fertility was not cited. Of those plots, 26% used organic fertilizer compared to 15% of plots that did not cite soil fertility as the primary reason for intercropping.¹⁷ There was no significant difference for inorganic fertilizer use.

INTERCROPPING AND PRODUCTIVITY

The survey did not include information on planting density or spacing for intercropped plots. As a result, it is not clear exactly how much of a particular crop was planted on a given plot, so yields by crop could not be accurately determined. We examine the impact of intercropping strategies on annual plot-level land and labor productivity.¹⁸ Total land productivity was calculated for a complete year by combining the value of the harvest for the long rainy season, short rainy season, fruit and permanent crops and dividing this total value by the plot size. We calculate land productivity over the entire year because a large number of plots are planted with annual as well as permanent (49% of all intercropped plots) and fruit (52% of all intercropped plots) crops, so an assessment by agricultural season may understate the total value produced on the plot. Labor productivity was calculated for each season by dividing the value produced by long and short rainy season crops by the days of household unpaid labor and hired labor dedicated to land preparation and planting, weeding, and harvesting in each season.¹⁹

16 Too few observations to report inorganic fertilizer use in the short rainy season.

17 p-value: .0096

18 We removed outliers for land productivity using visual inspection of scatter plots.

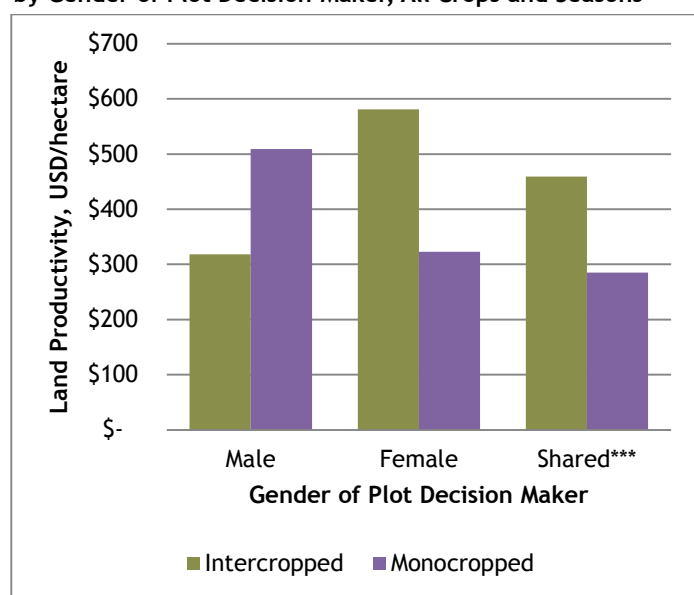
19 The TZNP survey did not include questions about labor for fruit and permanent crop cultivation. While only long rainy season and short rainy season crops were included for the calculation of labor productivity based on value and labor hours, plots that also grew fruit and permanent crops are also included in this analysis. The presence of fruit or permanent crops may alter the growing environment for other crops (such as by changing shade, nutrient availability or water uptake) and thus affect the total value of production. If respondents included time spent on fruit or permanent crops in seasonal labor hour estimates, then labor productivity measure may be underestimated when fruit and permanent crops are present.

Land productivity did not vary between total intercropped and monocropped plots

The land productivity of Intercropped plots was \$436 per hectare, higher than monocropped plots at \$383 per hectare, though not significantly different.

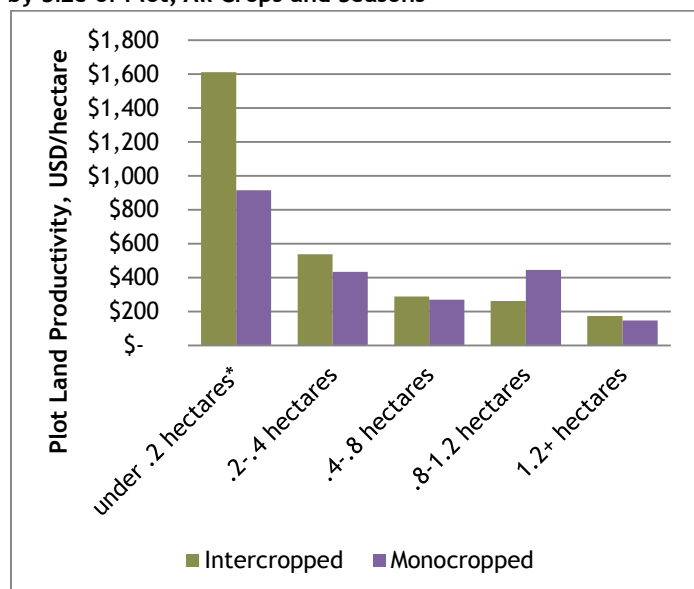
As seen in *Figure 5*, land productivity for plots with male decision-makers was \$191 per hectare *lower* on average on intercropped plots than monocropped plots, but this difference was not statistically significant, likely because of the high variability of productivity across plots. Plots with female decision-makers had on average \$258 *more* per hectare on intercropped plots, but again this difference was not significant due to wide variations in productivity. Intercropped plots with

Figure 5: Intercropped and Monocropped Land Productivity by Gender of Plot Decision-Maker, All Crops and Seasons



*** Statistically significant at the .01 level

Figure 6: Intercropped and Monocropped Land Productivity by Size of Plot, All Crops and Seasons



*Statistically significant at the .10 level between monocropped and intercropped plots by size level

shared decision-making had significantly higher productivity (\$174 more per hectare on average) than monocropped plots with shared decision-making.²⁰

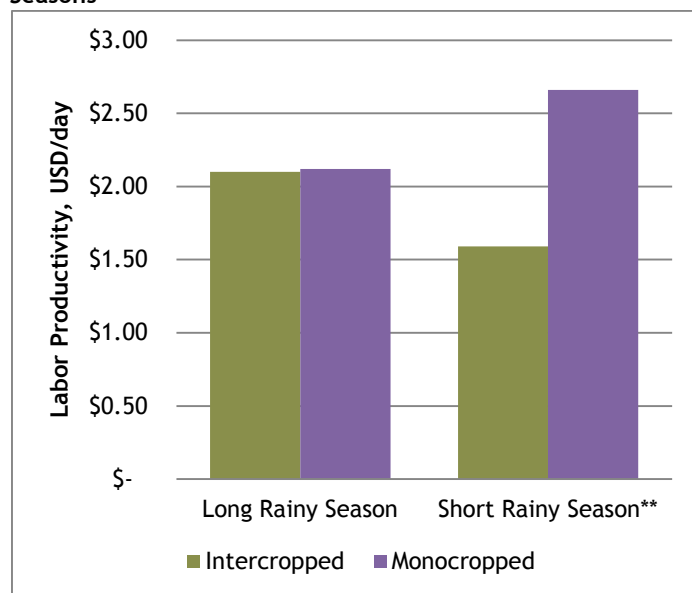
In general, smaller plots had higher land productivity than larger plots for both monocropped and intercropped plots (see *Figure 6*). For plots under 0.2 hectares, land productivity was substantially higher for intercropped plots than for monocropped plots.²¹ As women tend to have control over smaller plots, it is unclear whether the productivity differences are attributable to the gender of the decision-maker, or the size of the plot. Other plot size classifications revealed no significant difference between intercropped and monocropped plots.

Intercropped plots do not have higher labor productivity

Labor productivity for plots planted in the long rainy season showed no significant differences between intercropped and monocropped plots, with values of \$2.10 per day and \$2.12 per day respectively, as shown in *Figure 7*. Intercropped plots planted in the short rainy season had a labor productivity of one dollar less than monocropped plots (\$1.59 versus \$2.66).²²

Neither plot size nor the gender of the plot decision-maker was significant in differences between labor productivity outcomes on intercropped and monocropped plots.

Figure 7: Labor Productivity in the Long and Short Rainy Seasons



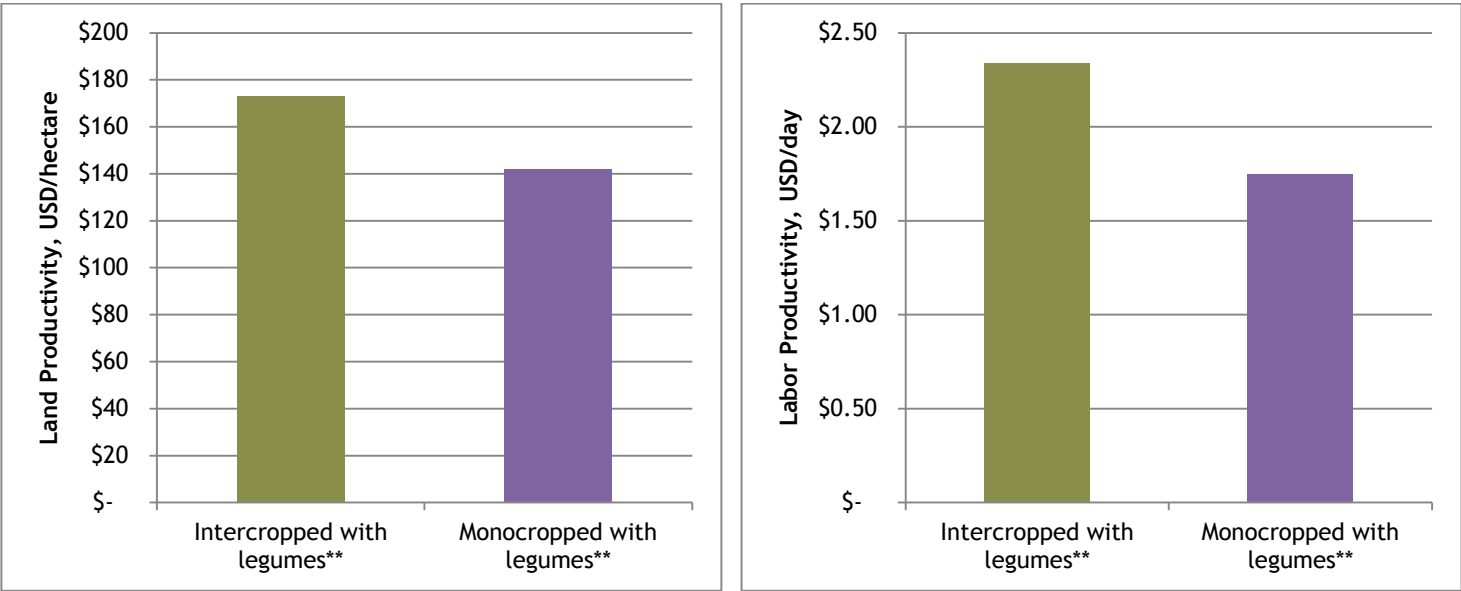
**Statistically significant at the .05 level

20 p-value: .0054

21 p-value: .0837

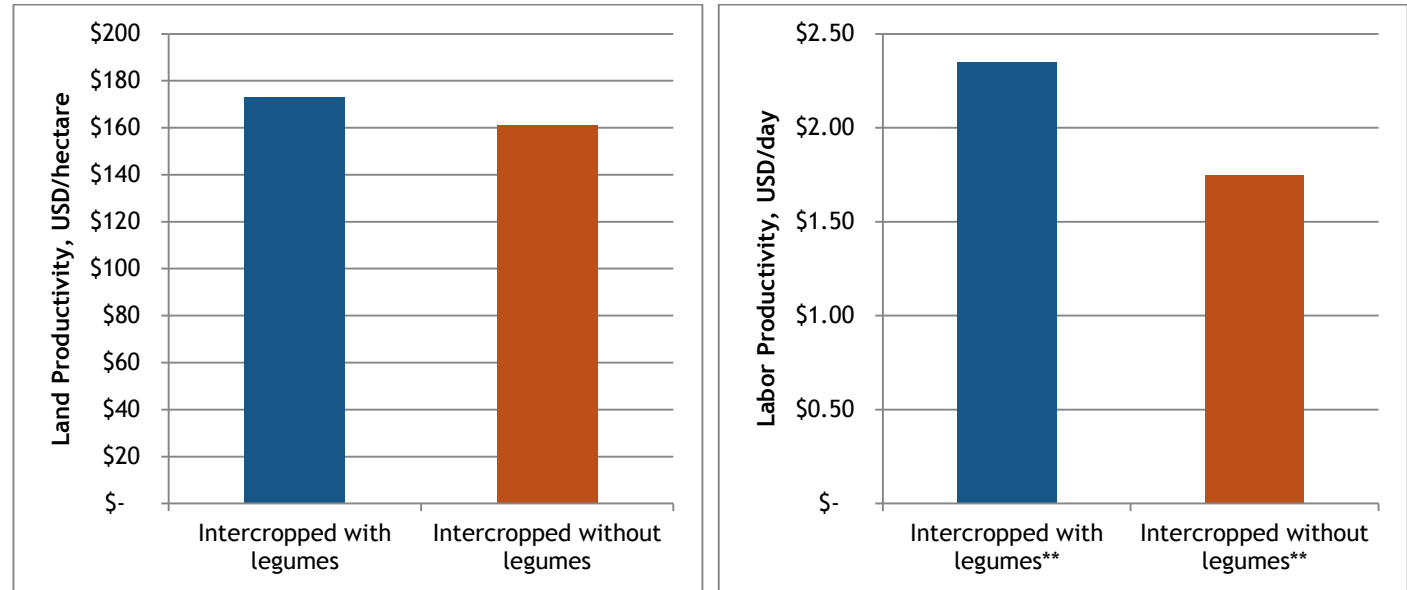
22 p-value: .0404

Figure 8: Land and Labor Productivity for Plots Planted with Legumes in the Long Rainy Season



**Statistically significant at the .05 level

Figure 9: Land and Labor Productivity on Plots Planted with Legumes or without Legumes in the Long Rainy Season



***Statistically significant at the .01 level

Intercropping with legumes positively affects plot productivity measures

Intercropped plots planted with legumes²³ in the long rainy season had significantly higher land and labor productivity compared to monocropped plots planted with legumes (see Figure 8).²⁴ Eighty-one percent of all legume plots planted in the long rainy season were intercropped. Fifty-nine percent of intercropped plots were planted with legumes.

Land productivity for intercropped plots planted with legumes was slightly higher than intercropped plots that were not planted with legumes, although the difference was not significant in either the long or short rainy seasons (see Figure 9). Labor productivity was significantly higher on intercropped

23 Legumes include beans, cowpeas, groundnuts, mung beans, chickpeas, bambara nuts, fieldpeas, soya beans, and pigeon peas.
24 Land Productivity p-value: .0426; labor productivity p-value: .0421

plots planted with legumes than those not planted with legumes in the long rainy season (see Figure 9).²⁵

Differences in productivity measures may be due to wide variation in individual crop values

Value-based productivity comparisons between monocropped and intercropped plots are complicated by the presence of multiple crops with different prices. Land and labor productivity for monocropped plots reflect the price of a single crop. Intercropped plots reflect the combined value of multiple crops and it is unclear how much of the productivity difference is due to enhanced production from intercropping or

25 p-value: .0119

Table 4: Crop Specific Analysis of Plot Land and Labor Productivity

	Total Land Productivity USD/hectare		Long Rainy Season Labor Productivity		Short Rainy Season Labor Productivity	
	Intercropped	Monocropped	Intercropped	Monocropped	Intercropped	Monocropped
Maize	\$281***	\$174***	\$2.19	\$1.91	\$1.65	\$1.32
Rice	\$356**	\$490**	\$1.69**	2.39**	-	\$4.44
Beans	\$323***	190***	\$2.24	\$1.63	\$1.38	\$2.15
Sorghum	\$183***	\$106***	\$1.72*	\$1.15*	-	-

*Statistically significant at the .10 level

**Statistically significant at the .05 level

***Statistically significant at the .01 level

-indicates insufficient observations

variation in crop prices. *Table 4* shows that intercropped maize and bean plots had significantly higher land productivity than monocropped plots, while intercropped rice plots had lower land productivity. Differences in labor productivity were less pronounced except for rice in the long rainy season, where labor productivity was higher under monocropping.

In summary, intercropped plots are not systematically more productive (in terms of value produced per unit land or hours worked) than monocropped plots unless legumes are present. Land productivity is higher for intercropped plots that are very small or have shared decision-making.

Pre-harvest losses were more frequent on intercropped plots

The survey asks two different questions about pre-harvest losses—was area harvested less than area planted, and were there any losses of crops before the harvest. Although the most commonly cited reason for intercropping was to protect against crop failure, intercropped plots had significantly more reported pre-harvest losses than monocropped plots, according to both survey questions. Area harvested was less than area planted on 42% of intercropped plot and only 28% of monocropped plots (question: *was area harvested less than area planted?*).²⁶ Responses for intercropped plots more frequently cited insects, animals, and ‘other’ as the reason for the difference between area planted and area harvested (see *Table 5*). Responses for monocropped plots cited drought more frequently than intercropped plots as the reason for the difference between area planted and harvested.

Pre-harvest losses were reported significantly more frequently on intercropped plots than on monocropped plots according to the question: *were there any losses of crops before the harvest?* Fifty-one percent of intercropped plots reported pre-harvest losses compared to only 40% on monocropped plots.²⁷ Intercropped plots were significantly more likely to have losses due to insects, animals, and disease than monocropped plots.

26 p-value: <.001

27 p-value: <.001

Monocropped plots were significantly more likely to have pre-harvest losses related to birds than intercropped plots (see *Table 6*).

Table 5: Reasons Cited for the Difference Between Area Planted and Area Harvested

Reason for Losses	Intercropped	Monocropped
Drought***	44%	53%
Rain	12%	9%
Insects***	18%	12%
Animals**	9%	6%
Disease and Community Problems	4%	5%
Other***	29%	18%

**Statistically significant at the .05 level

***Statistically significant at the .01 level

Table 6: Reasons Cited for Pre-harvest Losses

Reason for Losses	Intercropped	Monocropped
Birds***	20%	32%
Insects***	35%	21%
Animals***	37%	28%
Disease	8%	4%
Theft	17%	14%
Other	7%	6%

***Statistically significant at the .01 level

No clear relationship between intercropping and nutritional status

The proportion of households at consumption levels of less than \$1.25/per person per day, less than \$2 per person per day or over \$3 per person per day was not significantly different between intercropping households and monocropping households. In households with a consumption level under \$2 per day per adult equivalent, children under five years old living in intercropping households were more likely to suffer from moderate or severe stunting than monocropping households (see *Table 7*). Children in intercropping households

were no more or less likely to suffer from other malnutrition²⁸ measures than children in households that did not intercrop at this consumption level. Intercropping is also associated with children under five in the household being overweight. For households consuming greater than \$3 per day per adult equivalent, there is no significant difference in malnutrition measures between intercropping and monocropping households.

Table 7: Malnutrition Measures for Children Under Five in Households Consuming Less than \$2 per Day

Malnutrition Measure	Intercropping Household	Monocropping household
Stunting*	52.2%	45.0%
Underweight	23.0%	22.1%
Wasting	4.1%	3.7%
Low BMI for age	4.0%	2.7%
Overweight**	6.8%	3.5%

*Statistically significant at the .10 level

**Statistically significant at the .05 level

Strategic Implications and Outstanding Questions

Intercropping is widely practiced throughout Tanzania with maize the mostly commonly planted crop on intercropped plots. Several other crops, particularly beans and cowpeas, are almost exclusively planted as intercrops. Because intercropping is concentrated among a few crops, some of the analysis on characteristics of intercropped plots and intercropping households may reflect characteristics associated with these particular farming systems, crops, and their values, rather than with the practice of intercropping. See EPAR Briefs on TZNPS analyses of Maize (#187), Rice (#188), Legumes (#189), and Sorghum & Millet (#224) for more information on specific crops.

The analysis reveals few significant, consistent productivity benefits to intercropping as currently practiced. Intercropped plots are not systematically more productive (in terms of value produced) than monocropped plots. The survey does not

28 All malnutrition measures include: stunting, underweight, wasting, low BMI for age, and overweight.

provide information on planting practices or the density of planting, which might affect the value of intercropping. For example, some farmers may be using sub-optimal intercropping strategies. In addition, intercropped plots may be planted with a lower value crop, which would affect value-based productivity comparisons.

On average, plots with female decision makers tend to be smaller than plots with male decision makers, and smaller plots overall are associated with higher land productivity. Female decision makers also have more success on intercropped than monocropped plots, as measured by land productivity, compared to male decision makers. It is unclear whether gender, land size or something else is behind these productivity differences. Female plot decision makers (but not female headed households) also have a greater tendency to intercrop, which may reflect a preference for growing a wider diversity of crops for household consumption, or for sale.

Female headed households with at least one intercropped plot were closer to roads than female headed households that did not intercrop. This same distinction is not true across all households suggesting that women's intercropping decisions may differ according to whether they are in charge of the household, or just in charge of planting decisions on a secondary plot.

The data also suggest that intercropping with legumes can be a productivity enhancing strategy.

We find no clear indication of nutritional benefits from intercropping. Intercropping may have other benefits in terms of food security or seasonal food availability that we could not examine with the data.

The literature indicates that intercropping can improve soil health. But few respondents identified soil health as their primary reason for intercropping, although it may have been a secondary consideration. The most commonly cited reason for intercropping was to provide a substitute crop in the case of crop failure. This suggests that food and income security are primary concerns for smallholder farmers in Tanzania.

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 Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) for Tanzania. 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. 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.

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.

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