Is there a Minimum Required Landholding for Food and Nutritional Self-Sufficiency?

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Poster prepared for presentation at the Agricultural & Applied Economics Association's 2012 AAEA Annual meeting, Seattle, Washington, August 12-14, 2012.

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**The authors wish to acknowledge the Agricultural Development Group of the Bill and Melinda Gates Foundation who funded the data collection effort.

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BACKGROUND

The urgency of understanding if there is a future for small farms increases, particularly in Sub-Saharan Africa, as populations grow faster than arable land area (Hazell, 2003; World Bank, 1965-2009). There is ongoing debate between those who favor consolidating landholdings and those who favor increasing smallholder productivity as alternative means of promoting food security (Binswanger and Pingali, 1988; Jayne *et al.*, 2003; Collier, 2008). Resolving this debate hinges on, among other factors, defining the "optimal" landholding size for a given farming system.

Recent studies finding inverse relationships between land productivity and farm size raise questions about long-held assumptions that economies of scale will make larger farms out-perform smaller farms (see Carletto *et al.*, 2011). Economists now recognize that the farming production possibility frontier is both temporally and spatially context-specific: optimal landholding size can only be defined for given outputs, inputs, climate, and technology levels.

We believe approaching this question from a slightly different perspective can produce valuable information. Instead of looking for "optimal" land size, we ask **what is the *smallest* land size needed for viable subsistence farming?** In other words, what is the minimum required landholding (MRL) for a family to produce enough food to adequately nourish itself?

OBJECTIVES

Advantages to establishing a lower threshold for viable smallholder production are methodological and practical. Methodologically, establishing an MRL for a given caloric output requires less specific knowledge about farmer constraints and objectives than needed for "optimum" land size estimates. Practically, an MRL may distinguish between those for whom farming will never be viable under current conditions (i.e., they simply have insufficient land), and those with sufficient land but other productivity constraints, such as labor or fertilizer.

METHOD

Minimum required landholding (MRL) depends on factors that affect land productivity that may be area-specific (such as climate and governance) or farm-specific (such as crop choice or input use). We begin by using Tanzanian Ministry of Agriculture and United Nations Food and Agriculture Organization (FAO) approximations of farming systems and agro-ecological zones to define regions within which we expect MRL to reasonably differ (Lobell et. al., 2009). We further incorporate national, regional and sub-regional climate data from the Tanzanian Meteorological Agency and the National Oceanic and Atmospheric Administration (NOAA) to control for spatial climatic variation. We then use agricultural production data from the 2008-2009 Tanzania Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) to estimate median land productivity and median input use levels across regions.

Finally, based on the median family size and World Health Organization (WHO) indicators of household nutrition (both reported on the LSMS-ISA) we attempt to calculate the minimum land area needed to adequately feed and nourish the median family in each region.

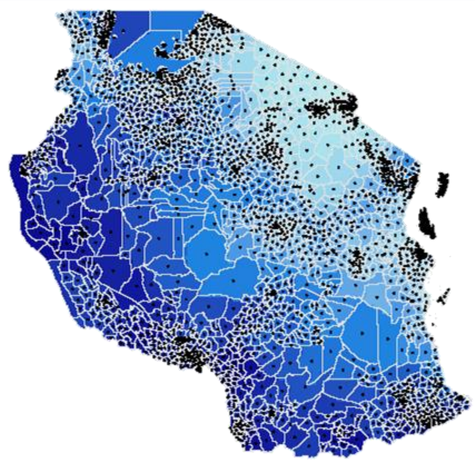

Figure 1. Rainfall data for Tanzania (NOAA, 2008) and LSMS-ISA sampling points for the 2008 Tanzanian household and farming survey.

RESULTS & IMPLICATIONS

The 2008 LSMS-ISA sample was constructed to produce nationally representative estimates and consists of 3,265 Tanzanian households, including 2,474 agricultural households. Spatial correlograms of crops planted (Fig. 2) and crop yields strongly support the inclusion of both geographic factors and farm management techniques in models of land productivity.

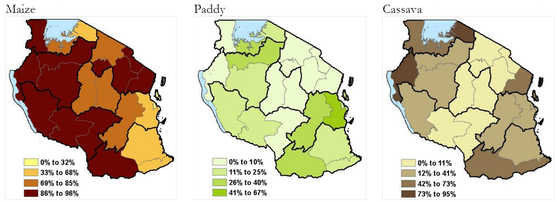

Figure 2. Maize, paddy rice, and cassava cultivation by region in Tanzania (based on LSMS-ISA 2008 data).

Use of productivity-enhancing inputs also varies by both farm and region. However across most regions in Tanzania the use of fertilizers, pesticides, herbicides, and improved seed varieties and techniques remains restricted to a small fraction of farmers (Fig. 3).

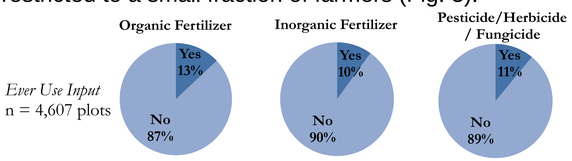

Figure 3. Patterns in input use by agricultural households / farm plot in Tanzania (based on LSMS-ISA 2008 data).

Per acre yield estimates based on 2008 LSMS-ISA data are well below values previously reported by the FAO and other sources. Large differences between median and maximum observed yields (Fig. 4) imply potential per-acre yield increases through input use. But absolute land limits remain remain salient for per-farm productivity. .

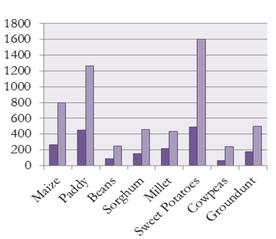

Figure 4. Median yield versus attainable yield, kg per acre (based on LSMS-ISA 2008 data).

CONCLUSIONS

Food security is a function of many factors, among them access to adequate land to ensure consistent and adequate nutrition and/or income over time. The debate over the future of small farms – including the minimum required landholding (MRL) for farming in a given environmental and institutional context – has relevance for crafting effective land reform policies, and designing interventions for increasing smallholder productivity or, if necessary, facilitating alternative non-farm livelihoods.

There are currently drastically differing philosophies in the international development community regarding the best way forward for agriculture, especially in Sub-Saharan Africa. We hope that this research helps us to refine and further test whether our method is a reasonable heuristic for calculating minimum land requirements for smallholder farmers, and whether minimum required landholding is a reasonable heuristic for guiding agricultural development interventions.

In the short run improvements to land policies, credit markets, technology access, and other factors needed to attain the highest potential crop yields are unlikely to be realized by most farmers. This study suggests many Tanzanian farmers could achieve somewhat higher yields given resources currently at their disposal. But yield potential varies dramatically by agro-ecological zone and by individual farm practices and household characteristics. Such regional and farm variation merits expanded consideration in current debates. .

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