Feed the Future Innovation Lab for Food Security Policy

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Area Mismeasurement Impact on Farmers' Input Choices and Productivity

William J. Burke, Stephen N. Morgan, Thelma Namonje, Milu Muyanga and Nicole M. Mason

INTRODUCTION

Most data sources throughout Africa rely on farmers to self-report agricultural data, and these are used to generate statistics on total production, total land use, yield and so on. However, measurement error in self-reported agricultural field area and productivity (yield) data is widely acknowledged. Using a combination of self-reported and GPS measured area from over 1,600 fields in Zambia, we find that although errors are often made in either direction on all field sizes, the prevailing tendency is for agricultural area to be overstated on smaller fields and understated on larger fields. This is consistent with many other findings in similar contexts (De Groote and Traoré 2005; Carletto, Savastano, and Zezza 2013; Holden and Fisher 2013; Carletto, Gourlay, and Winters 2015; Dillon et al. 2019; Abay et al. 2019).

Most studies of this phenomenon focus on what these errors imply for researchers – how accurate are yield and production estimates, and how accurate is our understanding of how these outcomes are determined. These are important questions, but we believe they overlook another important issue – If farmers do not well know the area of their fields, does this affect their input use and, ultimately, their productivity?

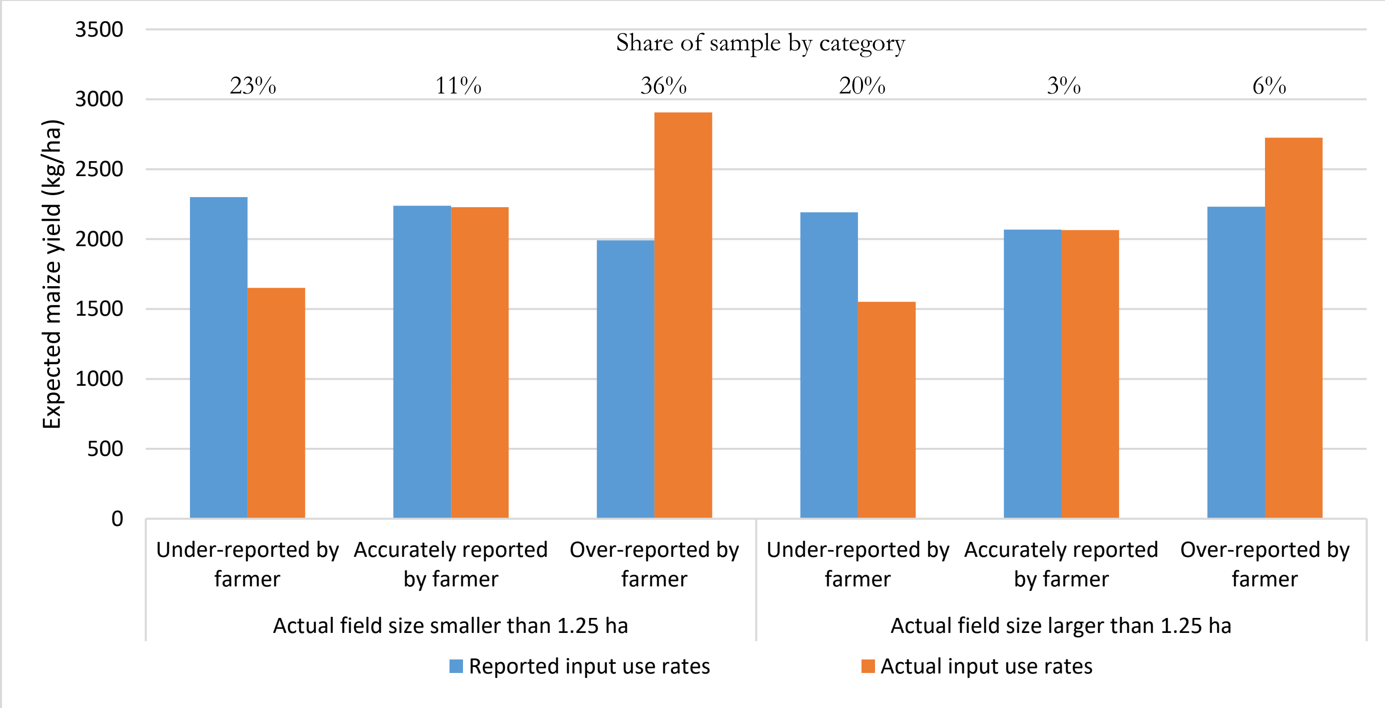
Before trying to answer this question, it is important to be clear that the potential concern lies not with a farmer's misunderstanding of a field's size, but with the disconnect that may exist between a farmer's description of size and the descriptions used to convey agronomic recommendations. A farmer looking out at the piece of land may know its size in every real sense. However, they may not have very accurate knowledge of how big a piece of land is in terms of the units of measurement that are used to communicate recommendations for application of inputs like seed and fertilizer. The problems such a disconnect would present could be immensely important. If a farmer believes they are following recommendations (or even if they are going against recommendations but using recommendations as a benchmark), one major potential downside is that the yields they realize may be inconsistent with what they were told to expect. This makes it more difficult to plan for input purchases, jeopardizes fragile incomes and food security, and has the added disadvantage of lowering the perceived credibility of the advice they are given. Instead, they will ultimately be left to rely solely on their own practical knowledge and experimentation – which is of enormous value, to be sure, but which would be better if it were complemented with the knowledge of collective experience and scientific research.

Key Findings

- Comparing self-reported to GPS measurements, we find farmers frequently mis-state the size of their fields in survey data
- Although errors are often made in either direction on all field sizes, we find evidence that, on average, smaller fields tend to overstate and larger fields tend to understate actual field size.
- Input application rates are more consistent with self-reported area than GPS-measured area, suggesting farmers believe the inaccurate data they provide.
- Productivity itself and productivity measurement are hampered by area measurement errors in self-reported data, highlighting important deficiencies in data collection and farmer training.

Central to the question of whether errors in self-reported area data affect input use is whether the evidence suggests self-reported data are honest but incorrect measurements, or whether farmers are compelled to deceive data collectors. There may certainly be incentive for the latter case. In Zambia, for example, agricultural survey enumerators are often employees of the same ministry responsible for allocating input subsidies, which may give farmers the perceived incentive to over-report field sizes and thus, it follows, fertilizer needs. If farmers are being deceptive, there is not much reason to believe measurement errors are affecting input use. On the other hand, if farmers appear to

Figure 1: Expected Yields for Reported Versus Actual Input Application Rates by Field Size and Measurement Error Groups



Source: Zambia Rural Agricultural Livelihoods Survey 2012, Largest Maize Field sub-sample. Notes: Expected values are computed using parameters reported in Burke et al. (2019), which estimate yield and response to fertilizer and seed using the same dataset. "Accurate" means reported within the GPS margin of error.

be generally honest with enumerators, but factually inaccurate, it is worth investigating the correlations with measurement error so that policy makers can aim to improve farmer knowledge of field sizes in terms of the units used for extension recommendations. Reducing field size measurement errors would benefit farmers and researchers alike.

DECEPTIVE REPORTING OR HONEST MISTAKES?

We can examine whether farmers seem to believe their reported field areas explicitly using some basic regression analysis. This method is discussed in more detail in the companion paper to this brief. Essentially, we regress input use on both GPS measured field size and the errors in self-reported field size (this was done separately for seed, basal dressing fertilizer and urea). If farmers are being deceptive, it would stand to reason that the area they report would have no explanatory power vis-à-vis input use after controlling for actual field size. If they believe the erroneous data they report, however, then we would expect to find input use to be correlated with errors in reported field area (after controlling for true area). For every input we examined, we found input use to be significantly more correlated with reported field size than actual field size. In other words, the data are more consistent with farmers that mis-report field sizes because they are truly mistaken than with farmers that intentionally deceive enumerators.

REAL EFFECTS ON INPUTS AND YIELD

In addition to suggesting farmers are truly mistaken about the area of their fields, the evidence suggests real effects on their productivity. For example, if all farmers applied the major capital inputs, seed and fertilizer, at the rates they reported, the expected yields would be fairly similar across field sizes, ranging from 2 – 2.3 metric tonnes per hectare (blue bars in Figure 1). If anything, farmers who seem to believe their fields are smaller than they actually are also seem to believe they are using their land more intensively. This would be sensible – the less land a farmer believes they have, the more incentive they may have to increase, say, plant population density to maximize output (even if that means exceeding agronomically efficient seed rates and/or requiring more labor input per unit of land).

Expected yields at the actual application rates, however, have the opposite relationship with the farmer's perception of their field size: expected yields are lowest on the 42% of fields farmers believe are smaller than they actually are, and highest on the 43% fields that farmers believe are bigger than they are (orange bars in Figure 1). Again, this makes sense – if a farmer believes they are planting 20 kgs of seed on 1 hectare (the recommended rate (ZARI 2002)), but in fact their field is ¾ of a hectare, they would be in the "over-reported" category and achieved higher yields than a farmer who similarly followed recommendations on an accurately reported field. The problem, of course, is that the higher yield would be a result of inadvertent over-crowding (in this example). It may have also thus required more labor per hectare for planting, weeding, and harvesting.

The important points that stand out are that: 1) farmers seem to be making decisions based on the hectarage they believe they have, 2) in most cases they are mistaken about their actual hectarage, and 3) this discrepancy has real implications for their productivity.

CONCLUSION

The implications of misunderstanding of field area units for researchers and data collection have received much attention, but the real-world implications for farmers have not. It bears repeating what our and several other datasets have evidenced: farmers in developing countries are often not literate in the units of measurement used to advise them. The evidence presented here suggests farmers believe the often-erroneous area figures they report to enumerators. This is problematic, because the advice they receive is often based on area units (e.g., plant 20 kg of seed per hectare; use 200 kg of urea per hectare).

As a follow up to this analysis we visited several farmers and governmental and non-governmental extension agents to get a sense of how farmers are trained to and actually estimate their fields sizes. Many farmers, we learned, are trained to estimate their field size according to how much seed they use – for a maize field, for example, wherever they plant 20 kg of seed, they should assume one hectare. The flaw with the "seed method", of course, is that if seed application rates are used to measure field size, field size is not a reliable way to recommend seed application rates. The seed method may be useful for ensuring, say, fertilizer-to-seed ratios, but seed-to-area and fertilizer-to-area ratios may be subject to agronomically important mistakes, as our data suggest they are.

Our major conclusion, therefore, is that farmers would be well served by better training on how to measure field areas. For example, if seed and row spacing is taught to be done with a higher degree of precision, the seed method might become more reliable. Training in this area would need to take into account the fact that many farmers do not read and write; distributing ropes with knots tied at 90-centimeter intervals (recommended spacing for maize) may be more useful and less expensive, for example, than distributing measuring tapes.

Finally, there is the issue of extension efforts overall receiving a low priority in the agricultural budget – just 1% of Zambia's agricultural budget on average from 2010-2019, for example (ZMF, various years). Our interviews with officials reveal that every government camp officer is meant to be responsible for educating up to 4,000 farmers, and the actual number can be much higher. Moreover, they are usually ill equipped to travel to farmers in remote areas, or to bring farmers to them. Reinvigorating defunct extension systems would be achievably affordable (if not inexpensive) compared to the large-scale input subsidy and maize price subsidy programs that dominate most of Zambia's agricultural budgets. A relatively small investment in emphasizing feasible ways to apply first-principles agronomics could potentially return substantial benefits.

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About the authors

William J. Burke is a Research Consultant at Agricultural and Food Policy Consulting, Baltimore, MD.

Stephen N. Morgan is an Assistant Professor in the Food and Resource Economics Department, University of Florida, Gainesville, FL.

Thelmal Namonje is a Research Associate at the Indaba Agricultural Policy Research Institute, Lusaka, Zambia.

Milu Muyanga is an Assistant Professor in the Department of Agricultural, Food, and Resource Economics, Michigan State University, East Lansing, MI.

Nicole M. Mason is an Associate Professor in the Department of Agricultural, Food, and Resource Economics, Michigan State University, East Lansing, MI.

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