METHODS & TOOLS BRIEFS

Rethinking Land Measurement: The Promise and Limitations of Tablet-Based GPS

50x2030
DATA-SMART AGRICULTURE

MAY 2026

Rice paddies in Rwanda. / Photo by A'Melody Lee, via World Bank.

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Photo via World Bank.

BACKGROUND

This brief examines recent advances in land area measurement in agricultural surveys, with a focus on emerging tablet-based GPS tools. It situates these innovations within the broader shift from self-reported to objective measurement approaches and assesses whether tablets can offer a cost-effective alternative to dedicated GPS devices. Drawing on recent validation evidence, the brief highlights both the operational advantages and the data quality tradeoffs associated with this new approach.

KEY POINTS

- **Accurate land data matters:**

  Farmer self-reports are often systematically biased, distorting key indicators like productivity and inequality, while GPS-based measurement substantially improves accuracy.

- **Tablets offer a practical opportunity:**

  Built-in GPS allows enumerators to measure plots directly on the same device used for interviews, potentially reducing costs and simplifying fieldwork.

- **Tradeoffs need to be weighed:**

  Tablet-based measures outperform self-reports but still differ from handheld GPS, requiring careful consideration of accuracy versus operational gains.

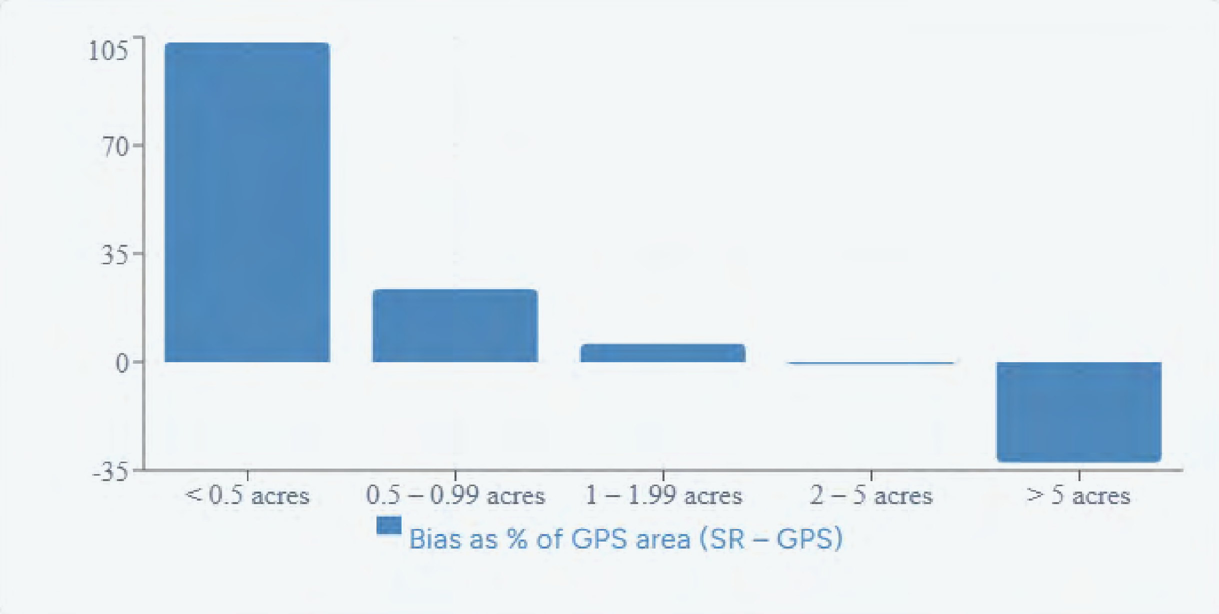
Zanzibar. Photo via World Bank.

MANY AGRICULTURAL SURVEYS, if not most, are now implemented using tablet-based data collection, meaning enumerators are already equipped with tablets. Those tablets often have built-in GPS receivers. Could they replace the dedicated handheld GPS devices that surveys currently rely on for objective plot area measurement — saving $200–$300 per device without sacrificing data quality? New research from the 50x2030 Initiative explores this question, with positive findings for implementation but some data quality tradeoffs to be considered.

75%
of the world's extreme poor population lives in rural households

To understand why the question matters, it helps to understand how far land area measurement has already come. For decades, most surveys relied on a simple shortcut: asking farmers to estimate the size of their own plots. That shortcut has consequences. Farmers tend to overestimate small plots — sometimes by 90% or more — and underestimate large ones (Carletto et al., 2015). The pattern is not random noise: it is a systematic bias that runs in opposite directions depending on farm size, compressing the apparent distribution of land and distorting every estimate that depends on it (see Figure 1). The result is bias baked into the data that policymakers use to design food security programs, target subsidies, and assess rural poverty. In a world where roughly 75% of the extreme poor live in rural households, this is not a minor data quality issue (World Bank, 2024).

FIGURE 1 — Self-report bias as a percentage of GPS-measured area, by plot size category. Pooled data from Malawi, Uganda, Tanzania, and Niger (n = 22,643 plots). The smallest plots (<0.5 acres) are overestimated by 103% on average, while the largest (>5 acres) are underestimated by 33% — with near-zero bias in the 2–5 acre range. Produced based on Table 1 in Carletto et al. (2015).



FROM GUESSWORK TO GPS

The shift toward objective measurement of agricultural land has been one of the most impactful methodological advances in agricultural survey practice over the past decade.

Surveys have historically relied on three approaches:

- **Farmer self-reports** are fast and inexpensive, but systematically biased and unreliable for the reasons above.
- **Compass-and-rope (traversing)** — walking the perimeter of a plot with physical instruments — is highly accurate but extremely time and labor intensive, making it impractical at scale.
- **Handheld GPS devices** offer the best balance of accuracy and efficiency. Enumerators walk the plot boundary with a dedicated GPS device, capturing coordinates that are automatically converted into area estimates. The method can take around 15 minutes per plot, reduces measurement error by over 90% compared to self-reports, and produces estimates within 1–2% of the gold-standard traversing method (LSMS Guidebook, 2016; Carletto et al., 2017).

15

minutes is the average time to measure plot area using a handheld GPS, based on studies in Ethiopia, Nigeria, and Tanzania

Handheld GPS measurement is now the recommended approach for collecting plot and parcel areas in the context of household and agricultural surveys, and has been scaled up into national survey operations in numerous countries, including Malawi, Uganda, Ethiopia, Nigeria, and more.

Importantly, the recommendation to adopt GPS measurement does not mean abandoning farmer self-reports altogether. Best practice is to collect both: self-reported areas remain a valuable input, particularly as a predictor when GPS measurements are missing due to field constraints such as inaccessible plots or equipment failure. Research by Kilic et al. (2017) has shown that multiple imputation approaches — which use self-reported area alongside other plot and household characteristics to predict missing GPS values — can recover reliable area estimates in these cases, preserving sample coverage without sacrificing data quality.

Photo via World Bank.

WHAT BETTER DATA REVEALS

The shift to GPS-based measurement has not just improved data quality — it has changed what the data shows. Because plot size sits in the denominator of every yield calculation, systematic errors in area measurement translate directly into systematic errors in estimated productivity and land distribution.

> **Self-reported data on plot area can alter our understanding of the relationship between plot area and productivity**

A cross-country study using survey data from Malawi, Uganda, Tanzania, and Niger found two consistent and policy-relevant patterns (Carletto et al., 2015). First, self-reported land data systematically understates land inequality: because small farms are overestimated and large farms are underestimated, the distribution of land appears more equal than it actually is. Across the four countries, GPS-based Gini coefficients — a standard measure of inequality — were consistently higher than those derived from self-reports, with the gap reaching 12 percentage points in Tanzania. Second, the well-known finding that small farms tend to be more productive per acre than large farms — the so-called inverse farm-size productivity relationship — weakens somewhat when GPS area measures replace self-reports, though it does not disappear. In other words, self-reported data on plot area alter our understanding of the relationship between plot area and productivity. Both findings have direct implications for how governments and development partners design land policy, target agricultural programs, and interpret productivity data.

A HIDDEN DIVIDEND: GEOREFERENCING SURVEY PLOTS

One of the less obvious — but increasingly valuable — benefits of GPS-based area measurement is that enumerators are already in the field, walking plot boundaries. This creates a natural opportunity to georeference survey plots: recording the GPS coordinates of plot boundaries alongside the area measurement itself. That spatial information, once collected, can be linked to a wide range of external geospatial datasets — including data on soil properties, rainfall, temperature, vegetation cover, and proximity to markets — that are otherwise impossible to connect to individual farm households.

As satellite imagery becomes more widely available and higher in resolution, georeferenced survey data is becoming essential infrastructure for a new generation of agricultural analysis. Survey plots with known boundaries can serve as ground-truth training and validation data for remote sensing models that estimate crop type and yield from satellite imagery at scale. Research in Uganda and Mali has demonstrated that calibrating these models with georeferenced, ground-based data significantly improves their accuracy (Lobell et al., 2019a, 2019b). Work by Azzari et al. (2021) on crop mapping in Malawi and Ethiopia found that the approach to georeferencing — whether full boundaries, center points, or corner points were collected — materially affected model performance, with less precise georeferencing leading to overestimates of cultivated maize area of between 8 and 24 percent. In short, collecting GPS coordinates at the time of plot measurement is not merely a data quality improvement — it is an investment in the analytical infrastructure needed to monitor agricultural outcomes at scale and at lower cost over time.

WHAT'S NEW: EMERGING TOOLS UNDER INVESTIGATION

What if enumerators could measure a plot using the same tablet they use for interviews, without needing a separate GPS device? That idea is now reality. The 50x2030 Initiative supported the development of a tablet-based land measurement feature integrated into the World Bank's Computer-Assisted Personal Interviewing (CAPI) platform, Survey Solutions. This new tool leverages the tablet's built-in GPS receiver to capture the plot boundary as the enumerator walks around the field. The process is similar to using a handheld GPS unit: the enumerator paces the perimeter of the plot, and the software logs coordinates (either automatically at intervals, or by letting the enumerator mark key boundary points). Survey Solutions then instantly calculates the plot's area and stores both the area and the full boundary coordinates directly in the digital questionnaire, eliminating the need to link data records across tablet and a separate handheld device.

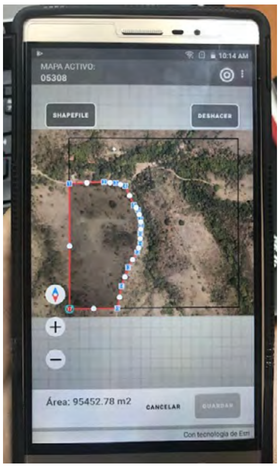


Photo via World Bank.

Findings from the Uganda Climate Land Area and Soil Study (CLASS), which set out to test the new tool in field conditions, especially given that tablet-embedded GPS chips are generally of lower caliber than those found in dedicated handheld devices, are encouraging: tablet-based measurements showed mean absolute errors of around 11–12%, a substantial improvement over self-reports (see Figure 2). However, the methodological validation work found that area measures — and the yield estimates derived from them — differ from handheld GPS results to a statistically significant degree, so tradeoffs in terms of the operational advantages of using the tablet-based measurement need to be weighed against data quality limitations. The Uganda CLASS used a specific tablet model - Samsung Galaxy T580 - and results might differ with older or lower-quality devices.

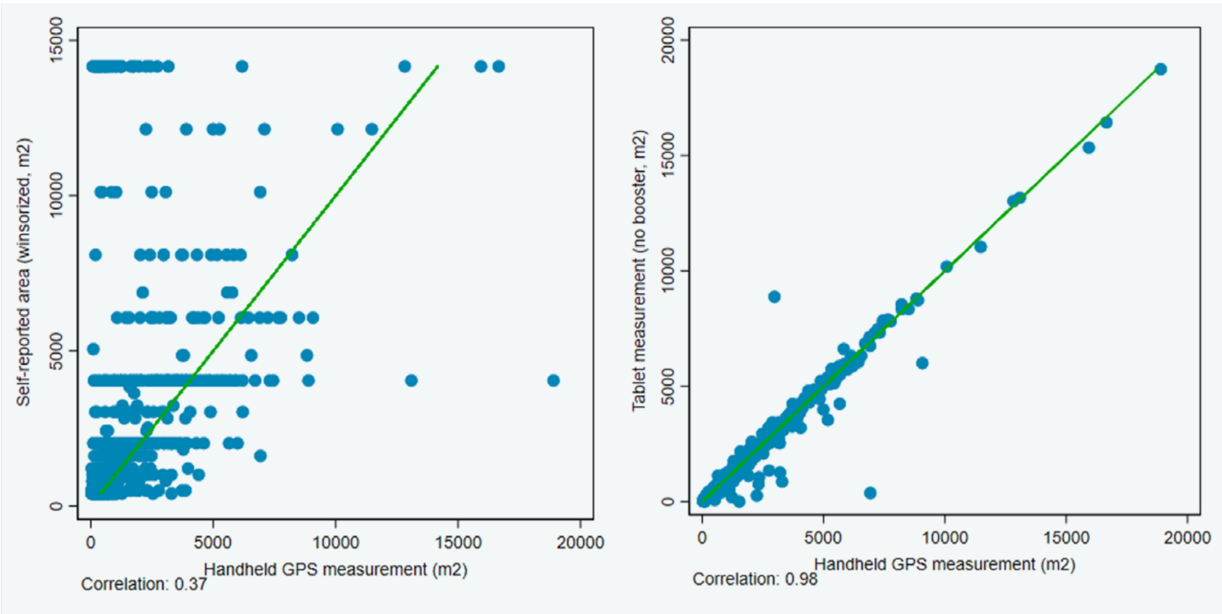
For more details, see the recent paper by Petruccelli et al. (2026): [In Tablets We Trust? Validation of the Use of Tablet-Based Tools for Land Area Measurement in Household Surveys](). The tablet-based approach is an active area of methodological research, and 50x2030 will continue to share findings as the evidence develops.

FIGURE 2 — Scatterplots of self-reported areas versus handheld GPS areas (left) and tablet-measured areas versus handheld GPS areas (right), from Uganda CLASS study. Tablet GPS dramatically outperforms self-reports, but the difference in means between tablet and handheld GPS is statistically significant. Source: Petruccelli et al., 2026.

Learn more:

The findings summarized here are drawn from a growing body of rigorous research. For technical details on survey design, field implementation, and validation evidence, see the resources below:

- In Tablets We Trust? Validation of the Use of Tablet-Based Tools for Land Area Measurement in Household Surveys (Petruccelli et al., 2026)
- 50x2030 Technical Note on Land Area Measurement
- 50x2030 Technical Note on the GPS Coordinate Collection in 50x2030 Surveys
- LSMS Guidebook – Land Area Measurement in Household Surveys: Empirical Evidence and Practical Guidance for Effective Data Collection



THIS 50x2030 BRIEF WAS PREPARED BY:

Sydney Gourlay,
Senior Economist with the World Bank's Living Standards Measurement Study
sgourlay@worldbank.org

WORLD BANK DEVELOPMENT DATA GROUP

Via Abruzzi 10,
00187 Rome, Italy
the50x2030initiative@worldbank.org
www.50x2030.org
#50x2030

50x2030
DATA-SMART AGRICULTURE

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP