A Field Comparison of Data Collection Efficiency Using iPod Touch and Paper-Based Systems

Jon Cambron and Michael Bomford
Kentucky State University Community Research Service, 400 East Main Street, Frankfort, KY 40601

Abstract

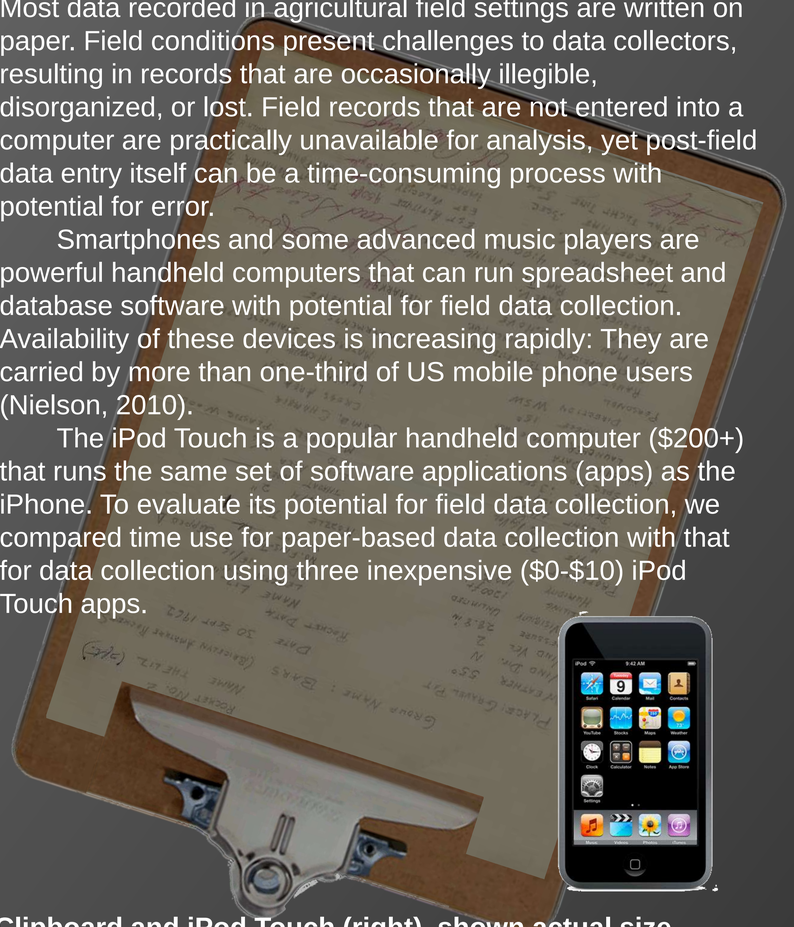
Agricultural field data have traditionally been recorded in field notebooks or on paper datasheets. Paper-based data collection systems present challenges associated with bulk, consistency, legibility, organization, and data transfer to computer for analysis. The iPod Touch is one of several widely-used handheld computers that runs several software applications that could allow direct entry of data in agricultural field settings. To assess the potential of the platform and available software, individuals were randomly assigned either a notebook and camera or a handheld device equipped with one of three applications. Times required for setup, data collection, data recording, and data transfer to a desktop computer were recorded for a set of standardized field and laboratory tasks. The four data collection methods were compared in terms of speed, accuracy, and ease-of-use. The handheld device required more setup time and slowed data collection relative to the field notebook, but did did not speed data transfer to the desktop computer. Advantages of the handheld computer included portability, data legibility, and breadth of available functions.

Introduction

Most data recorded in agricultural field settings are written on paper. Field conditions present challenges to data collectors, resulting in records that are occasionally illegible, disorganized, or lost. Field records that are not entered into a computer are practically unavailable for analysis, yet post-field data entry itself can be a time-consuming process with potential for error.

Smartphones and some advanced music players are powerful handheld computers that can run spreadsheet and database software with potential for field data collection. Availability of these devices is increasing rapidly: They are carried by more than one-third of US mobile phone users (Nielson, 2010).

The iPod Touch is a popular handheld computer ($200+) that runs the same set of software applications (apps) as the iPhone. To evaluate its potential for field data collection, we compared time use for paper-based data collection with that for data collection using three inexpensive ($0-$10) iPod Touch apps.



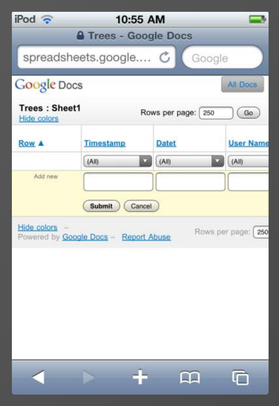
Clipboard and iPod Touch (right), shown actual size.

Methods

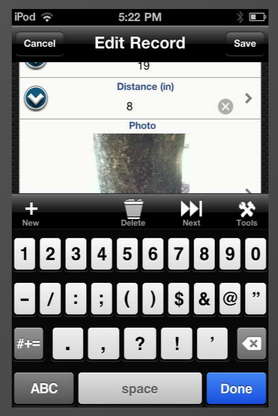
Each of four data collection methods were assigned to four individuals in random order, constrained by a Latin Square design. Data collection methods were:

1) **Paper-based**, using a clipboard, paper, pen, and digital camera;
2) **Office²** spreadsheet running on an iPod Touch;
3) **Google Docs** spreadsheet running on an iPod Touch; and
4) **HanDBase** database running on an iPod Touch.

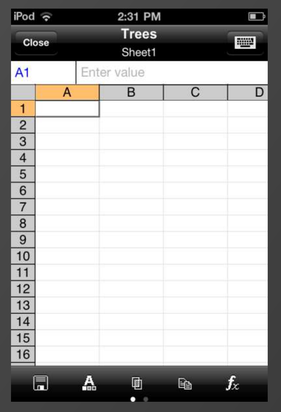
Google Docs



HanDBase



Office²



Setup, data collection, and data transfer phases were timed for each method and participant in field and laboratory settings.

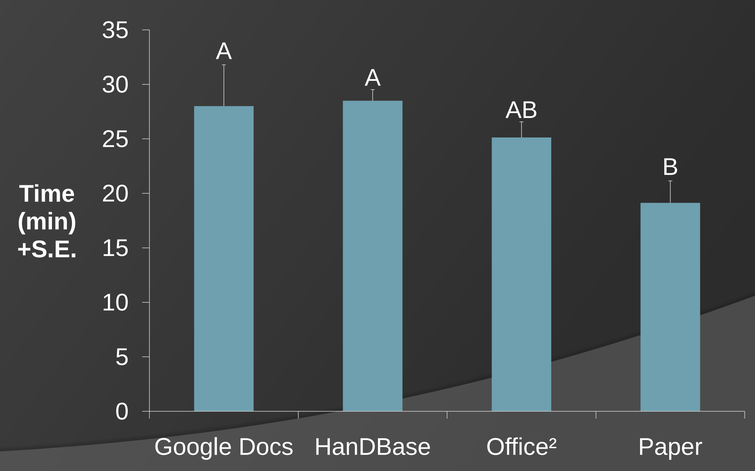
Field data collection involved measuring and recording the diameter at breast height and distance to the nearest neighbor for each of five trees, and collecting a labeled photograph of each tree. Data collectors carried calipers and a measuring tape in addition to data recording equipment.

Laboratory data collection involved measuring and recording the temperature and pH of each of three liquid samples, and collecting a labeled photograph of each sample. Thermometers and pH sensors were available in the laboratory near the sample locations.

Results

Setup, data collection, and data transfer to a desktop computer took up to 50% longer with a handheld computer than with paper (Fig. 1). The data collection component of the process accounted for most of the observed difference. Time required to transfer data to a desktop computer did not differ significantly between methods.

Means and variance of recorded measurements did not differ between treatments, suggesting no effect of data recording method on data quality.



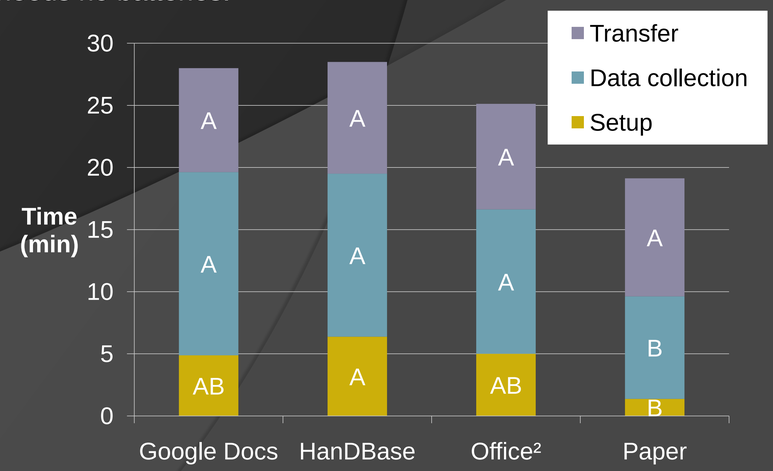


Fig. 1. Average time used for setup, data collection and data transfer to a desktop computer using a conventional paper-based system or one of three apps running on the iPod Touch. Means shown with standard errors (left) or broken down into components of total time (right). Means labeled with the same letter do not differ significantly (Tukey's HSD, α=0.05)

Discussion

Recording data on a handheld computer was slower than recording data on paper. Nonetheless, individuals involved in data collection reported several qualititative differences between data collection methods that suggest the need for further exploration of the potential of handheld computers for data collection.

Individuals involved in the study had many years' experience with paper-based data collection methods, but little or no previous experience with the apps used for data recording on handheld devices. Increasing familiarity with these apps would likely reduce time requirements.

The time required to transfer data to a desktop computer did not differ between treatments, but the bulk of this time was spent on data entry for the paper-based method, and on photo transfers for the methods involving handheld devices. Cameras incorporated into the handheld devices were expected to speed image collection and archival. Instead, they slowed the data transfer process and recorded poorer quality images than the standalone digital cameras used in combination with paper-based data collection. Transfer of data that do not include images is likely to be faster from handheld devices than from paper. Transferring data from paper to the desktop computer required as much time as setup and data collection combined.

Data recording with the Google Docs spreadsheet requires an internet connection, which may be unavailable in some field settings. No internet connection was required for the other methods tested.

Although the HanDBase database was slower than paper-based methods in this test, it incorporated features that could strengthen data quality and even speed data collection by experienced operators. For example, it checked data at the point of entry to ensure it conformed to the appropriate type for a given field; it allowed operators to build drop-down lists to speed re-entry of repeating values; it automatically recorded the time of every entry; it allowed dates and times to be edited quickly using an intuitive spinning wheel interface; and it allowed values to be drawn from external tables of related data.

The iPod Touch appears to be well adapted to field conditions. It is smaller and lighter than a clipboard, so may prove useful if occasional data recording is interspersed with use of tools or operation of machinery. Its screen brightness adjusts to ambient light levels, making it legible in a range of field conditions. Although it is sturdy, the glass screen can crack or shatter if dropped on a hard surface, making use of a protective case advisable for field use.

In addition to the time efficiency advantage documented here, paper-based data collection is intuitive, inexpensive, and needs no batteries.

MASTERS IN ENVIRONMENTAL STUDIES