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**Thomas Daum “The potential of smartphone apps to collect self-recorded data in agricultural households. A study on time-use in Zambia”, University of Hohenheim, 2019**

### Summary

Mobile information and communication technologies (ICTs) have spread across the developing world and are used increasingly by smallholder farmers. While the potential of ICTs, such as smartphone applications, to provide new opportunities for agricultural development is widely acknowledged, the potential to use them as research tools has not been explored. This thesis assesses the potential of smartphone applications for the collection of data from agricultural households in developing countries. Can smartphone applications that use visual tools be used for self-recording of data by the respondents themselves where literacy levels are low? Can such smartphone applications that allow for real-time data recording increase the accuracy of the collected data?

Answering these questions is important as, so far, data from agricultural households are usually collected using surveys, which are prone to recall biases. This is a problem, as researchers, policymakers and development practitioners need reliable data for their work. Poor data can lead to misguided policy recommendations and actions with adverse effects on vulnerable population groups. This can lead to agricultural development trajectories that are socially unequal and unsustainable.

To assess the potential of smartphone apps to collect self-recorded data, a smartphone application called Timetracker was developed as part of this thesis. The Timetracker allows study respondents to record data in real time with the help of illustrations. Recording data in real time reduces recall bias, and using pictures ensures that participants with low literacy can use the application. In its current form, the Timetracker can be used to collect data on time-use and nutrition. Collecting reliable data on time-use and nutrition is key for various strands of research. For example, time-use data are needed to calculate labor productivity and analyze how productivity is affected by new technologies. Time-use data can also help reveal gender-based power relations and asymmetries by pointing out unpaid domestic work. Similarly, nutritional data are crucial for various academic fields and debates. For example, nutritional data are needed to explore the factors determining food and nutrition security, to study how farm diversity affects consumption diversity and to monitor food and nutrition policies and programs.

This study is based on three main chapters, which reflect the main objectives of the whole thesis: 1) to explore and test whether smartphone applications can be used to collect data from rural households in developing countries focusing on time-use and nutrition data, 2) to assess the accuracy of data collected with smartphone applications vis-à-vis recall-based data

collection methods, and 3) to use the data to understand the effects of agricultural mechanization on the intrahousehold allocation of time-use within smallholder farming households in Zambia. The first two chapters have a primarily methodological focus. The last chapter is an empirical study.

The second chapter, which addresses the first objective, explores and tests whether smartphone applications can be used as data collection tools in developing countries. For this purpose, the lessons learned from the use of user-oriented smartphone apps in developing countries and from examples where smartphone apps have been used to collect data in developed and developing countries were extracted. Based on these lessons, the Timetracker application was developed, which is presented in detail. The second chapter reflects on the preconditions that need to be fulfilled when using smartphone apps to collect data in developing countries based on the authors' experiences when using the Timetracker in rural Zambia, such as the need to address the challenge of low literacy levels and social beliefs. The chapter concludes with a discussion on the future potential to use smartphone applications to collect data from smallholder farming systems.

In the third chapter, which addresses the second objective, the accuracy of the collected data is tested. The chapter discusses the potentials and pitfalls of the Timetracker application vis-à-vis the advantages and disadvantages of existing methods to collect time-use data in developing countries. Then, the accuracy of the Timetracker application is tested by comparing the data collected with the application with the data collected using 24-hour recall questionnaires. The results confirm the literature on recall biases, suggesting that using the Timetracker application leads to valid results. Additional methods to validate the collected data are discussed, and limitations and directions for future research are noted.

In the fourth chapter, which addresses the third objective, the collected data are used to explore the effects of agricultural mechanization on farm families. Agricultural mechanization has been rapidly growing in Asian countries and has received growing attention in Africa, but its effects are ambiguous. The chapter investigates the effects of mechanization on the intrahousehold time-use divisions in smallholder farming households in Zambia, paying particular attention to gender, child labor and seasonality. This study was formulated against the background that the adoption of new technologies, policies, and practices can change the intrahousehold time allocation, which may disadvantage vulnerable household members, such as women and children. This study uses compositional data analysis, which accounts for the intrinsic codependence of time-use data, and different regression tools. The results show, for example, that both men and women benefit from agricultural mechanization during land preparation and that a gender differentiation only emerged with mechanization. There is some evidence that the time "saved" is used for off-farm and domestic work. No negative second round effects during weeding and harvesting/processing and no negative effects on children were found. This chapter provides proof of concept that using digital tools can help to collect more reliable socioeconomic data and that compositional data analysis can be used to analyze such data with regard to time use.

Returning to the three objectives formulated above, this thesis showed that 1) picture-based smartphone applications can be used to collect data in rural areas of developing countries with low literacy levels; 2) smartphone applications can help to improve the accuracy of time-use data in developing countries; and 3) having such accurate and detailed data allows to explore the socioeconomic aspects of agricultural development that are otherwise difficult to analyze, such as the effects of agricultural mechanization on the intrahousehold allocation

of time-use within smallholder farming households.

This thesis concludes that in addition to improving the accuracy of socioeconomic data collection, smartphone applications may open new research pathways, including through the opportunities provided by real-time data collection and by combining self-recorded data with sensor-recorded data, which may open interesting transdisciplinary research pathways. This thesis suggests that there is a large and still untapped potential for using smartphone applications to collect data on complex agricultural systems in the digital age.