



FEED^{THE}**FUTURE**

The U.S. Government's Global Hunger & Food Security Initiative

Novel Metrics to Support Research, Programming, and Policy in Agriculture, Nutrition, and Health:

Findings from India, Nepal, and Ghana

Robin Shrestha

Lichen Liang

Giacomo Zanello

Feed the Future Innovation Lab for Nutrition



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The screenshot shows a Zoom webinar interface. On the left is a large black video area. On the right is a white sidebar titled "Zoom Group Chat". At the bottom is a dark toolbar. Two orange circles and arrows highlight specific features: one circle around the "Join Audio" button in the toolbar with an arrow pointing to the text "If you are unable to hear, connect your speakers by selecting 'Join Audio'", and another circle around the "To: All panelists and attendees" dropdown in the chat sidebar with an arrow pointing to the text "Please use the chat box to introduce yourselves and share thoughts and comments by sending a message to 'All panelists and attendees'".

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Q&A AND CHAT

Submit your questions for the panelists in the Q&A box

The screenshot displays a Zoom interface with a dark background. In the center, a white 'Q&A' box is open, featuring a 'Welcome' message with a gold coin emoji and the text 'Feel free to ask the host and panelists questions'. Below this is a text input field labeled 'Type your question here...'. At the bottom of the screen, the Zoom toolbar is visible, with the 'Q&A' icon circled in orange. An orange arrow points from this icon to the Q&A box. To the right, a 'Zoom Group Chat' window is open, showing a message that reads: 'If you're having any technical difficulties, please send a message to "All panelists" via the chat box and we will do our best to help resolve your issue'. Below this message, a dropdown menu is open, showing 'All panelists' selected. A blue circle highlights the chat area, and a blue arrow points from the 'All panelists' selection up to the instructional text.

Q&A

Welcome 🏆

Feel free to ask the host and panelists questions

Type your question here...

Zoom Group Chat

If you're having any technical difficulties, please send a message to "All panelists" via the chat box and we will do our best to help resolve your issue

✓ All panelists
All panelists and attendees

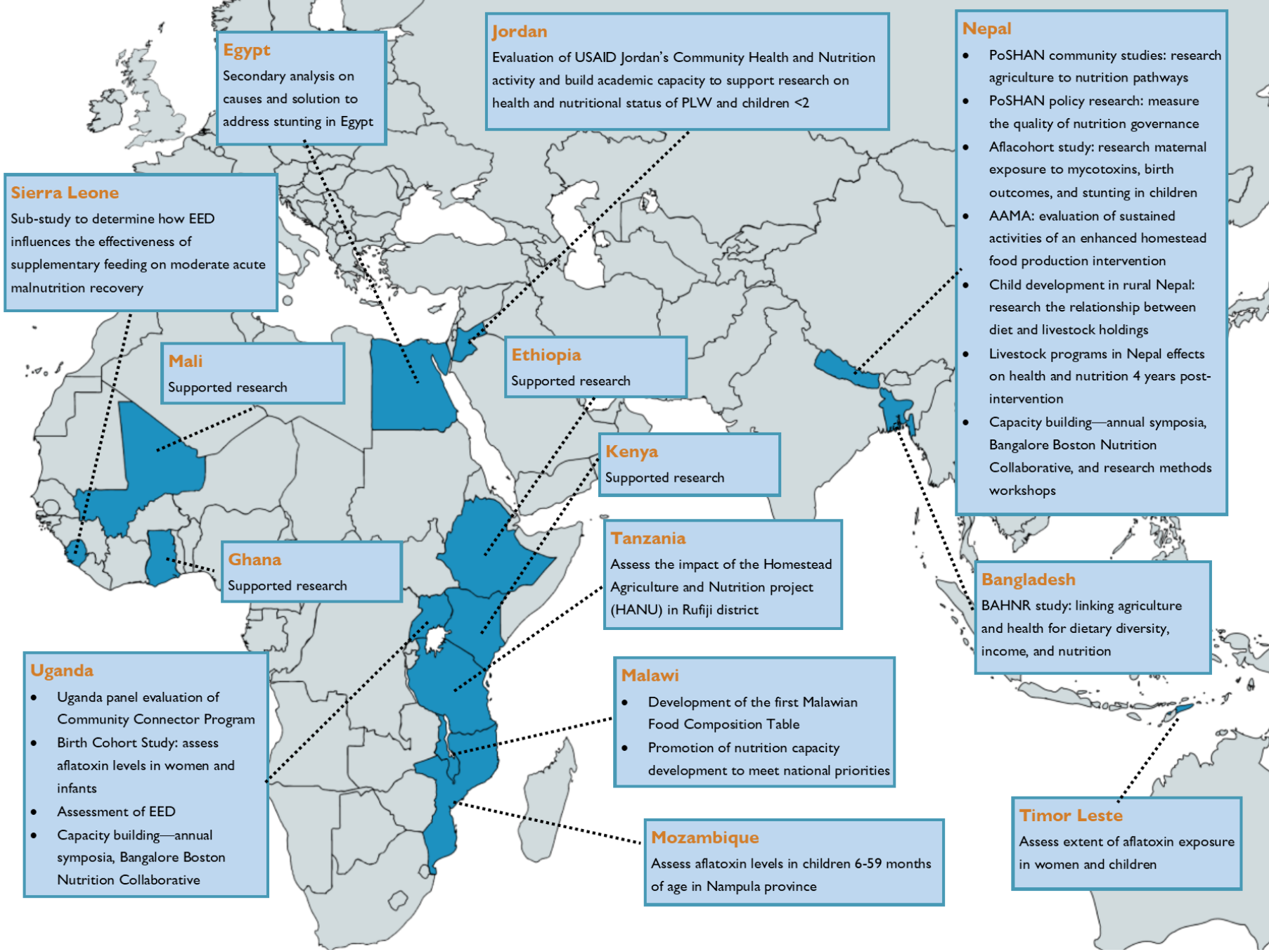
To: All panelists

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Audio Setting ^

Q&A Chat

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Giacomo Zanello and C.S. Srinivasan (University of Reading, United Kingdom)

Fiorella Picchioni (Greenwich University, United Kingdom)

Patrick Webb (Tufts University, United States of America)

Amanda Wyatt (IFPRI, United States of America)

Ghana

Paul Nkegbe and Yazida Ustarz (University for Development Studies, Ghana)

India

Radhika Cherukuri and Nithya Gowdru (National Institute of Rural Development, India)

Nepal

Shailes Neupane and Saurav Neupane (Valley Research Group, Nepal)

20+ dedicated and committed enumerators in Ghana, India, and Nepal



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WEDNESDAY, SEPTEMBER 16TH
9:00AM - 10:30AM (ET)

INNOVATION LAB FOR NUTRITION WEBINAR SERIES

**Novel Metrics to Support Research,
Programming, and Policy in Agriculture,
Nutrition, and Health:**
Findings from India, Nepal, and Ghana



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WEBINAR OUTLINE

- Presentation 1: Use of **mobile phone data (ownership and usage)** as a novel data source to adequately describe the food security in rural-population (Nepal)
- Presentation 2: Use of **novel technology (accelerometer devices)** to capture data on energy expenditure, dietary intake and nutrition in rural livelihoods (India, Nepal and Ghana)



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Use of mobile phone data (ownership and usage) as a novel data source to adequately describe the food security in rural-population (Nepal)

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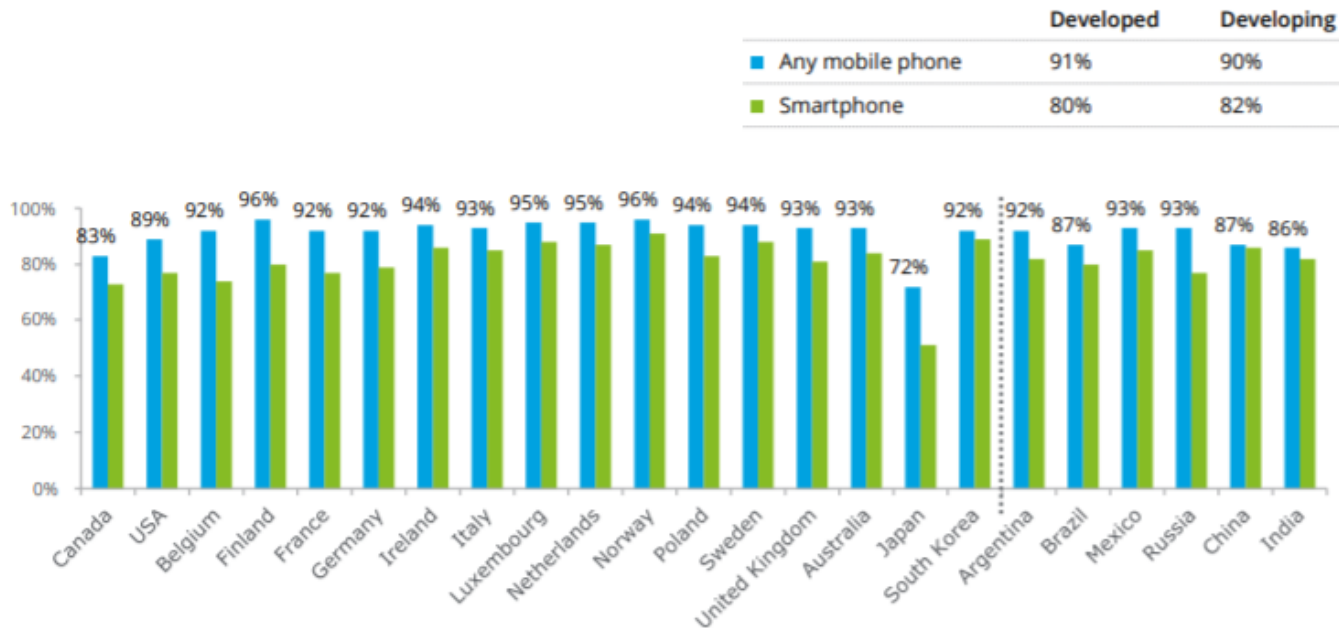


DIGITAL TECHNOLOGIES - MOBILE PHONES

Mobile: a part of modern life

Perhaps it's no surprise that roughly four decades after the introduction of the first mobile phone, almost every developed country surveyed has at least 90 percent mobile phone penetration.

Smartphone ownership



Deloitte's global mobile consumer trends report, 2017





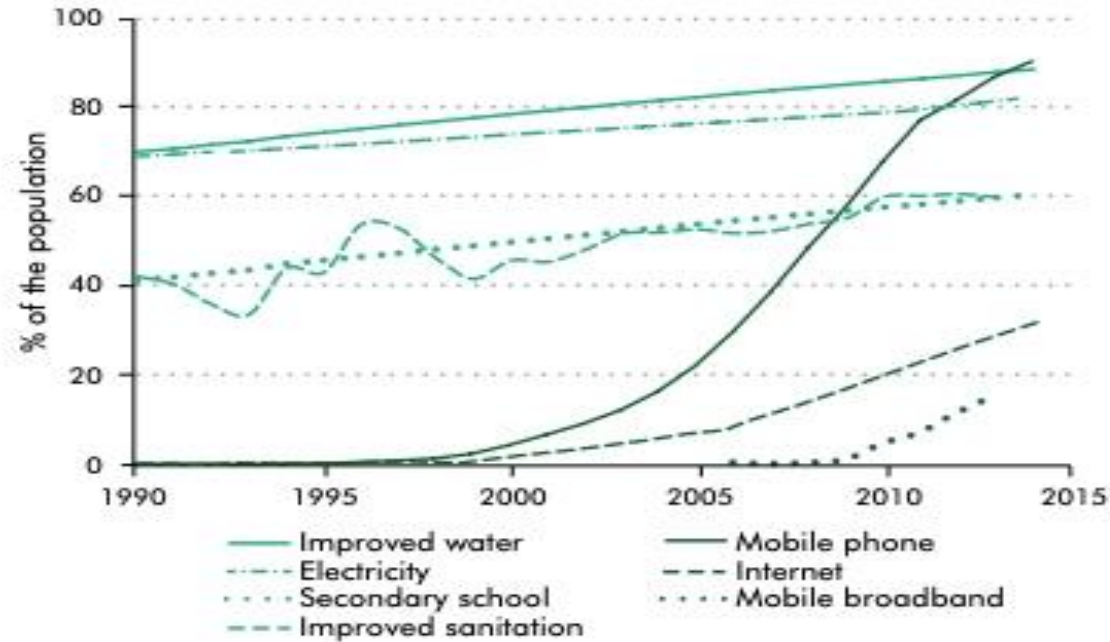
MOBILE PHONES - BRIDGING THE DIGITAL DIVIDE

6

WORLD DEVELOPMENT REPORT 2016

Figure O.4 Digital transformation in action

a. Digital technologies are spreading rapidly in developing countries





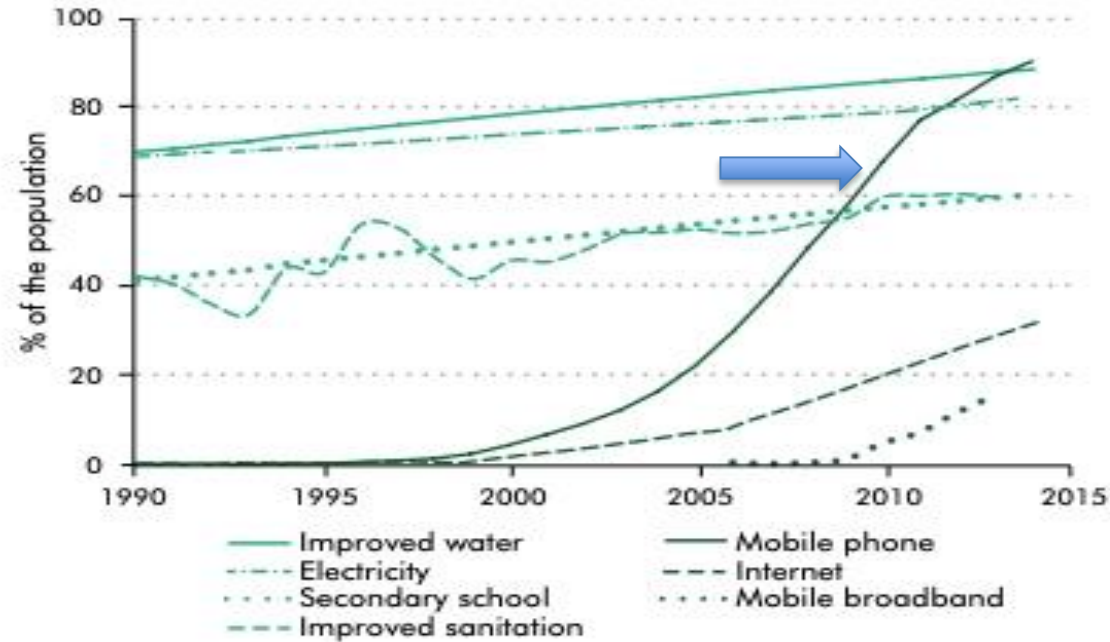
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WORLD DEVELOPMENT REPORT 2016

Figure O.4 Digital transformation in action

a. Digital technologies are spreading rapidly in developing countries





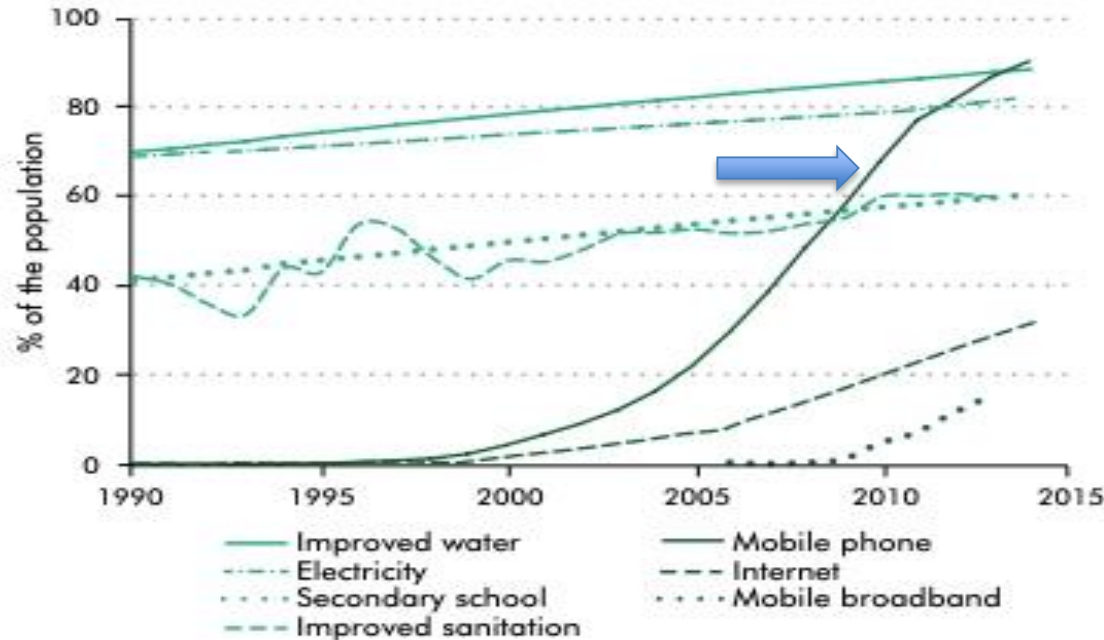
MOBILE PHONES - BRIDGING THE DIGITAL DIVIDE

6

WORLD DEVELOPMENT REPORT 2016

Figure O.4 Digital transformation in action

a. Digital technologies are spreading rapidly in developing countries



- Digital Divide – uneven distribution in the access to and use of technologies
- Improved physical access to mobile phones bridging the divide – competitive rates from telecom companies, and viewing mobile phones as necessity then just as a luxury item
- Uptake and use constrained by socio-economic factors - age, gender, location, income, education
- other dimensions (technology literacy, usage) of digital divide persist.

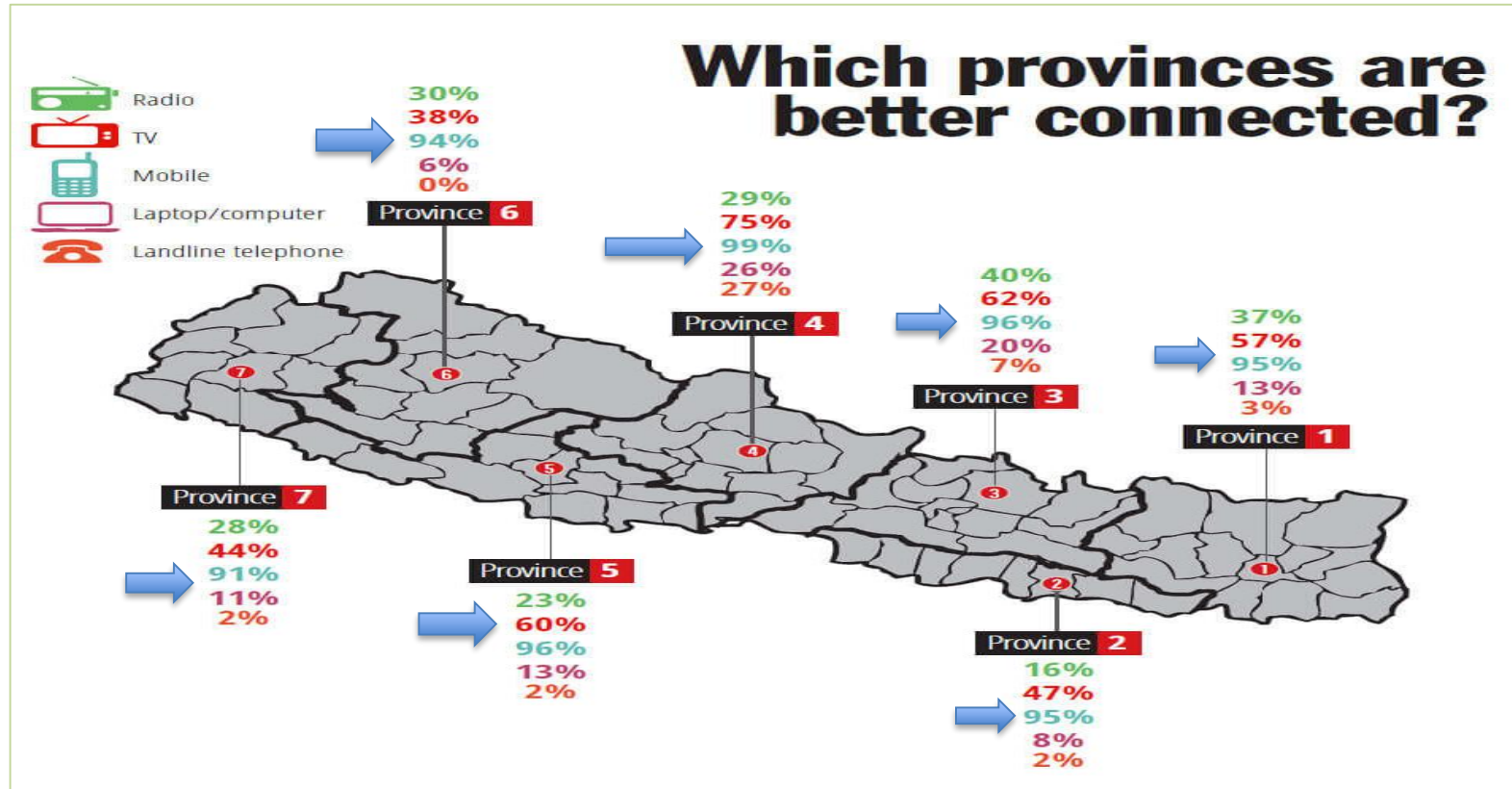




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DIGITAL TRANSFORMATION IN LMIC



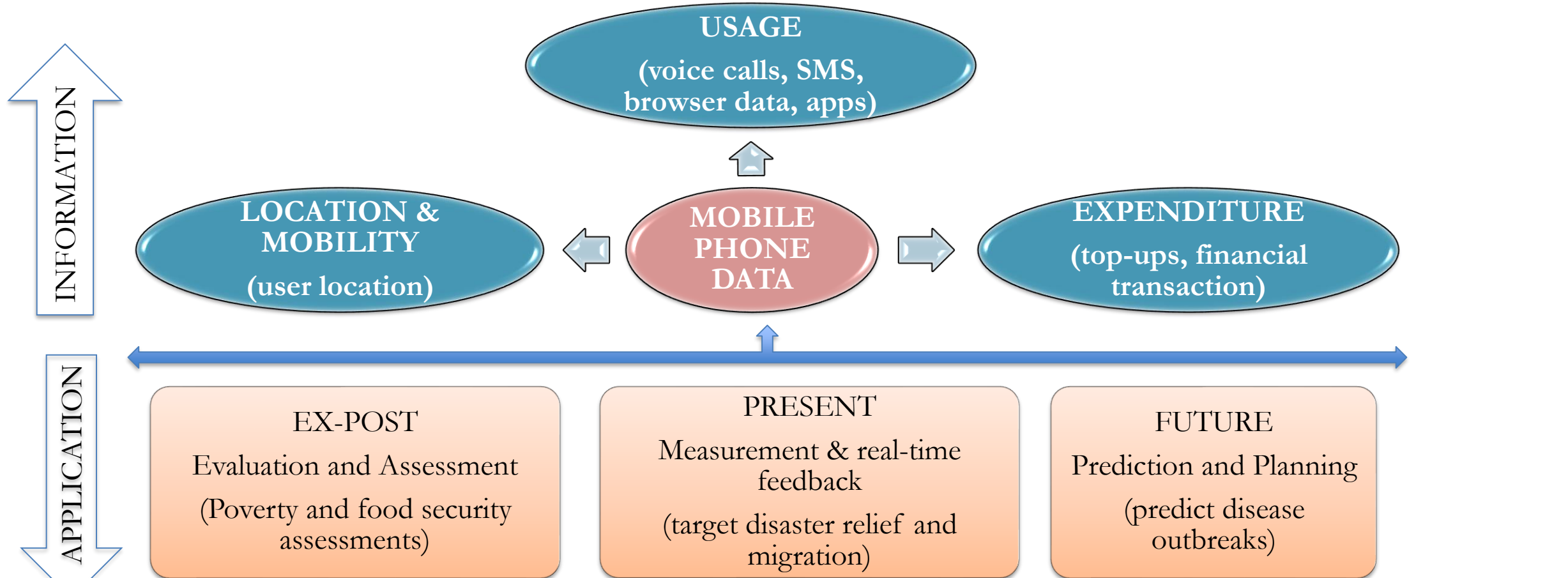
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MOBILE PHONE DATA



CHALLENGES IN MEASURING FOOD INSECURITY

- Depending on how food security is defined, the measurement changes
- Measuring food security is complex and targeted responses both require access to good data at a reasonably high spatial resolution and temporal frequency; response and recall biases
- Measurement involves:
 - large scale data collection
 - Relatively high cost, takes time
 - Difficult to access areas due to long distances, lack of transport infrastructure, security
 - Lack temporal frequency



WHY USE MOBILE DATA TO CAPTURE FOOD INSECURITY?

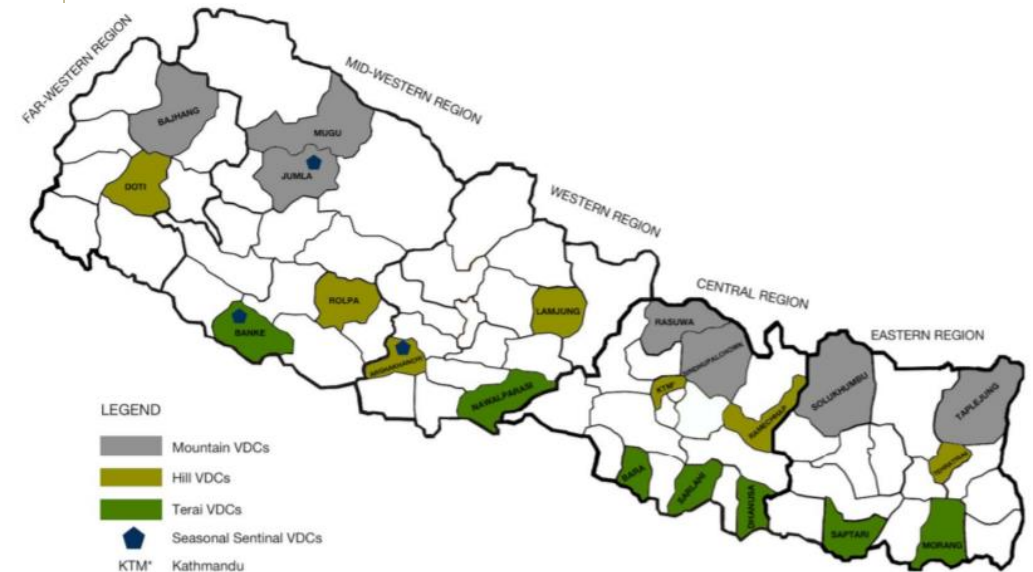
- Offers a relatively new source of information –
 - **Accurate and timely** data to monitor food insecurity for high-risk populations; allow quick response
 - **Real-time** monitoring
 - Linked at the level of countries, communities or households
 - **Cheaper** than face to face surveys
- Complement or alternative to currently available approaches:
 - **Traditional household surveys:** **a) Direct tools** – HFIAS, FIEMS; **b) Anthropometry** – weight, height, body size; **c) Proxy tools** – Household expenditure surveys, coping strategy index, dietary intake measurements (Battersby et al., 2014, Bashir and Schilizzi, 2013, De Cock, 2012)
 - **Remote, continuous food security monitoring** – mVAM using mobile phone voice technology to collect food security (Robinson, A. with Obrecht, A. 2016)

LITERATURE REVIEW

- The presence or absence of mobile phones reflects the level of potential interaction the consumers can have with the wider world, which makes it a strong proxy indicator of security
- Blumenstock et al. in Rwanda showed that an individual's history of mobile phone use can be used to infer their socioeconomic status.
- Gutierrez et al. in Cote d'Ivoire used call data records and airtime purchases to identify and extract proxies for wealth.
- Decuyper et al. conducted a model to determine a proxy indicator for poverty and food consumption based on aggregate mobile phone activity data at a scale of 10000-50000 inhabitants

METHODOLOGY

- Objective - To explore indicators derived from mobile phone data (ownership and usage) to estimate food insecurity at a community level across different time points
- Multi-year PoSHAN survey; Longitudinal panel data (P1-2013, P2-2014, P3-2015, P4-2016)
- Total N – 215, from 63 wards at each time point
- Unbalanced panel: 27 wards were followed in all 4 panels, 35 P1, P2, P4 and 1 in P1 and P2
- Nested structure: repeated measures for same ward over 4 years, wards nested in VDCs



Klemm et al., 2018

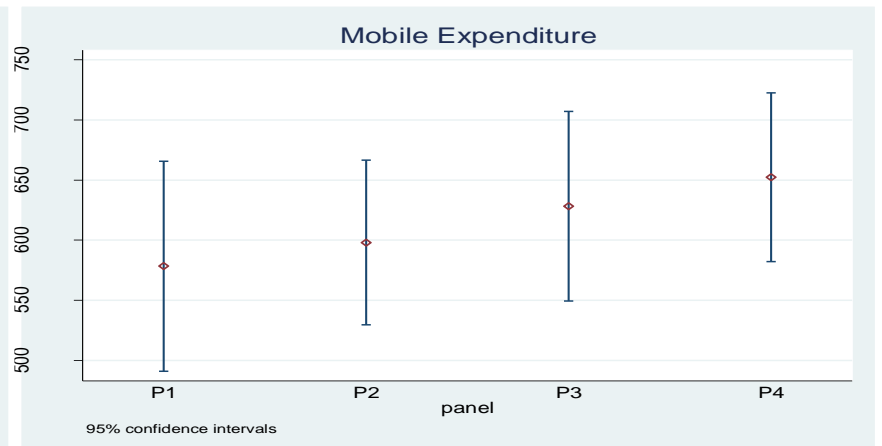
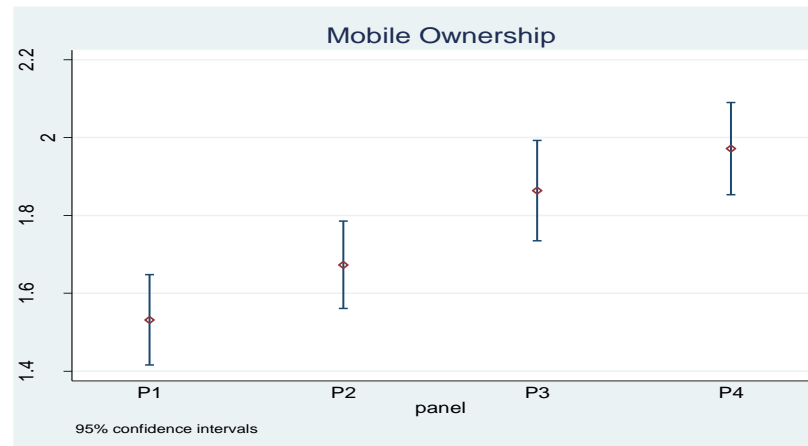
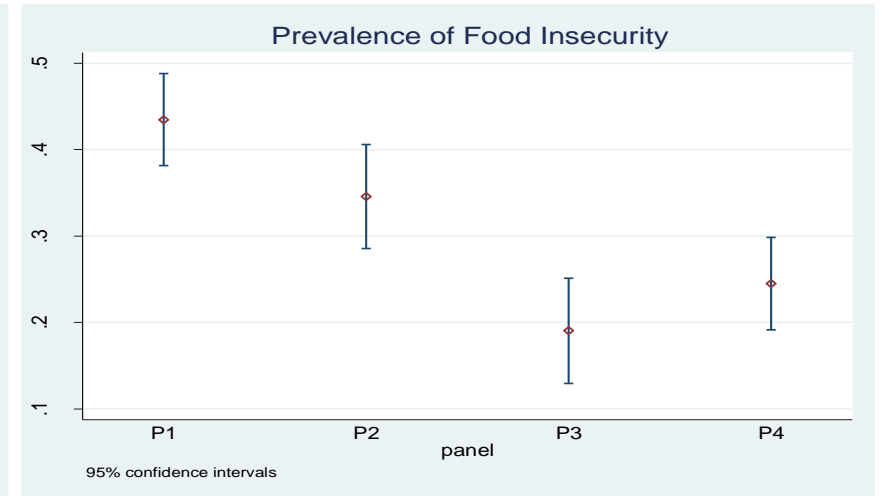
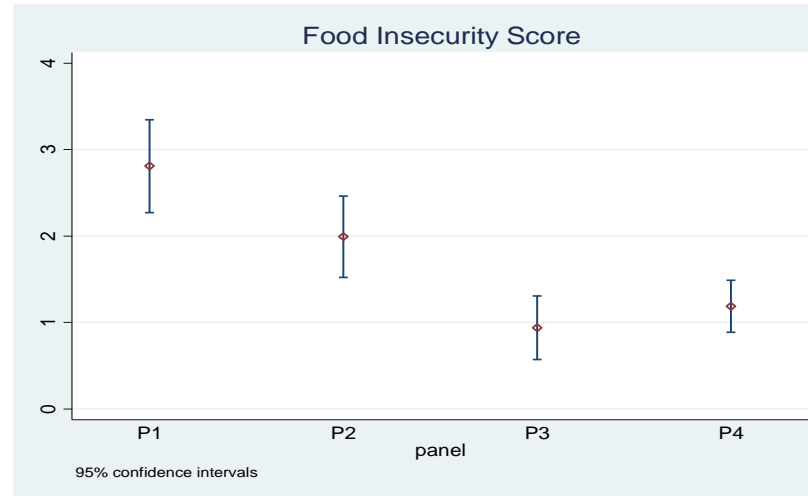
ANALYTICAL STRATEGY

- Community level mobile phone variables
 - 1) Average number of mobile phones owned by households within a community (wards)
 - 2) Average monthly mobile phone expenditure of all households in that community (wards)
- Community food insecurity variables
 - 1) Household food insecurity access scale (HFIAS) aggregated at the community level (wards)
 - 2) Prevalence of household food insecurity
- First-differences between survey rounds for empirical relationship
- Multilevel models to address any interdependence among observations within each level of clustering
- Model performance was evaluated using the mean absolute error (MAE)
- Repeated cross-validation (by VDC and survey rounds) to characterize model performance



RESULTS

- Annual trends in mobile phone ownerships/expenditure and food insecurity
- Food insecurity score and prevalence vary significantly by years ($p < 0.001$)
- Mobile phone ownership varies significantly over years ($p < 0.001$)
- Expenditure did not change significantly over years ($p = 0.52$)



CORRELATIONS BETWEEN COMMUNITY MOBILE PHONE & FOOD INSECURITY VARIABLES

	Mobile ownership	Mobile expenditure	HFIAS
Mobile ownership			
Mobile expenditure	0.6648***		
HFIAS	-0.6191***	-0.3419***	
Food insecurity prevalence	-0.5827***	-0.3495***	0.9019***

*** p<0.001



RESULTS

Wealthier wards have lower levels of food insecurity, own more phones and spend more on top-ups

Socio-economic status	Poorest (n=26)	Poorer (n=75)	Middle (n=62)	Richer (n=39)	Richest (n=13)	p-value*
HFIAS	3.26 (1.75,5.45)	1.56 (0.79,3.20)	1.23 (0.52,2.31)	0.73 (0.33,1.09)	0.43 (0.41,0.88)	<0.001
Prevalence of Household food insecurity	0.53 (0.40,0.73)	0.33 (0.19,0.51)	0.28 (0.14,0.45)	0.16 (0.09,0.23)	0.13 (0.10,0.19)	<0.001
Number of Mobile phones owned	1.30 (1.03,1.59)	1.59 (1.29,1.84)	1.85 (1.52,2.04)	2.03 (1.89,2.21)	2.17 (2.03,2.42)	<0.001
Mobile phone expenditure (Nepalese Rupees)	346 (288,451)	470 (343,571)	683 (448,807)	773 (645,969)	952 (754,1124)	<0.001

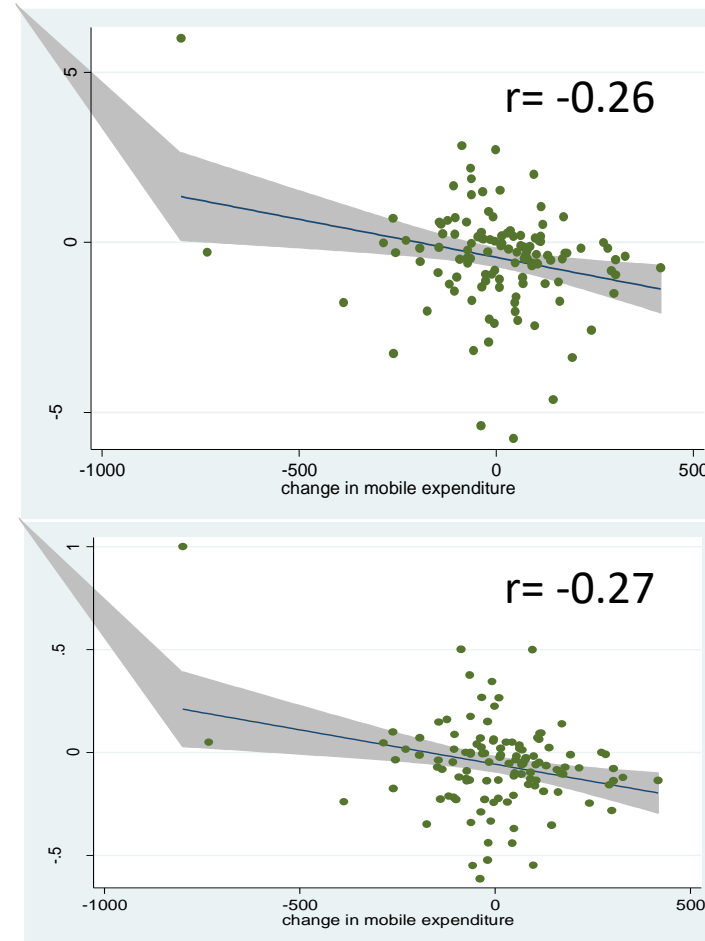
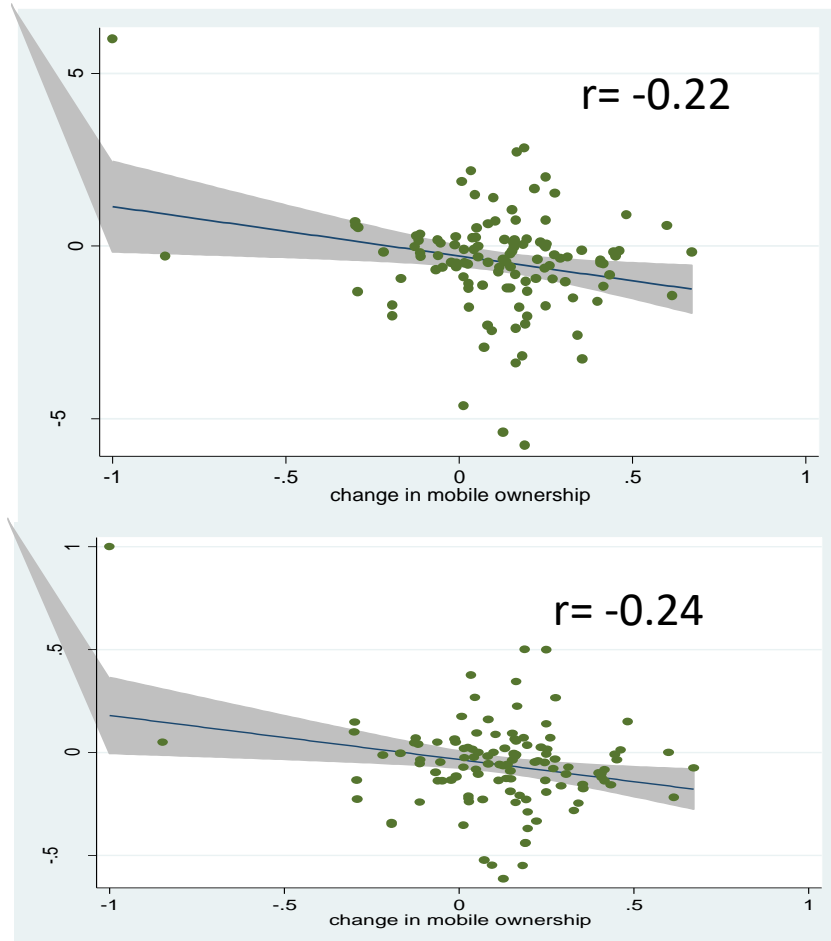




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EMPIRICAL RELATIONSHIP



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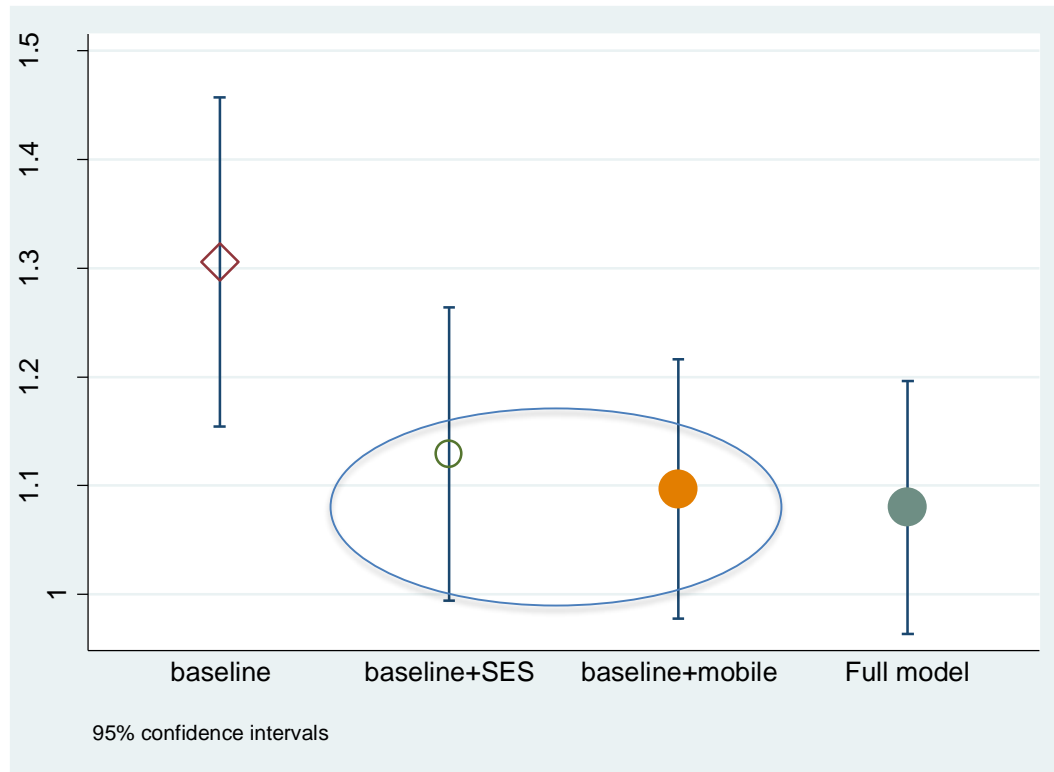


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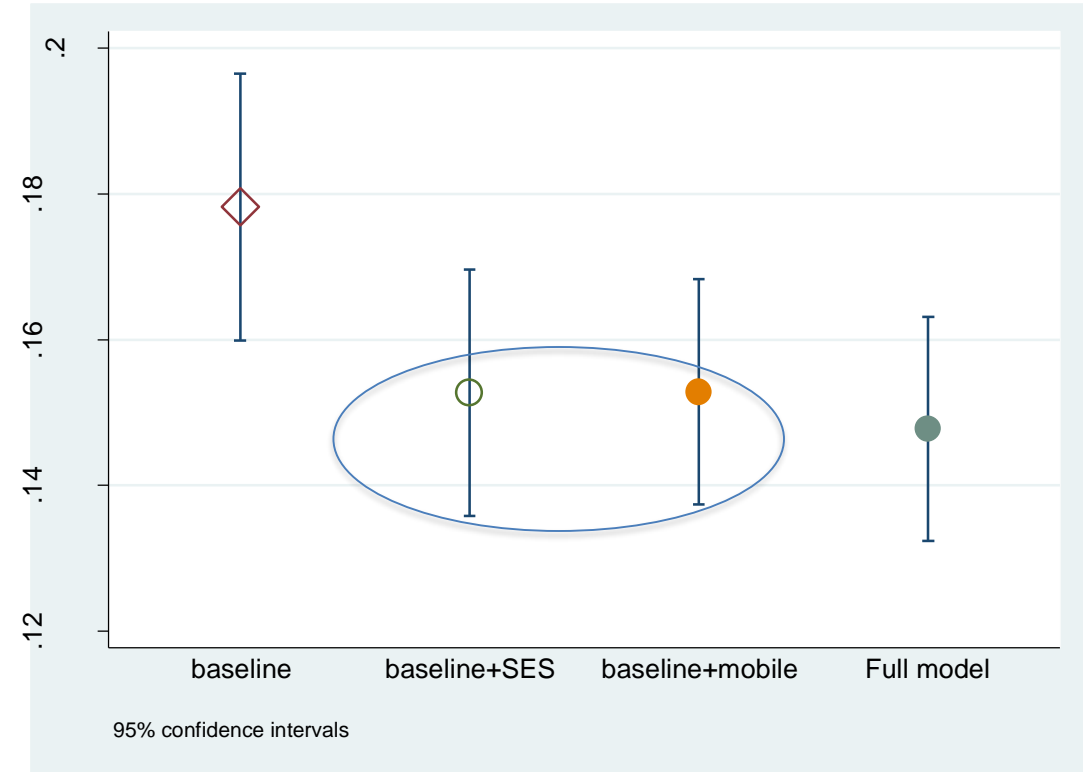
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MODEL PERFORMANCE (CROSS-VALIDATION)

HFIAS



Prevalence of food insecurity



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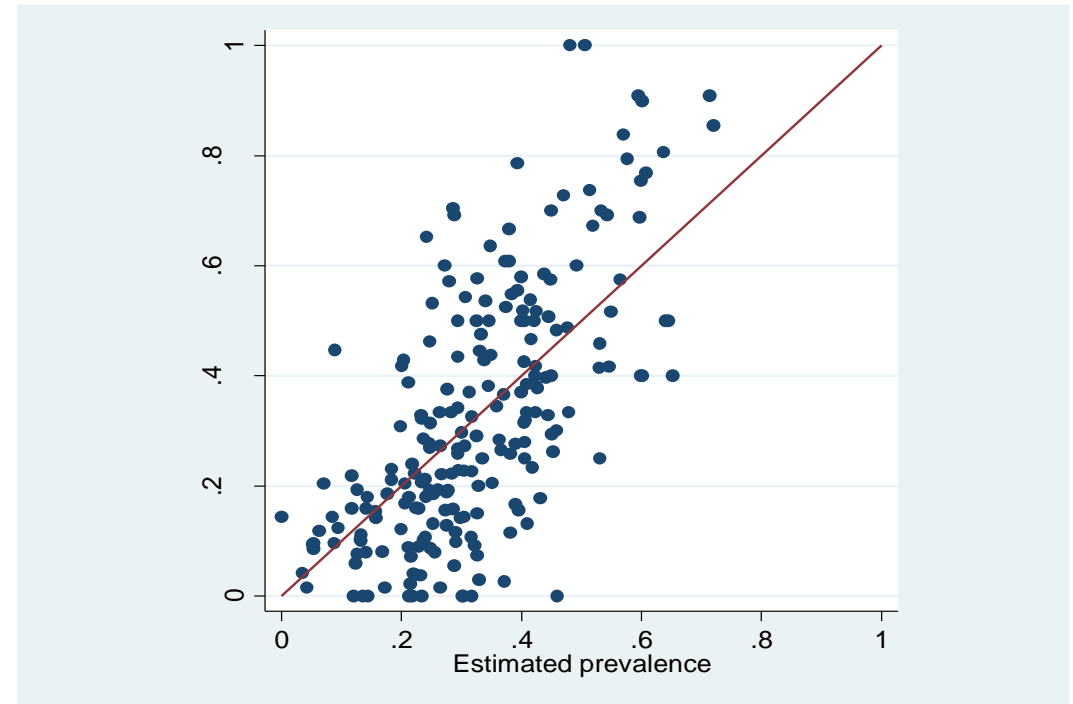
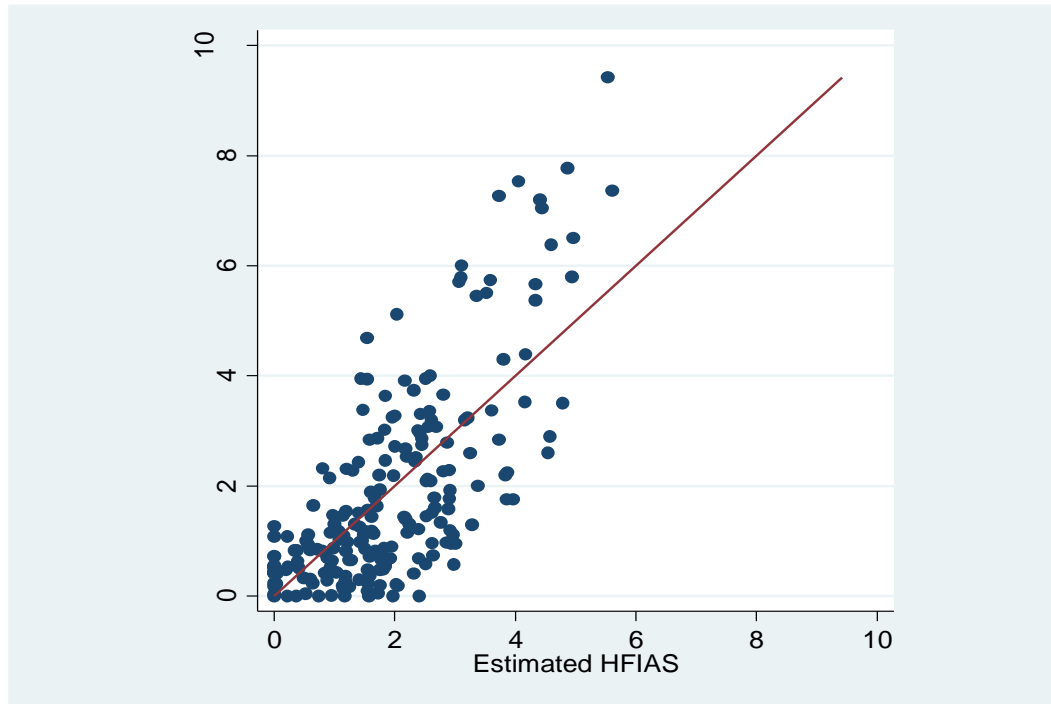


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MODEL PERFORMANCE

Estimated community HFIAS and prevalence of food insecurity explain 52% and 46% of variance, respectively



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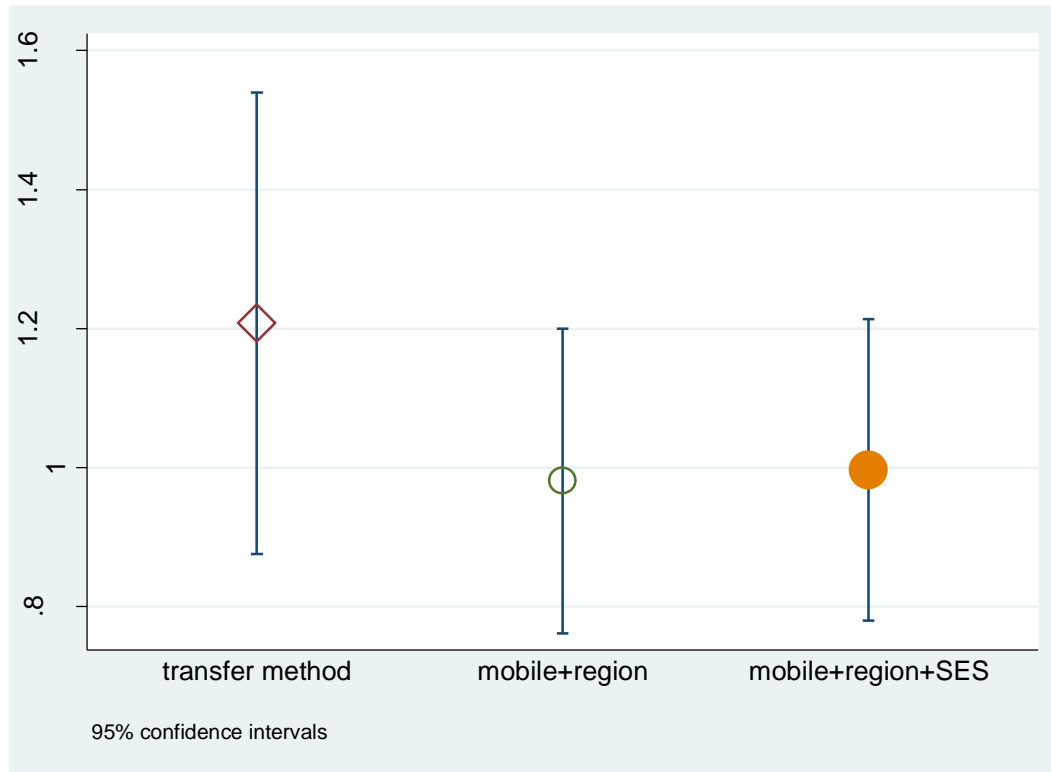


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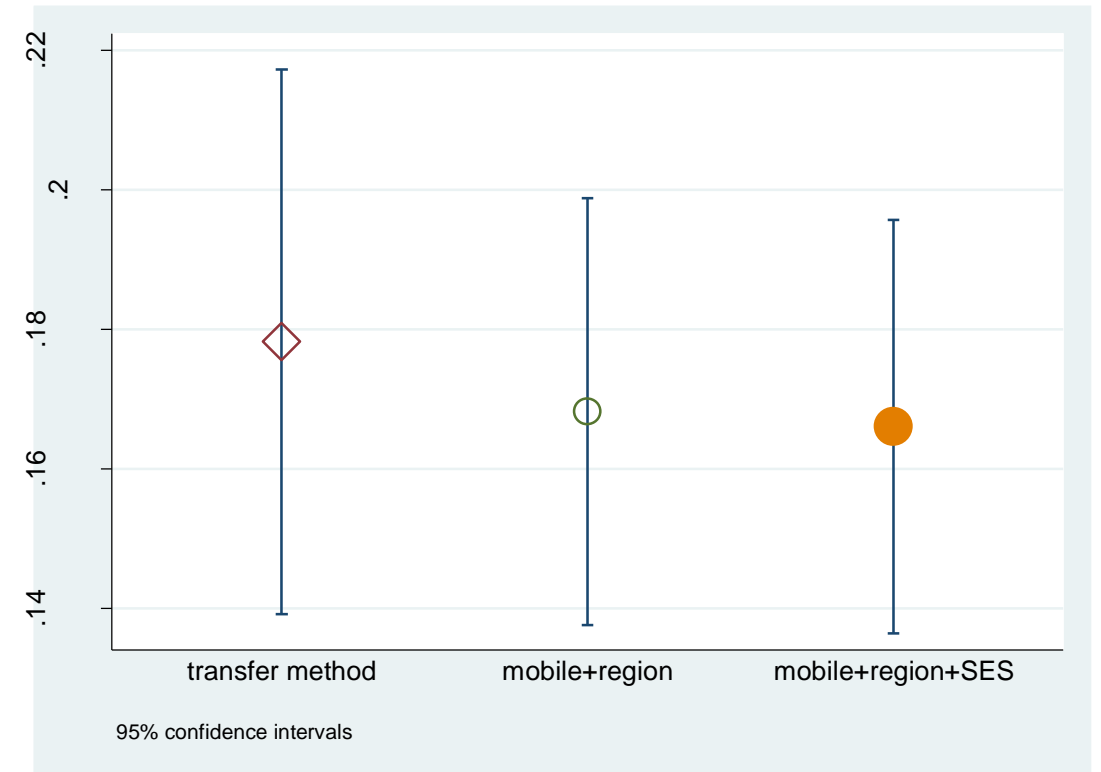
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ESTIMATING PANEL 4 FROM PANEL 1-3

HFIAS



Prevalence of Food Insecurity



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KEY TAKEAWAYS & FUTURE CONSIDERATIONS

- Empirical evidence for the potential ability of mobile phone variables to estimate food insecurity at a community level
- Using the panel data allowed us to capture the empirical relationship between the mobile phone variables and food insecurity.

Limitations: Lack of access to anonymized CDRs; SIM penetration

- Further research using aggregated time-series mobile phone call data records (CDRs) will help better estimate community-level food insecurity

Use of Accelerometer Devices to Capture Energy Expenditure in Agricultural and Rural Livelihoods:

Findings from Feed the Future and potential applications in
development studies

Giacomo Zanello

*Associate Professor in Food Economics and Health, University of Reading (UK)
LCIRAH Fellow*



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THE IDEA





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KEY PARTNERS



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WHY CAPTURING PHYSICAL ACTIVITY IN RURAL LMICS?

- Most of the research on studying nutrition in low- and middle-income countries has predominantly focused on changes in diets while **changes in physical activities have been largely neglected** (Popkin, 2006; Zanello et al., 2018)
- Productivity-enhancing agricultural interventions impact the calorie deficits of the undernourished via their effects on **energy intakes** and **energy expenditure**
- The **energy expenditure dimension** has previously not been incorporated in the analysis of **agriculture-nutrition linkages**



WHY THIS MATTERS?

- The focus on **energy-in** (food intakes) has not been matched with understanding of **energy-out** (physical activity)
- We have a **partial understanding** of 'dietary needs' by individual (age and sex) and household characteristics (e.g. mechanized vs non- mechanized households)
- Energy use should be to be incorporated into design of technologies through a gendered lens, promotion of labor-intensive crops versus others that may be less intensive, understanding women's time allocations in the context of messaging beyond agriculture on childcare, food preparation, dietary choice in the marketplace





1

Methodology and study design



2



3



4



5



1

Methodology and study design



2

Case study 1: Livelihoods description



3

Case study 2: Physical activity, drudgery reduction
in rural livelihoods



4

Case study 3: Measuring gendered patterns
of energy expenditure and time-use



5



1

Methodology and study design



2

Case study 1: Livelihoods description



3

Case study 2: Physical activity, drudgery reduction
in rural livelihoods



4

Case study 3: Measuring gendered patterns
of energy expenditure and time-use



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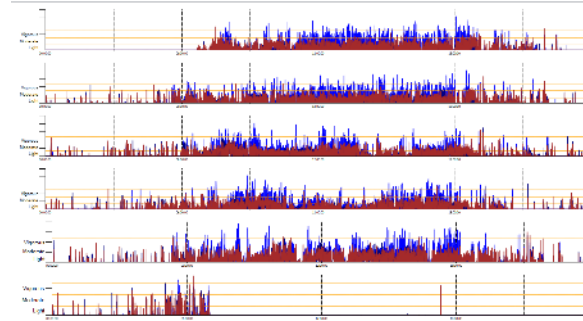
Field considerations and future expansions



METHODOLOGY

- Small devices using a tri-axial accelerometer sensor to capture movements (direction and intensity). It does not record effort
- Why ActiGraph GT3X+?
 - Research-graded devices
 - Non-intrusive and waterproof, and suitable for 24 hours continuous use.
 - Rugged, no screen, no on/off switch. Little resale value
 - Battery life of up to 30 days
- The reliability and validity of ActiGraph devices have been extensively assessed (Santos-Lozano et al., 2013; Sasaki et al., 2011)





**Energy
expenditure**

Food intakes



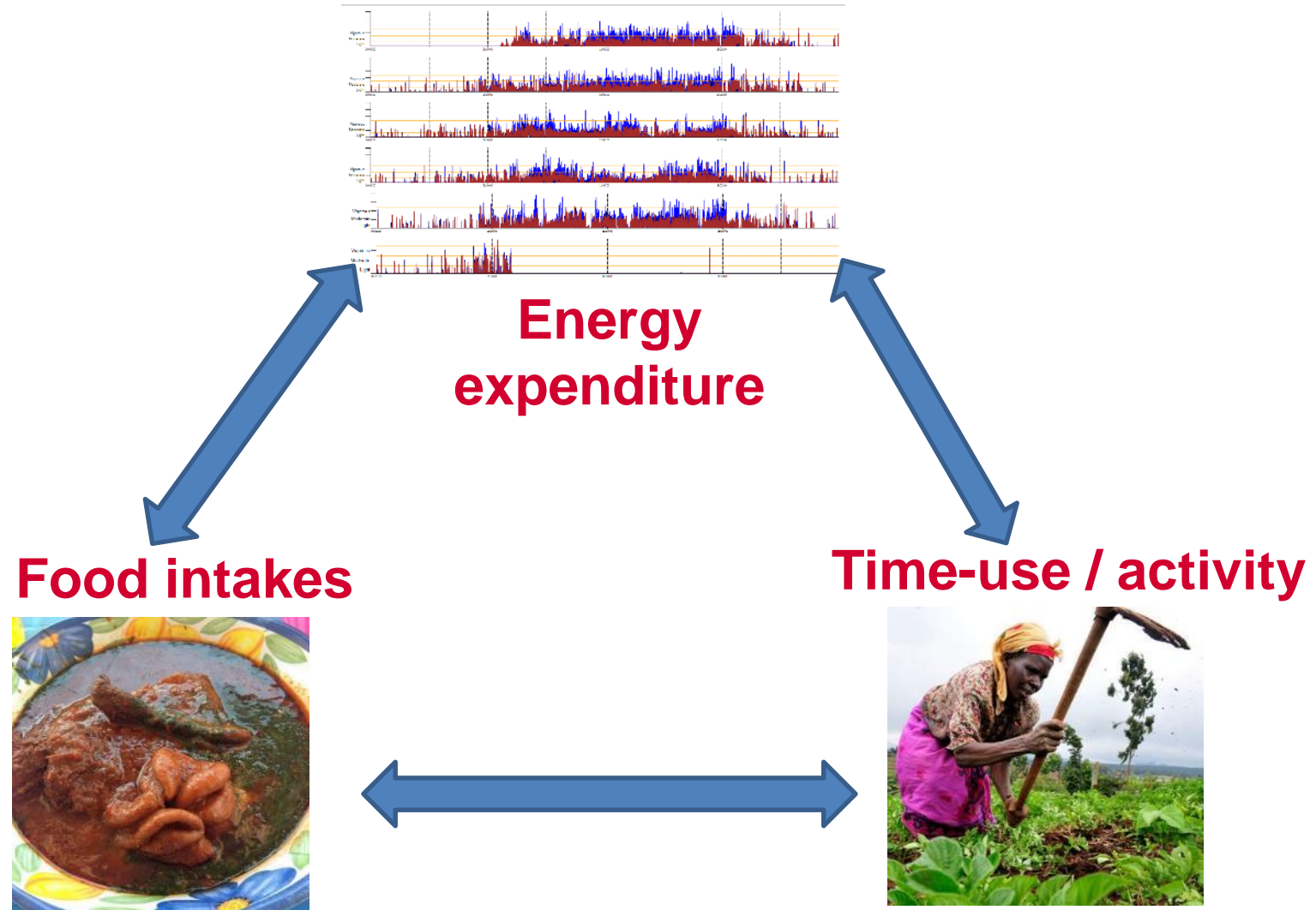
Time-use / activity





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THE STUDY DESIGN





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THE STUDY DESIGN

- **Multi-country** case studies (Ghana, India, Nepal)
- Total sample of **40 individuals** (20 males and 20 females living in 20 subsistence farming households) wearing accelerometry devices for **7 full days each**, for **4 weeks across the agricultural season**
- Capturing activities during: i) Land preparation; ii) Seeding and sowing; iii) Land maintenance; iv) Harvest
- In each country, total of **1,120 person/days** and hourly activity data was collected for **26,880 hours**
- **Data publicly available** (<https://dx.doi.org/10.5255/UKDA-SN-853777>)

Zanello, G, Srinivasan, C S, Picchioni, F, Webb, P, Nkegbe, P, Cherukuri, R, & Neupane, S (2020). **Physical activity, time use, and food intakes of rural households in Ghana, India, and Nepal**. Scientific Data, 7(1), 1–10.



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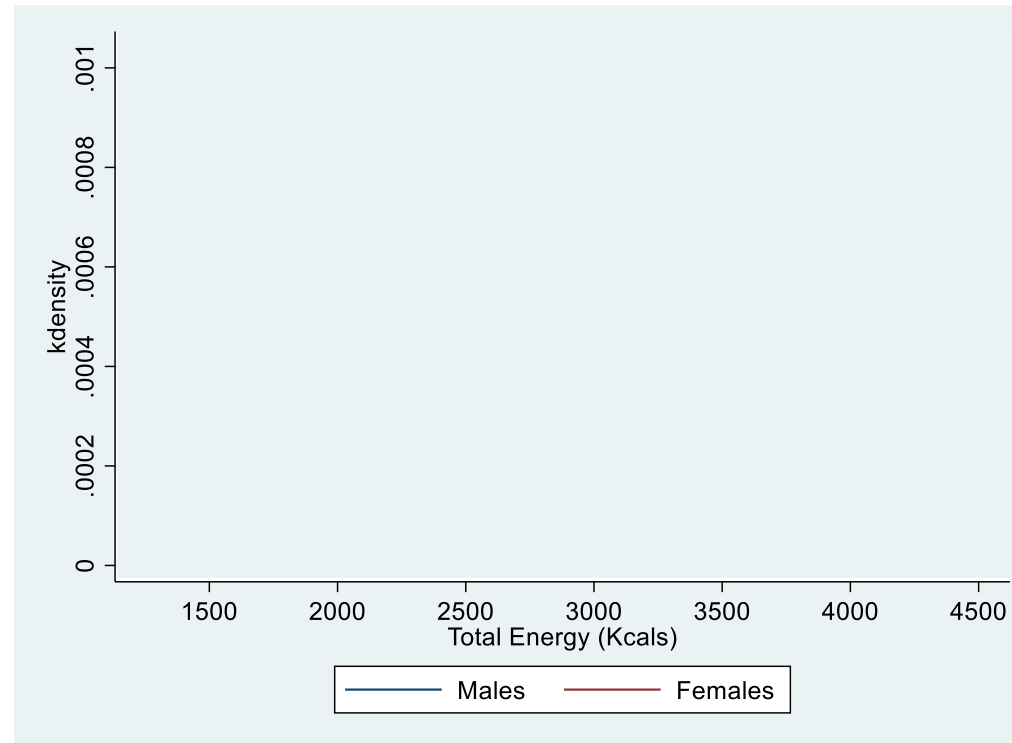
CASE STUDY 1: LIVELIHOODS DESCRIPTION

- Use of energy expenditure to shed new light into patterns of rural livelihood
- Gender and seasonal differences
- Case study of **Ghana**



DESCRIPTIVE STATISTICS

Distribution of total energy expenditure by gender (Ghana)



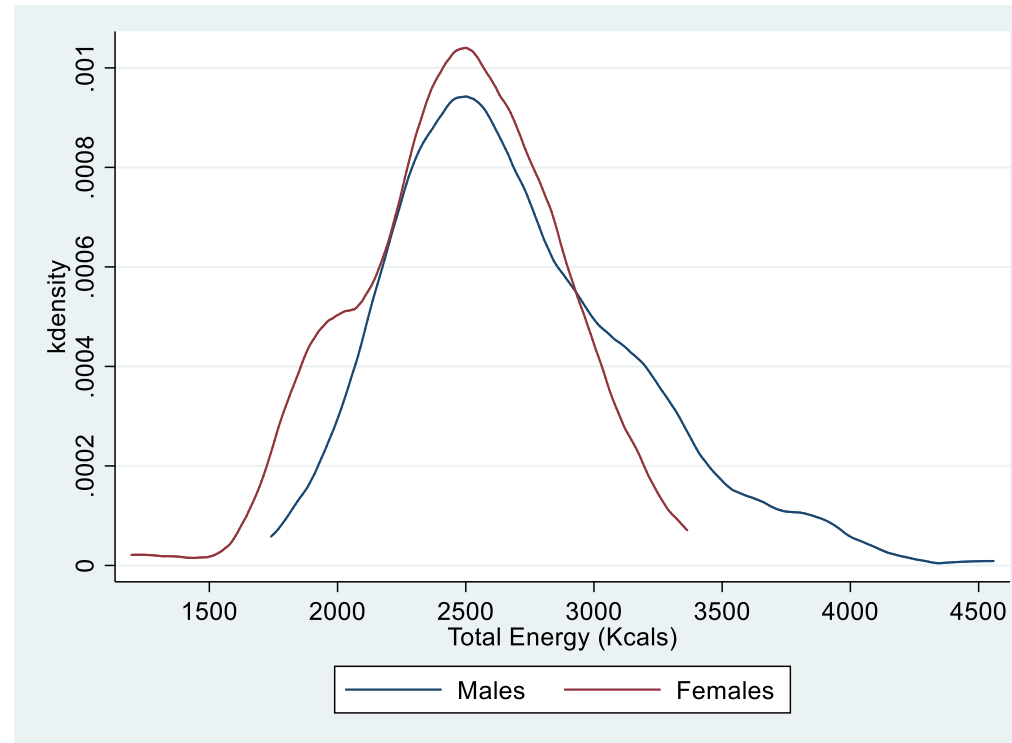


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DESCRIPTIVE STATISTICS

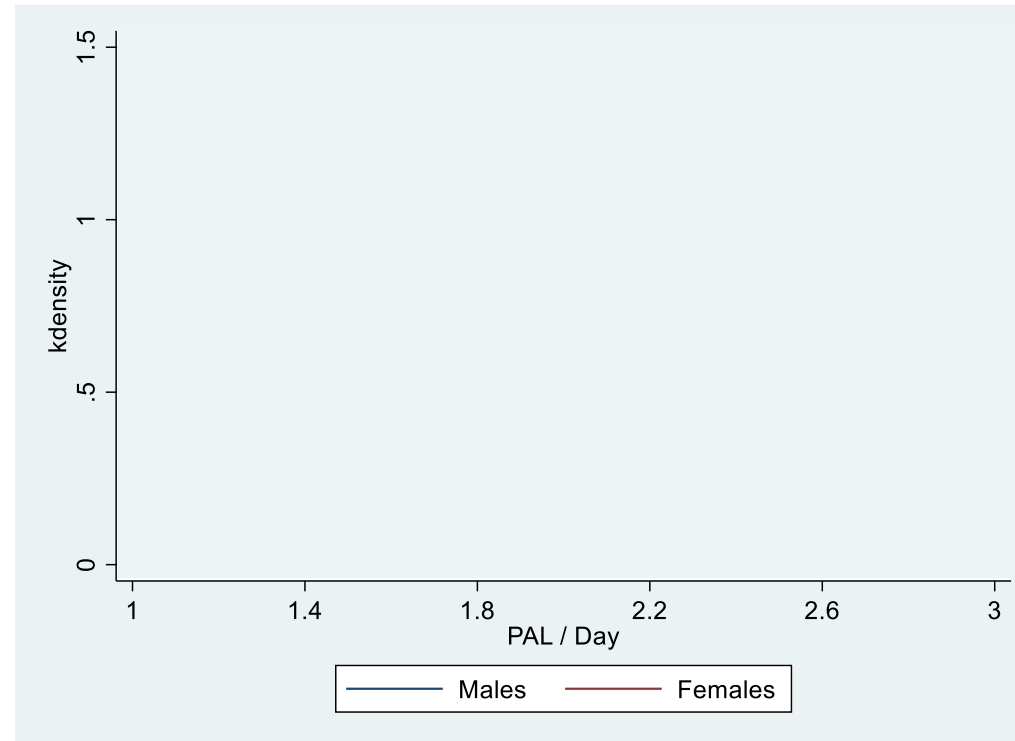
Distribution of total energy expenditure by gender (Ghana)





DESCRIPTIVE STATISTICS

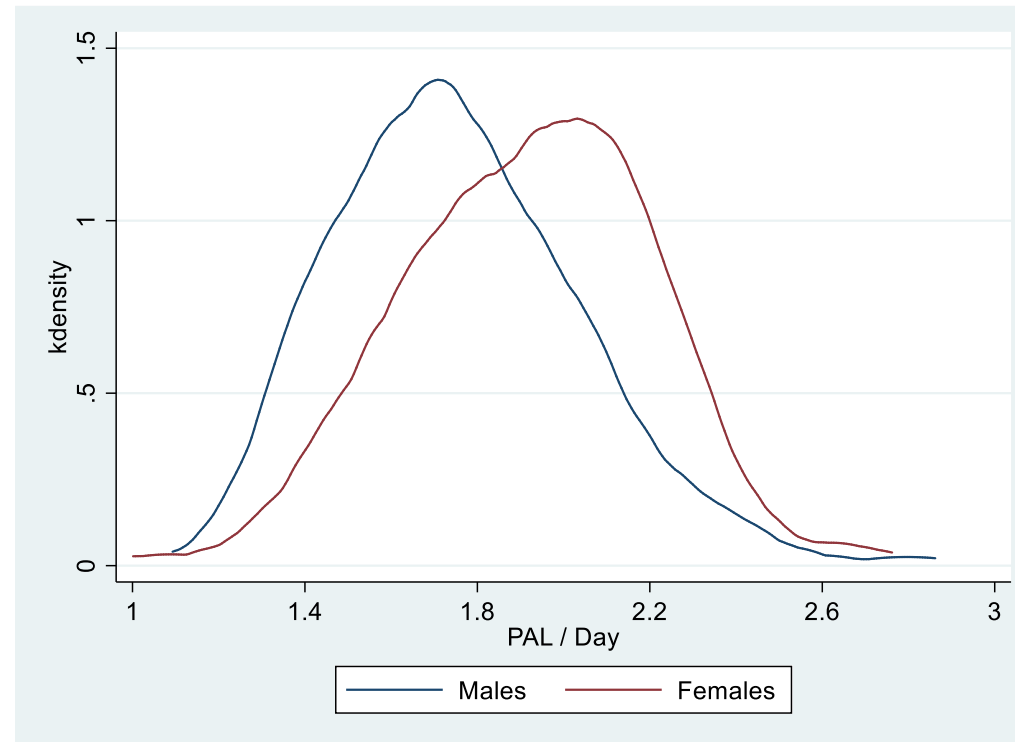
Distribution of Physical Activity Level (PAL) by gender (Ghana)





DESCRIPTIVE STATISTICS

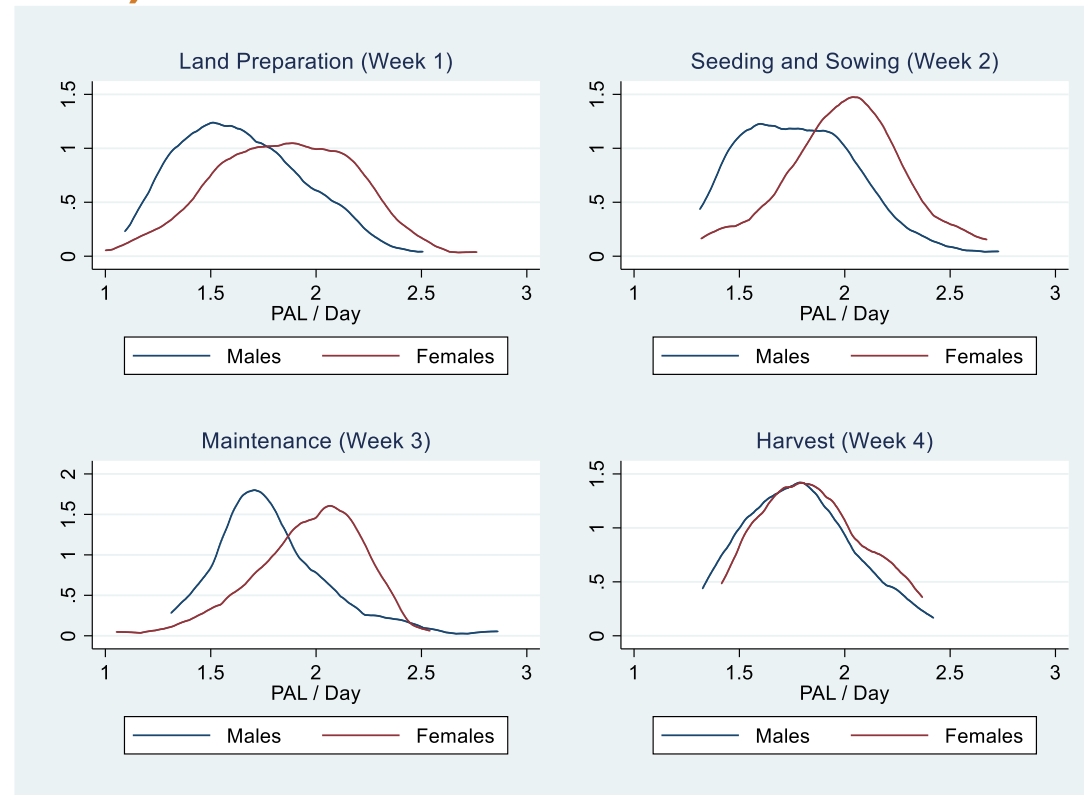
Distribution of Physical Activity Level (PAL) by gender (Ghana)





DESCRIPTIVE STATISTICS

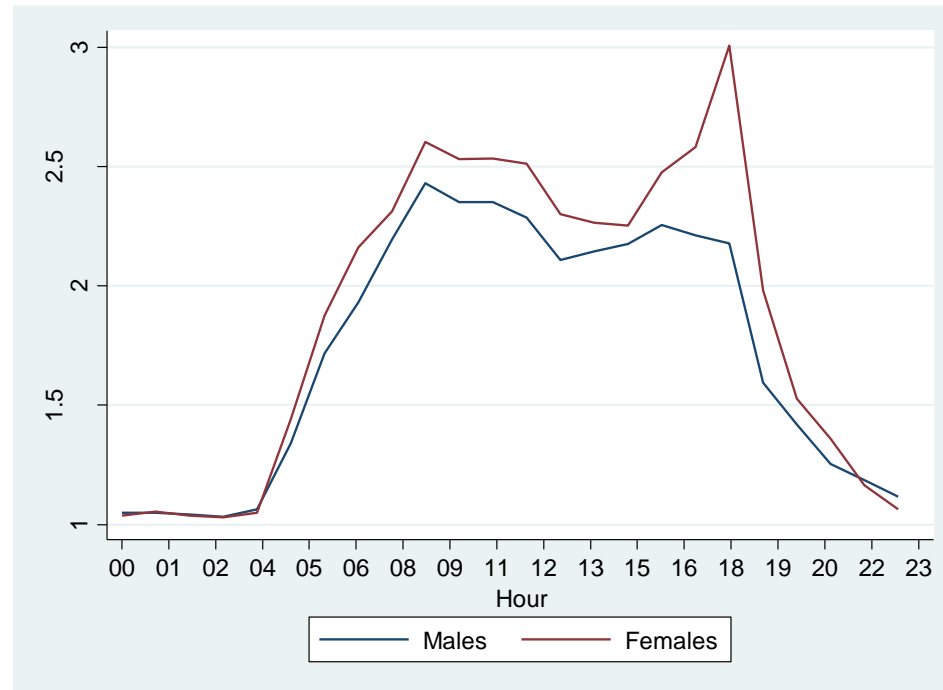
Seasonal patterns (Ghana)





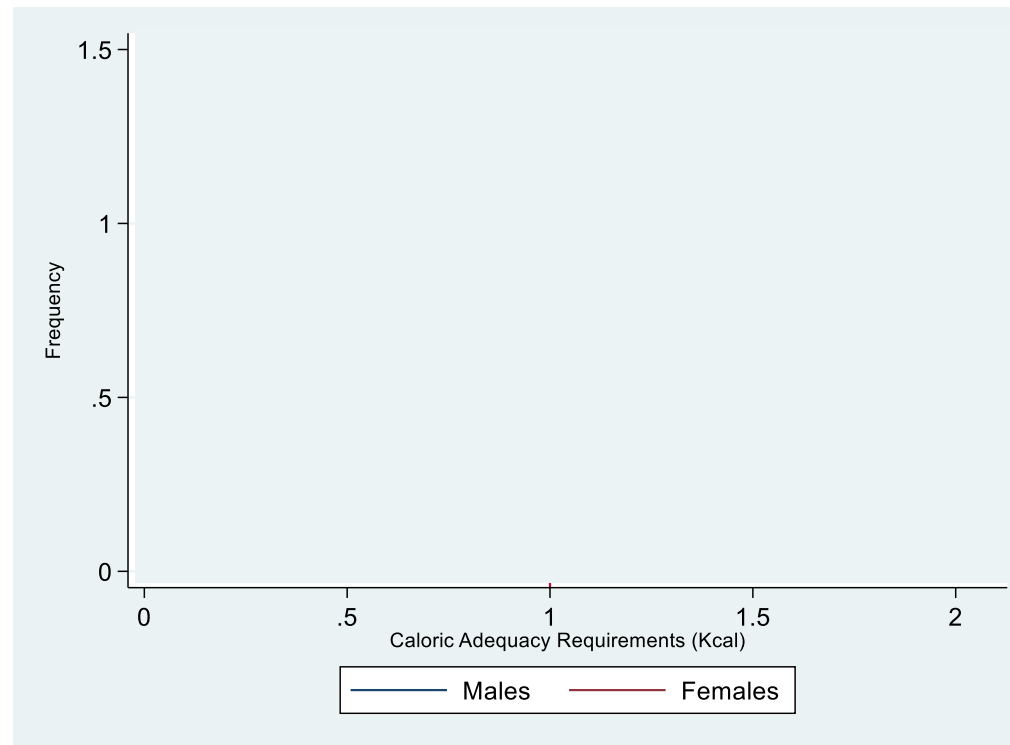
DESCRIPTIVE STATISTICS

Mean PAL for men and women through the day (Ghana)



DESCRIPTIVE STATISTICS

Caloric Adequacy Ratio (CAR) for men and women (Ghana)



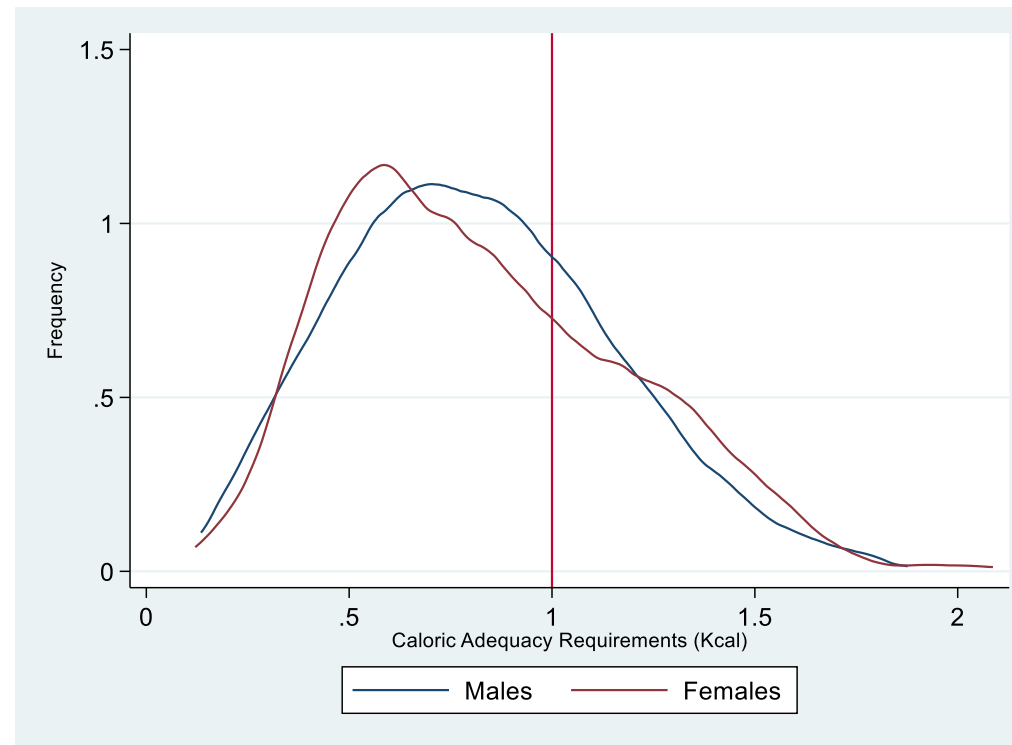


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DESCRIPTIVE STATISTICS

Caloric Adequacy Ratio (CAR) for men and women (Ghana)



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CASE STUDY I: DRUDGERY REDUCTION IN RURAL LIVELIHOODS

- Examine the **effect of “drudgery reduction”** (DR) – the substitution of less intense for more intense physical activity in rural livelihoods – on energy requirement
- What is the effect of substitution of one hour of light activity for one hour of moderate/vigorous activity on energy?
- Case study of **India**
- Gender differences and across different households

Srinivasan, C. S., Zanello, G., Nkegbe, P., Cherukuri, R., Picchioni, F., Gowdru, N. and Webb, P. (2020) **Drudgery reduction, physical activity and energy requirements in rural livelihoods**. *Economics and Human Biology*, 37. 100846. ISSN 1570-677X doi: <https://doi.org/10.1016/j.ehb.2019.100846>





RESULTS - INDIA

	Energy requirements (PAL)	
	M	F
Non-irrigated		
Irrigated		
Bottom half wealth		
Top half wealth		
Small land owners		
Large land owners		
Small dependency ratio		
Large dependency ratio		

Note: DR elasticities of PAL (% change in X / 1% change in proportion of time spent in light activity). All estimates significant at 1%.





RESULTS - INDIA

	Energy requirements (PAL)	
	M	F
Non-irrigated	-3.6	-2.4
Irrigated	-2.6	-2.6
Bottom half wealth	-3.2	-2.3
Top half wealth	-3.0	-2.7
Small land owners	-3.0	-2.3
Large land owners	-3.2	-2.7
Small dependency ratio	-2.9	-2.5
Large dependency ratio	-3.4	-2.5

Note: DR elasticities of PAL (% change in X / 1% change in proportion of time spent in light activity). All estimates significant at 1%.



CASE STUDY 2: MEASURING GENDERED PATTERNS OF ENERGY EXPENDITURE AND TIME-USE

- This study aims to:
 - i) Explore **patterns** of time and energy intensity of rural livelihoods work;
 - ii) Understand **differences** across agricultural season
 - iii) Explore the gendered **allocation** and **trade-offs** of both energy expenditure and time-use across productive tasks, reproductive work, and leisure
- Case study in Nepal

Picchioni, F., Zanello, G., Srinivasan, C. S., Wyatt, A. J. and Webb, P. (2020) **Gender, time-use, and energy expenditures in rural communities in India and Nepal**. World Development, 136. 105137



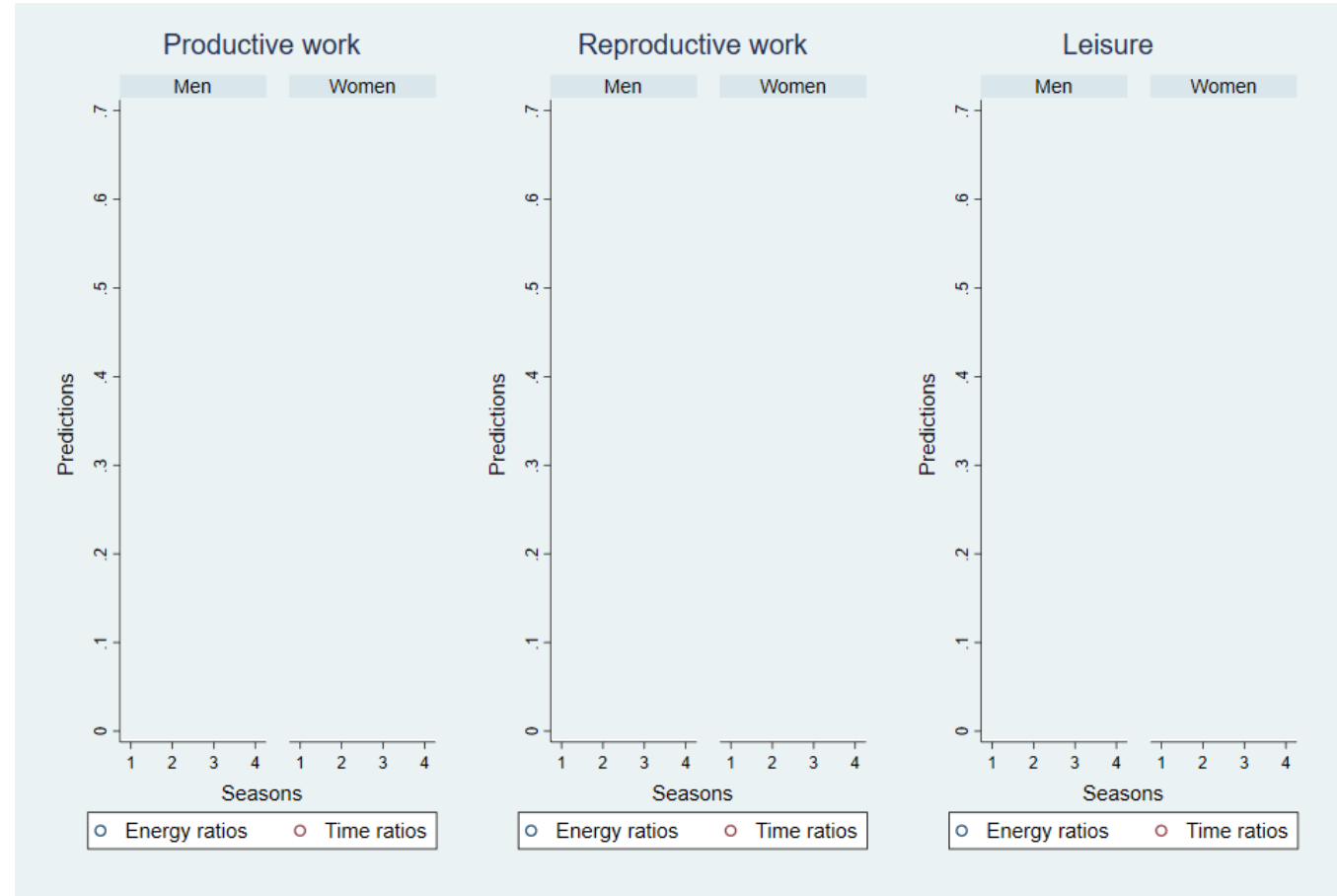
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RESULTS - NEPAL



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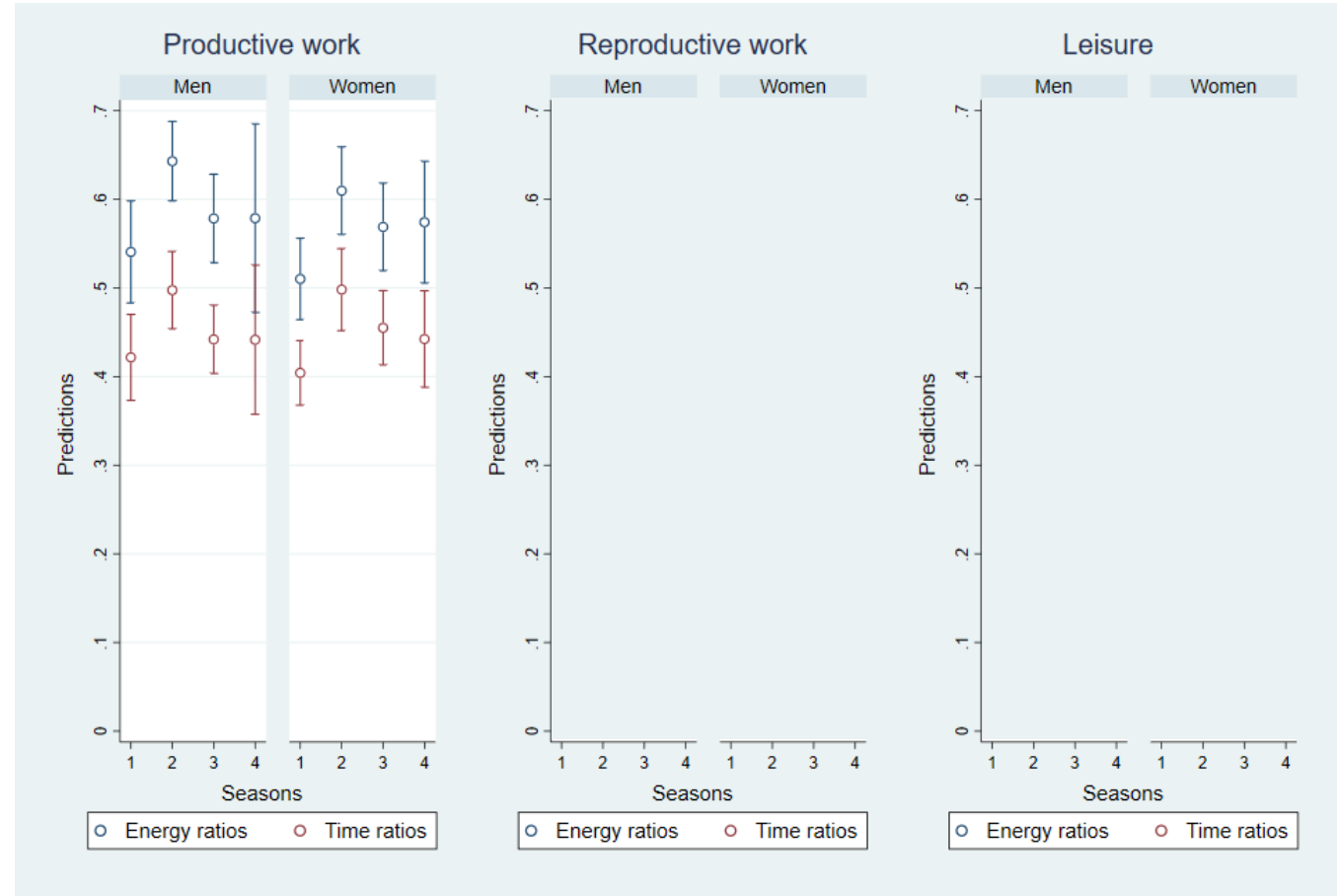
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Reading



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Friedman School of
Nutrition Science and Policy



RESULTS - NEPAL

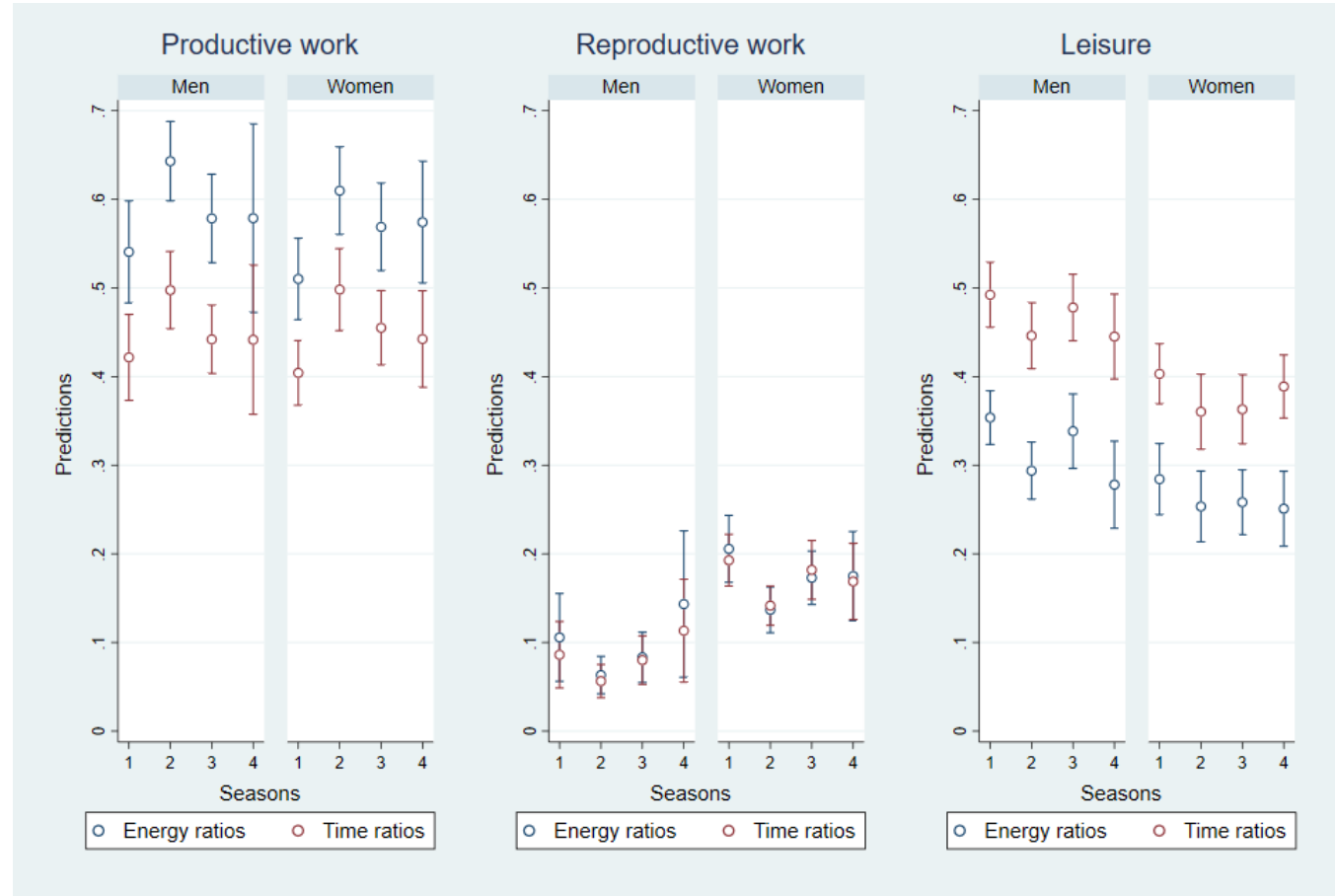




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FIELD CONSIDERATIONS AND FUTURE EXPANSIONS

- Cost implications and training
- Rich data for a small (sub-?) sample
- Field manual for practitioners
<https://tinyurl.com/yyqtv5yj>
- Fast evolving field – Use of mobiles?



Giacomo Zanello, C.S. Srinivasan, Fiorella Picchioni,
Patrick Webb, Paul Nkegbe, Radhika Cherukuri,
Shalles Neupane, Yazidu Ustasz, Nithya Gowdru,
Saurav Neupane, and Amanda J. Wyatt

FIELD CONSIDERATIONS AND FUTURE EXPANSIONS

- Focus on specific age groups (e.g. adolescents, elderly) or individuals (e.g. public workers)
- Use in program evaluation (e.g. introduction of technologies, communications campaigns)
- Physical activities in urban areas of LMICs
- Ill-health effects on rural livelihoods / productivity
- Activity recognitions from accelerometry data





NOVEL METRICS – IMPLICATIONS FOR POLICIES AND PROGRAMS

- New technologies and novel metrics offer the opportunities to collect new or better data; does not imply replacing on-the-ground data collection; rather complement current approaches
- Yet, know the limits and benefits: It is matter of identifying the right tool for the job
- Real-time data – targeted programming
- Scalability and cost-effectiveness of using novel metrics to implement targeted interventions versus conventional food security assessments should be carefully measured.



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Q&A



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THANK YOU

- Upcoming webinar - **Ecology and Prevention of Linear Growth Faltering in Nepal**, September 30th at 9:00 am (ET)
- To register for any of these events, you can visit **NutritionInnovationLab.org** or **AdvancingNutrition.org**.
- Recordings and slides for each webinar will also be posted on our websites.



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