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Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1528811
Project Title:	Collaborative Research: Prices, Peers, and Perceptions: Field Experiments on Technology Adoption in the Context of Improved Cookstoves
PD/PI Name:	Katherine L Dickinson, Principal Investigator Michael P Hannigan, Co-Principal Investigator Abraham R Oduro, Co-Principal Investigator
Recipient Organization:	University of Colorado at Boulder
Project/Grant Period:	09/01/2015 - 08/31/2018
Reporting Period:	09/01/2016 - 08/31/2017
Submitting Official (if other than PD\PI):	Katherine L Dickinson Principal Investigator
Submission Date:	09/01/2017
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Katherine L Dickinson

Accomplishments

*** What are the major goals of the project?**

This project seeks to understand how economic incentives ("prices"), social learning ("peers"), and subjective beliefs ("perceptions") interact to influence technology adoption dynamics. We refer to our project as the P3 Project. We are conducting a series of field experiments in the Kassena-Nankana Districts of Northern Ghana that offer improved cookstoves at different price levels to groups of households with and without social ties to households that have already received stoves during a prior study. Our specific goals are:

1. Obtain human subjects approval for study activities from participating institutions
2. Select improved stove models to be used in the intervention

3. Conduct formative research measuring willingness to pay for improved stoves in order to set range of price levels for intervention
4. Select study sample consisting of peer and non-peer group clusters
5. Conduct baseline survey with all study households
6. Make stove offers to households
7. Order and deliver stoves to households
8. Conduct follow up survey and instrument-based measurements of stove use and performance
9. Analyze study results
10. Disseminate results via peer-reviewed publications, websites, conferences, and community meetings

The core NSF-funded study builds on our team's prior work in the rural areas of the Kassena-Nankana Districts, and centers on improved biomass stove technologies that are most appropriate for this rural population. In Jun '16, we obtained funding to add a project component involving liquefied petroleum gas (LPG) stove/fuel packages in the urban areas of the district. We refer to the two arms of the project as P3 Bio (rural areas) and P3 Gas (urban areas). Given the synergies and overlap between these projects, we report progress on both arms here.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

1. P3 Bio Stove Selection

The P3 Bio intervention was designed to offer improved biomass stoves to peers and non-peers of households who received similar stoves for free in our earlier REACCTING study. However, our experience in the REACCTING study revealed problems with the two specific stove models used in that study (the Gyapa rocket stove and Philips forced draft stove). We thus selected two similar but improved stove models (Greenway Jumbo and ACE1) through a review of available technologies, consultation with manufacturers, and a focus group discussion conducted in Sept '16.

2. P3 Gas (LPG) Supply Survey

A key objective of the P3 Gas project is to understand supply- and demand-side factors driving adoption of LPG stoves in the study area, with a focus on more urban areas. To this end, we implemented a survey with all refilling stations in the Upper East region (N=7), and all other retail shops selling LPG stoves and cylinders in the Kassena-Nankana Districts (N=9) (Jun-Jul '16). The survey collected information about the types and quantities of products sold, as well as perceptions of barriers and opportunities for expanding LPG use in the area. Supplier locations are shown in Figure 1.

3. Household Sample Selection

We selected and enrolled 600 households to participate in the P3 Bio and P3 Gas study areas (300 in each arm).

For P3 Bio, sample selection proceeded in two phases. First, clusters were selected for inclusion in the study. 25 REACCTING study clusters were included to form the PEER group clusters. GIS mapping was then used to randomly select 25 NON-PEER clusters (non-adjacent to peer clusters).

Second, 6 households were selected from each cluster as nearest neighbors of REACCTING households (in the peer group) or randomly selected seed households (non-peer group). This procedure was used to create as similar as possible selection criteria and sampling methods between the peer and non-peer groups.

Similarly, for the P3 Gas sample we first randomly selected clusters from the urban area, and then randomly selected households within each cluster.

Locations of all 600 households, color coded by ownership of LPG stoves at baseline, are also shown in Figure 1.

4. Baseline Household Surveys (P3 Bio and P3 Gas)

For all 600 household participants, we conducted a comprehensive baseline survey (Dec '16 - Feb '17) to measure household composition and demographics, attitudes and priorities, cooking behaviors (including type(s) of stoves used, fuel use, foods cooked, who cooks within household), knowledge and perceptions of issues related to cooking practices, demand for new stoves, and self-reported health measures. Primary cooks (typically female) served as the main respondent; secondary surveys were conducted with male financial decisionmakers (where applicable).

5. P3 Bio Intervention Design and Execution

Following the baseline survey, stove offers were made to P3 Bio households (Mar - May '17). The intervention involved convening group meetings (6 households per group), demonstrating the two types of stoves and explaining their benefits, and providing participants the choice to purchase 0, 1, or 2 stoves (total) of either type at price levels that were randomized at the cluster level. The experimental design for these interventions involved selecting price levels for the two stoves and distributing these prices across the peer and non-peer clusters, with the aim of maximizing the statistical precision of estimated economic demand for the stoves. The design procedure adopted methods from the discrete choice experiment (DCE) literature, to select price levels which maximize the D-efficiency criterion (Kanninen et al. 2002) and used prior, preliminary information on households' willingness-to-pay for the stoves elicited in auctions in Year 1.

6. P3 Bio Perceptions Survey

After stove orders were made, but before the recipients received their new stoves, we conducted a short follow up survey with all P3 Bio households to measure perceptions of the different types of stoves (Jun-Aug '17). Since our central research questions involve the roles of both prices and peers in shaping stove perceptions, these surveys provide important data on how participants perceive the different stoves and what benefits they expect to derive from them a priori.

7. P3 Gas Intervention Design and Inception

We designed the LPG intervention using information from the LPG supply and household surveys, as well as literature review and engagement with other research teams in Ghana and internationally on LPG adoption. The resulting set of packages that will be offered to participants in this intervention is described in Figure 2.

The different LPG packages will be offered to participating households using a mechanism known as the Becker-Degroot-Marshak auction. In May '17, we developed a detailed protocol and trained the implementing team on how to carry out this auction. This procedure has been initiated with about 40 households so far. All P3 Gas households will be given an opportunity to participate in these activities by the end of 2017.

8. Emissions Measurements

Building on ongoing EPA-funded work, the research team has been collecting a set of emissions samples from multiple different sources. These samples help to characterize emissions from other sources, beyond residential cooking, that contribute to ambient air pollution and personal exposures. Our team has collected a total of 29 such samples

so far: commercial cooking (7), roadway (6), kerosene (5), trash burning (4), charcoal making (3), bush burning (2), and brewing (2).

9. Stove Use Monitoring Testing

Stove use monitors (SUMs) were piloted for traditional and improved stoves in the field and lab. Preliminary results show excellent durability and clear indication of stove use. SUMs deployed to test in rural households in May '17 are still intact as of Aug '17. Materials for 600 SUMs units were ordered, assembled and tested for the upcoming launch in the field. A subset of 56 eligible P3 Bio intervention households were randomly selected for SUMs. Eligibility was determined by peer, price, location and stove order results. P3 Gas SUMs households will be selected after all auctions take place.

10. Personal Exposure Monitoring Piloting

During our May '17 trip, personal exposure monitoring tools and protocols were piloted in the field with a small test group. 48-hour mock deployments were carried out monitoring personal exposure of carbon monoxide (CO) and particulate matter (PM). In conjunction with SUMs testing (above), proximity to pollution sources was piloted using Bluetooth Beacons and receivers (phones) along with GPS. Household kitchen CO and PM were measured during the pilot testing using low cost sensors and filters. A subset of 40 eligible SUMs households from P3 Bio were randomly selected for exposure and household air quality measurements. Eligibility was determined based on full sample-weighted stove group type. P3 Gas households sampled for exposure and air quality will be determined following SUMs sample selection.

11. Ethical Clearance Maintained and Updated

This study's protocols have been reviewed and approved by the University of Colorado-Boulder and the Navrongo Health Research Centre. Protocols have been updated and approvals renewed annually.

Reference:

Kanninen, B.J. (2002) Optimal design for multinomial choice experiments. Journal of Marketing Research, Vol. 39, pp. 214-227.

Specific Objectives:

During this reporting period, we achieved one of the major objectives of the study by successfully designing and implementing the focal experiments, which varied stove prices and peer exposure to assess their impacts on adoption of this technology. Referring to our list of major goals, the first 6 have been accomplished, and we are well on track to meet the remaining goals.

Significant Results:

Preliminary analysis of the P3 Bio stove offer results indicates that willingness to pay (WTP) for the improved biomass stoves was higher than we expected based on results from second price sealed bid auctions of these products conducted during the first year of the project. Mean household WTP for only one of the lower-cost Jumbo stoves was estimated at $25.07 USD* (with a 95% confidence interval of $4.41 to $45.72). Mean WTP for only one of the higher cost ACE stoves was $65.71 (95% confidence interval of $41.79 to $89.63). We did not find any evidence that households were willing to pay more for a second stove of the same type. But we did find that households were willing to pay an additional $27.34 (95% confidence interval $0.15 to $54.85) for a second stove in order to have one of each model. No statistically significant difference in stove demand was found between peer households in REACCTING clusters relative to non-REACCTING clusters.

* Calculations use exchange rate of 4.43 Ghana Cedis to US$1.

Key outcomes or Other achievements:

*** What opportunities for training and professional development has the project provided?**

Graduate students and professional research assistants at both US collaborating universities have been involved in the project this reporting period.

Elise Mesenbring (CU Mechanical Engineering PhD Student) led stove testing activities, stove use monitoring protocol design, and time activity monitoring activities. She also assisted with survey design, implementation, and data processing.

Evan Coffey (CU Mechanical Engineering Professional Research Assistant) has led emissions and exposure measurement activities. His role coordinating multiple activities for this project and its predecessor has earned him the (unofficial) title of "senior field engineer."

David Pfotenhauer (CU Mechanical Engineering PhD Student) participated in stove testing activities.

Lee Parton (NCSU Agricultural and Resource Economics PhD Student) developed the geospatial database and assisted with experimental design.

Kelsey Hample(NCSU Agricultural and Resource Economics PhD Student, now Assistant Professor at Furman University) completed a dissertation chapter on the effects of improved cookstoves on household fuelwood and charcoal demand, using data from the REACCTING study preceding the present project. This work will inform continued analysis of the present project, as well as points to future research pursuits for improving evaluations of fuelwood demand responses to improved cookstoves.

Additional impacts on training and human resource development are detailed in the Impacts section of this report.

*** How have the results been disseminated to communities of interest?**

The project website has been updated with reports, relevant publications, and photos. (http://sciencepolicy.colorado.edu/p3cookstoves/).

Over the past year, three blog posts have been disseminated through different University of Colorado lists and social media.

- Want to Buy a New Stove? by Katie Dickinson (March 23, 2017)
- What's Cooking in Ghana? CIRES News (December 29, 2016)
- Prices, Peers and Perceptions: Studying a Community's Adoption of Cleaner Cookware by Alison Gilchrist, CSTPR Writing Intern (December 6, 2016)

*** What do you plan to do during the next reporting period to accomplish the goals?**

The ACE1 and Greenway Jumbo stoves were imported from the manufacturers (in Lesotho and India, respectively), and successfully delivered to the NHRC in late August 2017. Once stoves are labeled and equipped with stove use monitors (for a subset of stoves), they will be distributed to P3 Bio participants.

The P3 Gas stove orders (using the BDM auctions described above) will be completed by the end of 2017. Stove-fuel package components will be ordered in batches and distributed to participants starting in October of 2017, with a subset of stoves equipped with stove use monitors.

For both groups, payments will be collected by our collaborating non-governmental organization partner over a six month period, with first payment due at the time of delivery. Data on stove payments (including refusals and defaults) will be collected over time.

Measurements of stove use (using electronic monitors), emissions, and exposure, will be collected periodically for a subset of participants; all participants will complete an endline survey in Jul - Aug 2018.

Analysis of baseline datasets is ongoing. Protocol papers for both P3 Bio and P3 Gas will be prepared and submitted for publication.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
p3y2report_figs.pdf	Figures 1 and 2 (referred to in text)	Katherine Dickinson	08/31/2017

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers

Licenses

Other Conference Presentations / Papers
Katherine Dickinson (2017). *Prices, Peers, and Perceptions: Implementation Science Network Year 1 Report*. Clean Cooking Implementation Science Network Workshop. Bethesda, MD, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Other Products

Other Publications
Katherine Dickinson, Maxwell Dalaba, Rex Alirigia, Elise Mesenbring, Evan Coffey, Zachary Brown, Michael Hannigan, and Abraham Oduro (2017). *LPG Supply Survey in Northern Ghana: Prices, Peers, and Perception (P3) Project Report*. Project report summarizing results from the P3 Gas supply survey.. Status = OTHER; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

Websites
Prices, Peers, and Perceptions: Improved Cookstove Research in Northern Ghana
http://sciencepolicy.colorado.edu/p3cookstoves/

Provides information about the P3 project, including information about the study team, links to reports and publications, and photos from our field work.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
P3 LPG Supply Report.pdf	LPG Supply Survey Report	Katherine Dickinson	09/01/2017

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Dickinson, Katherine	PD/PI	4

Name	Most Senior Project Role	Nearest Person Month Worked
Hannigan, Michael	Co PD/PI	1
Oduro, Abraham	Co PD/PI	1
Dalaba, Maxwell	Co-Investigator	9
Kanyomse, Ernest	Other Professional	12
Mesenbring, Elise	Graduate Student (research assistant)	6
Pfotenhauer, David	Graduate Student (research assistant)	1
Achazanaga, Manies	Non-Student Research Assistant	9
Achibase, Sabastian	Non-Student Research Assistant	3
Agao, Desmond	Non-Student Research Assistant	5
Agula, Michael	Non-Student Research Assistant	3
Ali, Moro	Non-Student Research Assistant	4
Alirigia, Rex	Non-Student Research Assistant	12
Aweduna, Vincent	Non-Student Research Assistant	3
Coffey, Evan	Non-Student Research Assistant	6
Kwose, Godfred	Non-Student Research Assistant	3
Nacu-Schmidt, Ami	Non-Student Research Assistant	1
Tivura, Moses	Non-Student Research Assistant	3

Full details of individuals who have worked on the project:

Katherine L Dickinson
Email: katherine.dickinson@colorado.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 4

Contribution to the Project: Leads project, coordinates collaboration among project team members, leads experimental design and social survey data collection and analysis, advises and mentors RAs

Funding Support: No other sources

International Collaboration: No
International Travel: Yes, Ghana - 0 years, 0 months, 21 days

Michael P Hannigan

Email: hannigan@colorado.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Study design and management, supervision of engineering research assistants

Funding Support: N/A

International Collaboration: No
International Travel: No

Abraham R Oduro
Email: Abraham.oduro@navrongo-hrc.org
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Project direction, coordination

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Maxwell Dalaba
Email: Maxwell.Dalaba@navrongo-hrc.org
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 9

Contribution to the Project: Project management and design, supervision of field data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Ernest Kanyomse
Email: Ernest.Kanyomse@navrongo-hrc.org
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Project coordination

Funding Support: N/A

International Collaboration: Yes, Ghana
International Travel: No

Elise Claire Mesenbring
Email: elise.mesenbring@colorado.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: Piloting and testing stove models as well as stove use monitoring methods, survey design and implementation, report preparation, emissions measurements.

Funding Support: N/A

International Collaboration: No
International Travel: Yes, Ghana - 0 years, 0 months, 20 days

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David John Pfotenhauer
Email: David.Pfotenhauer@colorado.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 1

Contribution to the Project: Stove testing

Funding Support: N/A

International Collaboration: No
International Travel: No

Manies Achazanaga
Email: Manies.Achazanaga@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 9

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Sabastian Achibase
Email: Sabastian.Achibase@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 3

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Desmond Agao
Email: desmond.agao@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 5

Contribution to the Project: Project management, data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Michael Agula
Email: Michael.Agula@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 3

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Moro Ali
Email: Moro.Ali@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 4

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Rex Alirigia
Email: Rex.Alirigia@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 12

Contribution to the Project: Data collection, project management

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Vincent Aweduna
Email: Vincent.Aweduna@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 3

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Evan Coffey
Email: Evan.Coffey@colorado.edu
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 6

Contribution to the Project: Instrumentation design and testing

Funding Support: EPA grant # RD – 8354201

International Collaboration: No
International Travel: Yes, Ghana - 0 years, 0 months, 20 days

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Godfred Kwose
Email: Godfred.Kwose@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 3

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

Ami Nacu-Schmidt
Email: Ami.Nacu-Schmidt@colorado.edu
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 1

Contribution to the Project: Website design

Funding Support: N/A

International Collaboration: No
International Travel: No

Moses Tivura
Email: Moses.TIVURA@navrongo-hrc.org
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 3

Contribution to the Project: Data collection

Funding Support: NIH Clean Cooking Implementation Science Network grant

International Collaboration: Yes, Ghana
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
North Carolina State University	Academic Institution	Raleigh, NC
Organisation for Indigenous Initiatives and Sustainability	Other Organizations (foreign or domestic)	Ghana

Full details of organizations that have been involved as partners:

North Carolina State University

Organization Type: Academic Institution
Organization Location: Raleigh, NC

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Co-PI Dr. Zachary Brown has led experimental design and econometric analysis of improved cookstove demand. He has also contributed to the design of the interventions studied in both the P3

Gas and P3 Bio projects, as well as in establishment of the survey data collection and inter-institutional transfer protocols.

Organisation for Indigenous Initiatives and Sustainability

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Ghana

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: This Ghanaian non-governmental organization (NGO) has led the implementation of the interventions for P3 Bio and P3 Gas. They have organized and led community meetings to introduce participants to the different types of stoves, and have made stove offers to participants. They will also work with local entrepreneurs to supply LPG stoves and fuel to participants, and will collect and distribute payments from participants for the stove packages.

What other collaborators or contacts have been involved?

NIH Clean Cooking Implementation Science Network: This organization is funding a companion project examining adoption of liquefied petroleum gas (LPG) stoves in the study area. Several aspects of this project, including the teams involved, research questions, and outreach activities, are shared across the two projects. Meetings hosted by the ISN, including a workshop in Bethesda in May 2016, provide opportunities to disseminate project results and foster new collaborations.

CoCubed: The Colorado Cookstove Collaborative was founded by PI Dickinson to provide a forum for sharing research methods and results among various teams along Colorado's Front Range engaged in cookstove projects around the world.

Joanna Pinneo is photojournalist who completed a Scripps Fellow at the University of Colorado-Boulder. She focused her fellowship project on the challenge of household air pollution. In May of 2017, she accompanied the P3 team to Navrongo, Ghana, and documented the project activities through photos and videos.

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The two arms of our project, P3 Bio and P3 Gas, are each using novel techniques to shed light on technology adoption processes of interest to the field of economics.

The P3 Bio project has now implemented a unique experiment that randomly varies both prices and peer effects (through proximity to peers who received free stoves in a prior study). Results from the stove orders that have been collected so far will shed light on how the combination of prices and peer effects influence the initial decision to purchase a stove. As stoves are delivered and payments are collected in the next phase of the project, we will gather additional information on the relationship between initial orders and actual purchase follow-through (and defaults / refusals). In addition, our results will shed light on how the perceptions of stoves shortly after stoves are ordered affect subsequent stove use.

The P3 Gas intervention uses a modified Becker-Degroot-Marshak auction. A key appeal of this approach is that it allows us to measure willingness to pay for each of the components of the LPG stove packages in the same way that a stated choice experiment does, with the added benefit of a revealed preference outcome (since the participant is bidding on a real item). This method has been discussed and debated amongst economists; our results will contribute to this debate.

What is the impact on other disciplines?

This study is well poised to improve exposure assessment from not only traditional and improved cooking technologies through the use of novel sampling techniques, but also allow apportioning of exposure to domestic vs non-domestic sources, a currently complicated and resource-demanding task. The P3 mechanical and environmental engineering team aims to

benefit the engineering community by improving existing models linking stove technologies to personal exposure of CO and PM using low-cost, high time resolution time-activity and air quality monitoring tools. Moreover, interest within the greater cookstove assessment community concerning the accuracy of low-cost tools for exposure assessment will be addressed by evaluating tried and true approaches (e.g. filters) with innovative and less cumbersome tools (e.g HAPEx Nano PM monitor) in the field.

What is the impact on the development of human resources?

This study is developing human resources through opportunities for education and training of several early career engineers and scientists at each of the participating institutions (CU-Boulder, NHRC, NCSU). Graduate student Elise Mesenbring and PRA Evan Coffey have received substantial training in project development and execution. The cross disciplinary nature of P3 has changed the way that the engineering students and staff think about technology development; they are learning and thinking about the many economic and social factors that impact technology use and adoption. The engineers really value this aspect of their development.

PI Dickinson obtained a faculty (Assistant Professor) position in the Department of Environmental and Occupational Health in the Colorado School of Public Health. Her experience as PI of this large NSF grant was a strong selling point for her qualifications and potential success in this position.

Co-PI Brown, an early career applied economist, has successfully completed his midterm tenure review in 2016/2017. This award - and research products in progress - comprised a significant accomplishment on his dossier and adds to his expertise and research portfolio in development economics and technology adoption. The project also provides significant experience to PhD student Lee Parton, applying his GIS skills to development economics, a new research area for him. Related work has also contributed to a chapter of a dissertation authored by Kelsey Hample (PhD student graduate of NCSU, now faculty at Furman University).

The project has provided significant opportunities for training and capacity building for NHRC researchers. The project provided opportunities for two of the project staff (Rex Alirigia and Moro Ali) to pursue further education. Thus, based in part on the experience gained from the project, in August 2017, Rex Alirigia gained an admission into the University of Colorado, Boulder to pursue a M.Sc. in Environmental Studies. Also, in August 2017, Moro Ali was accepted into the Kwame Nkrumah University of Science and Technology, Ghana, to pursue an MPhil in Environmental science. The topics for their thesis are related to the P3 project.

For Dr. Dalaba, the project coordinator at the NHRC, this project has improved his knowledge in his field of health economics. He has gained better understanding of how economic incentives such as prices influence cook stove adoption and improved health status. In addition the project has strengthened his knowledge and skills in collecting data on willingness to pay, project coordination as well as improved his knowledge in environmental health.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

Study participants stand to benefit from receiving improved stoves at subsidized prices. Entrepreneurs and NGO partners are also learning about potential marketing strategies that may lead to market development and business opportunities.

Changes/Problems

Changes in approach and reason for change

Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.