J-PAL
ABDUL LATIF JAMEEL POVERTY ACTION LAB

Payments for Ecosystem Services in Uganda

Theory of Change and Measuring Outcomes

A sloping landscape in western Uganda.

Photo: Alex Coutts | IPA

This case study is based on "Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation" by Jayachandran et al (2017), *Science*.

J-PAL thanks the authors for allowing us to use their paper as a teaching tool.

KEY VOCABULARY	
Hypothesis[1]	A proposed explanation for the effects of a given intervention. We can think of this as a claim to be tested. Hypotheses are intended to be made prior to the implementation of the intervention. E.g. *Giving textbooks to students will improve student learning.*
Theory of Change	A supposition made at the beginning of a program specifying steps in the pathways through which the intervention(s) could lead to an impact. A theory of change is a structured approach used in the design and evaluation of social programs. It maps the logical chain of how program inputs achieve changes in outcomes through activities and outputs.
Assumption	A precondition that underpins a theory of change or model. An assumption cannot be directly observed or verified, e.g., *When students read textbooks, they learn from them.*
Input	An activity carried out as part of a program or intervention, e.g., *Textbooks are given to schools.*
Output	A step in the planned implementation of a program or intervention – a.k.a. a direct result in response to the inputs, e.g., *Students receive textbooks through schools.*
Intermediate Outcomes	Observable changes or impacts caused by the program that are not the ultimate outcome of interest, but necessary along the way to achieving a final outcome, e.g., *Increase in students who have passing test scores for the semester.*
Final Outcomes	Changes or impacts that are of ultimate interest to researchers and/or program implementers; these are often the overall goals of a program, e.g., *Increase in high school graduation rates.*
Indicator	An observable metric used to measure an outcome, e.g., *Student test scores*.
Instrument	The tool used to measure an indicator, e.g., *A set of test questions*.

[1] These definitions of hypothesis and theory of change are based on those in Module 5.1: Theory of Change from Glennerster and Takavarasha's *Running Randomized Evaluations*.

Learning Objective

To better understand the conceptual framework of the theory of change and how it informs what research questions to ask, what data to collect, and what outcomes to measure.

Subjects Covered

Theory of change, defining a hypothesis, selecting indicators, measuring outcomes, and measuring the impact of a program or policy.

Introduction

Change in land use—mostly deforestation—represents 11% of global carbon emissions caused by humans, more than the transportation sector and second only to the energy sector.[2] When trees are cut, they stop absorbing carbon dioxide from the atmosphere, and as they decompose or are burned, they release stored carbon into the atmosphere. The majority of deforestation today occurs in low-income countries, where landowners often cut down trees to clear land for subsistence agriculture or to sell the trees for income from timber and charcoal. Curbing deforestation in low-income countries is potentially a very cost-effective way to reduce carbon emissions and mitigate climate change.

One policy approach is to provide payments for ecosystem services (PES), where individuals are paid to refrain from environmentally damaging behavior, such as cutting down trees on their land.[3] For example, the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD+) program promotes PES globally by subsidizing conservation programs in low- and middle-income countries with payments from high-income countries.

This case study will look at an evaluation of a program offering "cash for carbon" and paying private forest owners in Uganda's Hoima and Kibaale

[2] UN REDD+ program
[3] Wunder (2005) defines PES as "a voluntary, conditional transaction with at least one seller, one buyer, and a well-defined environmental service."

districts to not remove trees.[4] Private forest owners depend on timber and charcoal as natural resources for income and depend on cleared farmland for income and food. However, the value of intact forests is harder to quantify. The PES program aims to align the incentives of individuals and families who own forest-covered land with the public interest of climate and ecosystem protection. Reducing deforestation fights carbon emissions, protects biodiversity (an important source of tourism in Uganda), and maintains healthy soil by reducing flooding and silt loss.

Discussion Topic 1

1. Why might a landowner cut down trees on their land? What types of contributing factors might drive tree cutting?

2. Review your list. Can you suggest interventions that might reduce these contributing factors to deforestation? (Think of other policy options for protecting forest resources.)

[4] Forest covers an eighth of Uganda's land area, and the country lost 918 kilohectares of trees between 2001 and 2020, equivalent to a 12% decrease in tree cover since 2000 and 413 megatonnes of carbon dioxide emissions. Uganda's deforestation rates are highest on private land (Global Forest Watch dashboard).

Payment for Ecosystem Services

Payments for ecosystem services (PES) is the environmental equivalent of a conditional cash transfer, a common policy tool where, for example, families are offered a payment in return for investing in children's health or education. PES programs are increasingly popular, especially in low-income countries, because they are voluntary and thus do not force people to adopt a certain behavior or take away a key source of income. However, one potential concern is that PES payments go to forest owners who would have conserved their trees anyway, which would increase program costs without generating additional environmental benefits. Another concern is that individuals might shift deforestation activities to other land outside of the study area, which would not decrease net deforestation. The study discussed below is the first randomized evaluation of a deforestation PES program, designed to measure its effectiveness and cost-effectiveness.

The Intervention

Together with Innovations for Poverty Action, researchers conducted a randomized evaluation to measure the impact of a PES program in Uganda on the percentage of land area covered by trees. The program, implemented by the Chimpanzee Sanctuary and Wildlife Conservation Trust (CSWCT), offered landowners payments of 70,000 Ugandan shillings (about 28 USD) per hectare (about 2.5 acres) per year if they conserved their forest. Landowners could receive additional payments for planting seedling trees on their land.[5] Researchers evaluated the two-year program in a study of 121 villages, with 60 villages randomly assigned to receive the program in the treatment group and 61 villages randomly assigned to the comparison group.

The researchers used satellite imagery to select study villages that were forested and located within the study district. After identifying villages, the researchers conducted a baseline survey of private forest owners in the villages, and randomly assigned villages to the treatment and comparison groups. The PES program was then marketed to all private forest owners in treatment villages and they could choose to enroll.

The average landowner participating in this two-year program owned 2 hectares of forest, so the typical program enrollee could earn $56 per year for compliance (equal to 5% of mean or 16% of median household income).

[5] Payments were made in cash at the end of each year of the program.

At baseline, 85% of private forest owners reported cutting down trees over the preceding three years, and 29% reported earning income from timber products in the past year. Income levels indicate that income from timber products was on average slightly lower than the typical PES incentive payment, although the amount of potential income given up by complying with the program varied considerably between private forest owners.

The study combined survey data, administrative data from the operational records of the implementing partner, and satellite image data. The baseline and endline surveys collected data on self-reported tree cutting practices and motivations, other landowner behaviors such as patrolling the forest to detect and prevent others from removing trees, and household expenditures as a proxy for income. Administrative data from CSWCT tracked program enrollment and compliance, including the number of full and partial PES payments and their amounts. To measure the effect of the program on tree cover, researchers used a high-resolution commercial satellite to take images of the study area and classified each pixel in the satellite images as forested or not using a geospatial software analysis tool.[6]

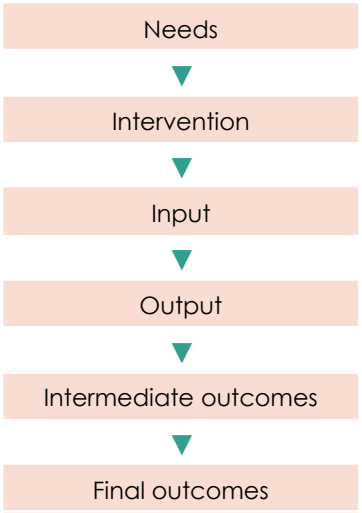
Discussion Topic 2

1. We will now discuss how an impact evaluation of the PES program might be conducted. What is a hypothesis that an impact evaluation of this program would test?

[6] At the pixel level (smaller than the crown of the typical mature tree), researchers could observe selective tree cutting as well as clear-cutting (cutting all trees from an area). Most existing studies of deforestation are only able to measure clear-cutting and deforestation at the edges of the forest.

Theory of Change

A theory of change (ToC) identifies the causal link between the intervention and the final outcome(s).



Definitions can be found in the key vocabulary chart above. A quick note on commonly confused terms:

- An **output** is a direct result of the inputs, and can help assess whether a program is being implemented as planned. For example: "students receive textbooks."
- An **outcome** is an observable change or impact caused by the program. For example: "change in students' reading scores."

Discussion Topic 3

1. Using the table on the next page, draw out a causal chain (a theory of change) that connects the intervention to your expected intermediate and final outcomes. The measurement column will be filled in later.

	Theory of change (Discussion Topic 3): What happens at this step?	**Measurement (Discussion Topic 4):** Indicators and data to provide information on each step of the theory of change.
Needs		
Intervention/ Inputs		
Outputs		
Intermediate Outcomes		
Final Outcomes		

2. What are the necessary conditions/assumptions underlying this ToC? What needs to occur or be present for this chain to work?

Measurement: Indicators and Data Collection

The ideal data collection plan measures indicators at every stage of the theory of change. Before deciding which data to collect, you need to:

- Clearly define the inputs, outputs, and outcomes you are targeting
- Identify the ways the intervention is thought to affect the outputs and outcomes

Defining a main hypothesis and theory of change at the beginning of an evaluation is a crucial step that will help you determine what data/information to collect.

For each step of the theory of change, you must identify **indicators** (what to measure) and **instruments** (tools for data collection, a.k.a. methods for measurement). If possible, you should also collect data to validate the assumptions underpinning your theory of change.

For survey data in particular, at every step of measurement, it is important to consider participants' response process (i.e., how they interpret the survey questions) and how this and other factors may affect measurement. For administrative data or remote sensing data (such as satellite images), it is crucial to be able to link each data source to the unit of observation, which requires collecting data to match records.

Discussion Topic 4

1. Which indicators would you measure at each step of your theory of change, and how would you collect data for these indicators?

   Add indicators and data in the right hand column of the table under Discussion Topic 3.

2. What challenges might arise during the data collection and measurement processes? For example: In this hypothetical plan for data collection, are survey questions, study protocols, and protocols for the intervention itself clear and easy to comprehend? Are survey questions worded so as to avoid social desirability bias? If not, what might be the effects on survey responses? How might this affect the conclusions researchers draw from the study?

Discussion Topic 5: Interpreting the Results

Keep in mind when discussing the questions below that an impact evaluation is not a "thumbs up" or a "thumbs down" about a program – regardless of the results, impact evaluations provide valuable information about lessons learned and offer important insights into how programs might be adapted moving forward.

1. In the real study by Jayachandran et al., enrollment in the PES program was 32% in treatment villages. Despite low enrollment of landowners in the program in treatment villages, the program led to significantly less deforestation in those areas. Both treatment and comparison villages experienced net tree loss over the course of the program, but while comparison villages lost an average of 9.1% of total tree cover, treatment villages lost only 4.2%. This corresponds to 5.55 hectares (13.71 acres) more tree cover in treatment villages.

    a. How would you explain or interpret these results?

b. Now imagine that instead the study found that there was no impact of PES on tree cover or self-reported conservation behaviors. How would you interpret these results?

2. [Optional– time allowing] As a policymaker, how would you react to the enrollment rate and the impact of the program? What other information might be needed to make a policy decision?

APPLICATIONS TO OTHER CONTEXTS

The theory of change behind the PES program and the measures used to validate each causal link have relevance beyond the Ugandan context. Deforestation is a key environmental challenge in countries across the world, and communities might choose different tools to address this, from incentives for tree planting (Jack, 2013) to targeted agricultural extension services providing information on intensive agriculture practices (Hörner et al, 2019).

PES programs use a similar theory of change to conditional cash transfers, a widespread type of intervention used to mitigate income shocks, improve preventative health, and incentivize investment in child health and education.[7] Costa Rica's *Pago por Servicios Ambientales* (PSA) program, launched in 1997, and Mexico's *Pagos de Servicios Ambientales Hidrológicos* (PSAH) program, launched in 2003, are two of the most established deforestation PES programs globally. PSA and PSAH use similar policies to the Uganda CSWCT intervention, with multi-year time periods and cash payments. While neither program has been evaluated using a randomized control trial, both are monitored using annual remote sensing and periodic on-the-ground spot checks. Wunder, Engel, and Pagiola (2008) review PES programs across many global contexts and note characteristics of successful programs.

Compared to taxing timber products, which can be difficult or impossible with informal markets, or prohibiting tree cutting, which is difficult to enforce in remote areas and requires state police capacity to do so, PES addresses the individual-level economic factors that typically lead private forest owners to choose to cut their trees. Targeted directly to private forest owners, PES potentially offers a cost-effective policy option when comparing the cost of payments to the value of deferred carbon emissions. PES programs also enable a global transfer of resources to reduce carbon dioxide emissions, as high-income countries—the biggest global polluters—finance environmental protection programs in low- and middle-income countries.

[7] For examples of conditional cash transfer programs, see The Role of Conditional Cash Transfers in Mitigating Income Shocks in Mexico and Conditional Cash Transfers and HIV/AIDS Prevention in Malawi.

References and Further Reading

Cheptoris, Samuel. "State of Uganda's Forestry 2016." Uganda Ministry of Water and Environment, 2016.

Food and Agriculture Organization of the United Nations. UN-REDD Programme Fact Sheet. Accessed May 5, 2021.

Gibson, Mike, and Anja Sautmann. "The elements of a randomized evaluation." J-PAL Research Resources. Accessed May 5, 2021.

Glennerster, Rachel, and Kudzai Takavarasha. 2013. *Running Randomized Evaluations: A Practical Guide*. Princeton: Princeton University Press. pp. 181-183.

Global Forest Watch. "Global Deforestation Rates & Statistics by Country.". Accessed May 21, 2021.

Hörner, Denise, Adrien Bouguen, Markus Frölich, and Meike Wollni. "The Effects of Decentralized and Video-based Extension on the Adoption of Integrated Soil Fertility Management – Experimental Evidence from Ethiopia." NBER Working Paper 26052 (2019).

Jack, B. Kelsey. "Private information and the allocation of land use subsidies in Malawi." American Economic Journal: Applied Economics 5, no. 3 (2013): 113-35.

Jack, B. Kelsey, and Seema Jayachandran. "Self-selection into payments for ecosystem services programs." Proceedings of the National Academy of Sciences 116, no. 12 (2019): 5326-5333.

Kopper, Sarah, and Katie Parry. "Introduction to measurement and indicators." J-PAL Research Resources. Accessed May 5, 2021.

J-PAL. "Testing the Effectiveness of Payments for Ecosystem Services to Enhance Conservation in Uganda." J-PAL Evaluation Summary, 2017.

Weisse, Mikaela and Peter Potapov, "Assessing Trends in Tree Cover Loss Over 20 Years of Data." Global Forest Watch blog post, April 28, 2021. Accessed May 21, 2021.

Wunder, Sven. "Payments for environmental services: some nuts and bolts." (2005).

Wunder, Sven, Stefanie Engel, and Stefano Pagiola. "Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries." Ecological economics 65, no. 4 (2008): 834-852.

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