Seeds of Learning: Uncertainty and Technology Adoption in an Ecosystem-Based Adaptation Game

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INTRODUCTION

We introduce a **detailed interactive game** for use in classrooms and trainings to familiarize participants with ideas related to **ecosystem-based adaptation** to climate change, **technology adoption** under uncertainty, and **small-scale agriculture** in developing countries.

The game is **fun and immersive**! It takes 50 mins to 2 hours to complete, and works best with 10-60 participants. **No background knowledge is required**, but different groups (from undergrads to grad students to policymakers) will get different things from the exercise.

Figure 1: A Riparian Buffer Strip
(Photo https://www.niwa.co.nz/news/dairy-turns-the-corner)

We provide **fully customizable materials** to make running the game easy: an Excel spreadsheet (see Figure 2) for recording decisions, a bullet-point instructor's guide, participant instructions, a background handout for participants, a list of suggested readings, slides to show during play, ideas about leading discussions and modifying the game, and more.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Player	Card	Farm Val	Adopt?	# adopters	Ecosystem boost rate	Ecosystem yield effect	Direct adptn effect	Farming income	Adoption cost	Govt payment	Total income
2	1	1	1,000 ₼		15	75%	750 ₼	0 ₼	1,750 ₼	0 ₼	0 ₼	**1,750 ₼**
3	2	2	2,000 ₼	1	15	75%	1,500 ₼	-200 ₼	3,300 ₼	1,000 ₼	1,500 ₼	**3,800 ₼**
4	3	3	3,000 ₼		15	75%	2,250 ₼	0 ₼	5,250 ₼	0 ₼	0 ₼	**5,250 ₼**
5	4	4	4,000 ₼	1	15	75%	3,000 ₼	-400 ₼	6,600 ₼	1,000 ₼	1,500 ₼	**7,100 ₼**
6	5	5	5,000 ₼		15	75%	3,750 ₼	0 ₼	8,750 ₼	0 ₼	0 ₼	**8,750 ₼**
7	6	6	6,000 ₼	1	15	75%	4,500 ₼	-600 ₼	9,900 ₼	1,000 ₼	1,500 ₼	**10,400 ₼**
8	7	7	7,000 ₼		15	75%	5,250 ₼	0 ₼	12,250 ₼	0 ₼	0 ₼	**12,250 ₼**
9	8	8	8,000 ₼	1	15	75%	6,000 ₼	-800 ₼	13,200 ₼	1,000 ₼	1,500 ₼	**13,700 ₼**
10	9	9	9,000 ₼		15	75%	6,750 ₼	0 ₼	15,750 ₼	0 ₼	0 ₼	**15,750 ₼**
11	10	10	10,000 ₼	1	15	75%	7,500 ₼	-1,000 ₼	16,500 ₼	1,000 ₼	1,500 ₼	**17,000 ₼**
12	11	1	1,000 ₼		15	75%	750 ₼	0 ₼	1,750 ₼	0 ₼	0 ₼	**1,750 ₼**
13	12	2	2,000 ₼	1	15	75%	1,500 ₼	-200 ₼	3,300 ₼	1,000 ₼	1,500 ₼	**3,800 ₼**
14	13	3	3,000 ₼		15	75%	2,250 ₼	0 ₼	5,250 ₼	0 ₼	0 ₼	**5,250 ₼**
15	14	4	4,000 ₼	1	15	75%	3,000 ₼	-400 ₼	6,600 ₼	1,000 ₼	1,500 ₼	**7,100 ₼**
16	15	5	5,000 ₼		15	75%	3,750 ₼	0 ₼	8,750 ₼	0 ₼	0 ₼	**8,750 ₼**
17	16	6	6,000 ₼	1	15	75%	4,500 ₼	-600 ₼	9,900 ₼	1,000 ₼	1,500 ₼	**10,400 ₼**
18	17	7	7,000 ₼		15	75%	5,250 ₼	0 ₼	12,250 ₼	0 ₼	0 ₼	**12,250 ₼**

Figure 2: Excel Sheet for Recording Decisions (cells for recording decisions are yellow; all calculations are automated)

THE GAME

In the game, participants **roleplay** this scenario:

- You are a **subsistence farmer** in a low-income country
- Weather is changing → **erosion** is increasing
- The government wants to **promote ecosystem-based adaptation** (EBA)
- But many EBA practices are experimental or have only been tested in other climates: **we don't know how they'll work here**!
- In each of a series of contract periods, you'll **decide whether to adopt a contract** to take up different EBA practices, with different circumstances.

Participants make their decision in each round and see the outcomes – their earnings, everyone else's earnings, and ecosystem service provision. We suggest you **pay a few participants** based on their earnings!

Figure 3: No-Till Maize
(Photo http://www.fao.org/docrep/009/a0100e/a0100e07.htm)

ECOSYSTEM-BASED ADAPTATION

The climate is changing, exposing communities worldwide to changing conditions that put lives and livelihoods at risk. People and communities reduce risk through **adaptation**: costly actions that reduce damages. In some cases, hard or grey adaptation measures like revetments and sea walls may provide protection from flooding; Adaptation can also happen through policies and social initiatives. But this game focuses on **ecosystem-based adaptation**: use of natural systems to reduce impacts of a changing world.

In the context of agriculture, ecosystem-based adaptation often **fights erosion** as weather patterns become more extreme. Examples include riparian buffer strips (Figure 1), low-till or no-till farming (Figure 3), and agroforestry (Figure 5). These techniques can **provide benefits to society** through ecosystem services, but farmers are often **uncertain about how they will affect their livelihoods**.

THE TREATMENTS AND THEIR LEARNING OBJECTIVES

Treatment	Learning Objectives
1: Baseline (No Government Involvement)	Impacts of climate change; ecosystem-based adaptation, subsistence agriculture in developing countries; erosion and water quality; provision of local public goods
2: Flat Adoption Subsidy	Payments for ecosystem services programs; cost-effectiveness in pollution abatement
3: Conservation Auction	Conservation and procurement auctions; incentive compatible bidding
4: Uncertain Direct Effect	Decision-making under uncertainty
5: Uncertain but Correlated Direct Effect	Different forms of uncertainty; learning spillovers in adoption of new technology
6: Uncertain but Correlated Direct Effect, with Pilot Bonus	Incentivizing learning about new technology

In each treatment, EBA adoption has an **explicit adoption cost to the farmer**, also **affects the farmer's own yield**, provides **ecosystem benefits to all participants** by boosting their yields (through water quality), and may come with a **government payment**.

In the first three treatments, the impact on the farmer's own yield is a **simple 10% reduction**. But this impact becomes more complex in the treatments that follow.

In Treatment 4, the own-yield impact is **uncertain**: it is equally likely to be -30% or +10%.

In Treatments 5 and 6, there are both **systemic uncertainty** (how well this technique works in this area for all farmers: in Figure 4, whether your area is High Type or Low Type) and **idiosyncratic uncertainty** (how well your particular field is suited to it; in Figure 4, whether you are Farmer 1, 2, or 3). Therefore, it is additionally socially beneficial for some people to adopt the technique, especially early, because that lets others learn what impact they are likely to see. Thus, a **pilot bonus** may be helpful to encourage early adoption.

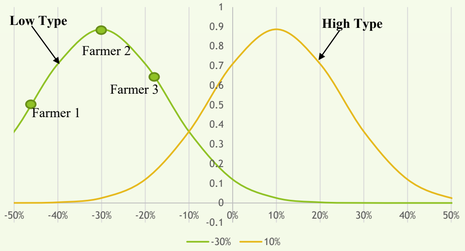

Figure 4: Correlated Uncertainty in Yield Impact for Treatments 5 and 6

SUMMARY: PLEASE PLAY OUR GAME! IT:

- Is detailed and context-rich
- Conveys concepts about payment for ecosystem services systems, efficient and cost-effective land conservation, and climate change adaptation, especially ecosystem-based adaptation
- Focuses on uncertainty and learning spillovers in adoption of a new technology

We make it easy for you to play the game and tune it to your interests, and fun for your participants!

Figure 5: Agroforestry
(Photo: https://greentumble.com/advantages-and-disadvantages-of-agroforestry/)

PLAY ALL OUR ENVIRONMENTAL / RESOURCE ECON GAMES! Find them at https://econ.williams.edu/profile/saj2/

Dissanayake, Sahan T. M. and Jacobson, Sarah A., 2016. "Policies with Varying Costs and Benefits: A Land Conservation Classroom Game." The Journal of Economic Education, 47(2), 142-160. (Available on https://economics-games.com/)

Dissanayake, Sahan T. M. and Jacobson, Sarah A., 2020. "Money Growing on Trees: A Classroom Game About Payments for Environmental Services in Community Forestry."

Abidoye, Babatunde, Dissanayake, Sahan T. M., and Jacobson, Sarah, 2020. "Seeds of Learning: An Ecosystem-Based Adaptation Game." (this game)

Jacobson, Sarah, 2020. "Your Mine! An Interactive Game Demonstrating the Economic Theory of Natural Resource Extraction." (work in progress)

WE WELCOME COMMENTS ABOUT THE GAME!

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