

Science and Technology Group Annual Report FY2024

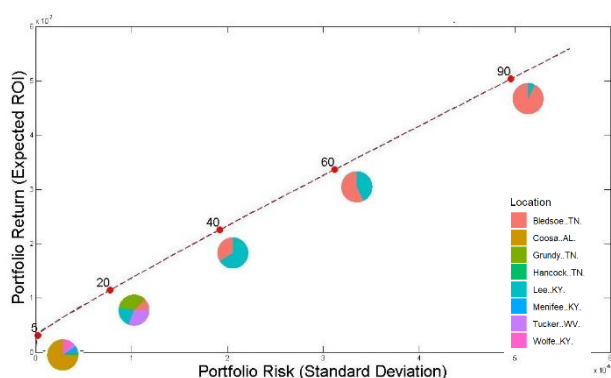
Payal Shah
Science and Technology Associate

1 Introduction

In my research, I use economic theory and statistical methods, combined with tools from ecology and biogeography, to analyze social and environmental impacts of natural resource management policies, to formulate optimal strategies to address environmental challenges such as climate change, and to evaluate preferences for ecosystem services. The major contributions of my research have been in advancing fundamental knowledge of: (1) how to do efficient and optimal conservation planning to deal with issues of climate change uncertainty, and (2) how to quantify and measure the impact of conservation policy on ecological outcomes.

2 Activities and Findings

Multi species conservation planning for the Appalachian ecoregion in a changing climate

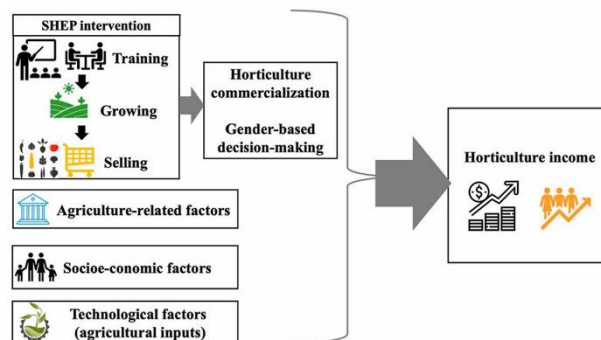


Climate change presents significant challenges to biodiversity conservation, making planning and resource allocation more complex. Traditional conservation approaches often overlook climate uncertainty, limiting their effectiveness in long-term biodiversity protection. In this study, we apply a diversification-based approach to improve conservation strategies in the Appalachian ecoregion—one of North America's most biodiverse landscapes. The region faces growing threats from habitat loss, climate change, and

economic pressures on land use which introduces uncertainty into both ecological outcomes and conservation costs. We apply a portfolio optimization approach to design conservation policies that strategically allocate limited resources across species and locations while maintaining flexibility to adapt to climate and economic uncertainty. By evaluating multiple future scenarios, this framework identifies conservation investment strategies that balance trade-offs between biodiversity goals and climate-induced risks while allowing for dynamic resource reallocation over time.

Heterogeneous effects of horticulture commercialization and gender-based decision-making on smallholder farmers' income: Evidence from a quasi-experimental study in Jimma, Ethiopia

This study investigates the heterogeneous effects of horticulture commercialization and gender-based decision-making on smallholder farmers' income in Ethiopia's Jimma zone. Using a quasi-experimental design, we employ propensity score matching—first at the village level via nearest-neighbor matching, then at the household level via kernel matching—to address selection bias. We apply quantile regression to analyze data from 610 farmers, including participants in the Smallholder Horticulture Empowerment and Promotion (SHEP) project. Results show that the interaction between horticulture commercialization and SHEP yields positive income effects, especially below the 50th income quantile. Joint decision-making significantly increases income at the 10th and 25th quantiles, though the SHEP intervention does not amplify this effect, likely due to the time needed for gender-focused training to take hold. Factors such as family labor, livestock ownership, and proximity to cooperatives



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are associated with higher income. Findings support market-driven approaches like SHEP and cooperative strengthening to uplift lower-income horticulture farmers.

3 Collaborations

1. Dynamic multi-species conservation planning under climate change for Appalachian ecoregion
Collaborators: Paul Armsworth (Professor, University of Tennessee, Knoxville)
Charles Sims (Associate Professor, University of Tennessee, Knoxville)
Seong-Hoon Cho (Professor, University of Tennessee, Knoxville)
James Mingie (Research Specialist, University of Tennessee, Knoxville)
2. Multidimensional risk diversification for invasive species management: A quasi-dynamic portfolio theory approach
Collaborators: Charles Sims, Associate Professor, University of Tennessee, Knoxville
Amy Ando, Professor, University of Illinois at Urbana-Champaign
3. Project: Optimal conservation planning and climate change uncertainty
Collaborators: Amy Ando, Professor, Ohio State University
Mindy Mallory, Associate Professor, Purdue University
4. Risk and uncertainty in biodiversity conservation under climate change
Collaborators: Charlotte Gerling (Post Doctoral Scholar, Brandenburg University of Technology)
Martin Drechsler (Professor, Brandenburg University of Technology)
Frank Watzold (Professor, Brandenburg University of Technology)
5. Empirical research on the effects of the SHEP approach on small-scale farmers in Ethiopia
Collaborators: Hisako Nomura (Associate Professor, Kyushu University)
Asmiro Abeje Fikadu (PhD Candidate, Kyushu University)
Girma Gezimu Gebre (Postdoctoral Research Fellow, Ritsumeikan University)

4 Publications and other output

4.1 Publications:

- Gerling Charlotte, Drechsler, Martin, Watzold, Frank and Shah, Payal. Risk and uncertainty in biodiversity conservation under climate change. Accepted for publication in *Review of Environmental Economics and Policy*.
- Fikadu, Asmiro Abeje, Hisako Nomura, Girma Gezimu Gebre, Payal Shah, Yoshifumi Takahashi, and Mitsuyasu Yabe., 2025. Heterogeneous effects of horticulture commercialization and gender-based decision-making on smallholder farmers' income: Evidence from a quasi-experimental study in Jimma zone, Ethiopia. *Journal of Agriculture and Food Research*, 19, p.101565.
- Nomura, Hisako, Asmiro Abeje Fikadu, Girma Gezimu Gebre, and Payal Shah., 2024. *Analysis of the Smallholder Horticulture Empowerment and Promotion ("SHEP"): Intervention on Income and Food Security in Ethiopia*. JICA Ogata Sadako Research Institute for Peace and Development.
- Dissanayake, Sahan TM, and Payal Shah, 2024. Land conservation and climate change.

5 External funding

1. Kakenhi C (April 2024- March 2027)
Project: Economic model of the spillover effects of protected areas on deforestation activity
Funding Amount: \$34,000
2. Japan International Cooperation Agency (JICA) Grant as Co-PI (April 2022 – March 2026)
Project: Empirical research on the effects of the SHEP approach on small-scale farmers in Ethiopia