Stanford Center on Food Security and the Environment

Helping alleviate global hunger, poverty, and resource depletion

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Stanford Woods Institute for the Environment

Of the world's 7.5 billion people, roughly one in every nine go hungry. The majority of chronically food-insecure live in developing countries that are also significantly affected by climate change. Multiple forms of malnutrition exist worldwide, with many countries experiencing high rates of child undernutrition and adult obesity. Meeting the nutritional needs of a growing global population proves a significant challenge. The Center on Food Security and the Environment (FSE) works with partners to meet that challenge by creating and distributing new knowledge and interventions that help eradicate poverty and malnutrition, while also promoting sustainable food systems.

Vision

A food-secure world is one that provides every person on the planet with physical and economic access to the food and nutrition necessary to lead a healthy and active life, while also protecting the environment.

Mission

The Center on Food Security and the Environment generates and disseminates vital knowledge and policy-relevant solutions to ensure Earth's lands and waters sustainably support the nutritional needs of a growing global population that is richer, but with increasingly unequal incomes.

Who We Are

Stanford researchers from throughout the university collaborate with FSE to address the challenges of feeding a growing global population. Leveraging our interdisciplinary and collaborative strengths, we link cutting-edge science with action designed to ensure the well-being of people and resources across the globe. FSE is a joint effort of the Freeman Spogli Institute for International Studies and the Stanford Woods Institute for the Environment.

How We Work

We seek to create and distribute the knowledge, tools and networks to meet the challenge of global hunger, poverty, and environmental degradation. As part of one of the world's leading research universities we collaborate with and convene global food security experts. Our unique relationship with Silicon Valley technology professionals enables us to develop and apply cutting edge innovation in our research. Leveraging our distinctive strengths, we work across disciplines and sectors creating research portfolios in relevant scientific and policy arenas.

Pioneering research focused on productive, sustainable food systems

World hunger is on the rise for the first time since the turn of the century.

In countries weakened by the combination of conflict and climate-related shocks, rural communities suffer from constraints on food production and availability, loss of incomes, and displacement. Improved small-farmer productivity is often critical for their survival. Moreover, malnutrition due to calorie, protein, and micronutrient deficiencies coexist with obesity in many countries, regions, and even households. As the world population grows to exceed 10 billion by 2050, innovative changes in food systems are necessary to meet these wideranging nutritional needs.

Our research portfolio forms the core of our organization. FSE researchers place priority on enhancing sustainable food production and on ensuring that everyone has access to a sufficient supply of nutritious food.

Our major research areas include:

- Water Resources
- Aquaculture and Fisheries
- Tropical Oil Crops
- Data Science for Food Security
- Food, Nutrition, and Health
- Climate Impacts and Adaptation
- Rural Education

Water Resources

Over 1 billion households in poorer regions of Africa and Asia rely on groundwater for their livelihoods and food security.

Global food demand is predicted to increase substantially over the next 50 years, resulting in added pressure on freshwater supplies. In areas of high population growth, which tend to be poor, rural, and fragile, increased drought and floods aggravate problems of water quantity and quality. In sub-Saharan Africa, less than 5 percent of agriculture is irrigated. In South Asia, competition for water between agriculture, energy, industrial, and urban uses leaves many of the poorest farmers without adequate water for irrigation. Additional investments at multiple scales, plus more responsible water management are key to future water and food security. Our researchers work to increase water availability and find field-based solutions for breaking the cycle of poverty caused by water-related hazards.

Assessing the impacts of water on farms, firms, and families

Postdoctoral scholar Esha Zaveri worked with colleagues at the World Bank to assess rainfall variability impacts on farms, businesses, and families in developing countries. Many farmers have experienced declining yields and expanded croplands that threaten forests and natural habitats. In cities, water limitations have stalled business production, aggravated waste disposal problems, and compromised long-term family health and welfare. Current water management practices appear outdated. Zaveri and her colleagues have proposed solutions such as incentives for farmers to alter cropping patterns, to improve water-supply infrastructure and regulation, and to create insurance and cash safety nets to help protect families made vulnerable by water crises.

Aquaculture and Fisheries

Ocean and fresh-water fish play key roles in eradicating poverty, improving nutrition, and supporting the livelihoods of over three billion people.

Our researchers team with experts from Stanford's Center for Ocean Solutions to find new solutions for ecologically friendly aquaculture and fishing practices. Healthy marine resources are essential for achieving global food security yet human impacts from overfishing, climate change, pollution, and coastal development increasingly threaten these ecosystems. Aquaculture provides about half of the fish consumed by humans worldwide, and in some parts of the world is the most accessible and affordable source of animal protein. Our experts focus on the intersection between ocean and aquaculture systems, especially via the fish feed sector, to ensure the economic and environmental sustainability of both sources of fish protein.

Advising China toward sustainable fisheries management

Roz Naylor and research scholar Ling Cao collaborated with an international group of scientists to examine the history of the Chinese government's marine fisheries policies and outcomes since China's 1978 Economic Reform. While China has attempted to reverse fish stock declines, efforts seem ineffective without country-wide fisheries reform. The researchers recommended new institutions for science-based fisheries management, secure fishing access, educational programs for fisheries managers, and increased public access to scientific data. Their results were widely circulated among marine and fisheries scientists, policy experts, and the media in China.

Data Science for Food Security

Data science presents massive opportunity to reshape global poverty, health, and crop production research.

Stanford's close proximity to Silicon Valley provides our researchers with access to extraordinary data sets from high-resolution satellites sensors, social media companies, and mobile phone carriers. In collaboration with Stanford's computer science department, our team develops new analytical techniques to evaluate food security issues by examining these rich data sources. Our researchers work to expand the capacity and scope of topics assessed, which include farm productivity, food prices, nutritional status, household assets, rural infrastructure, fishing patterns, human conflict, and social unrest. These low-cost and robust research tools are producing better and quicker measurements for a wide variety of stakeholders in the food-security arena.

Combining machine learning and satellite images to identify poverty zones in Africa

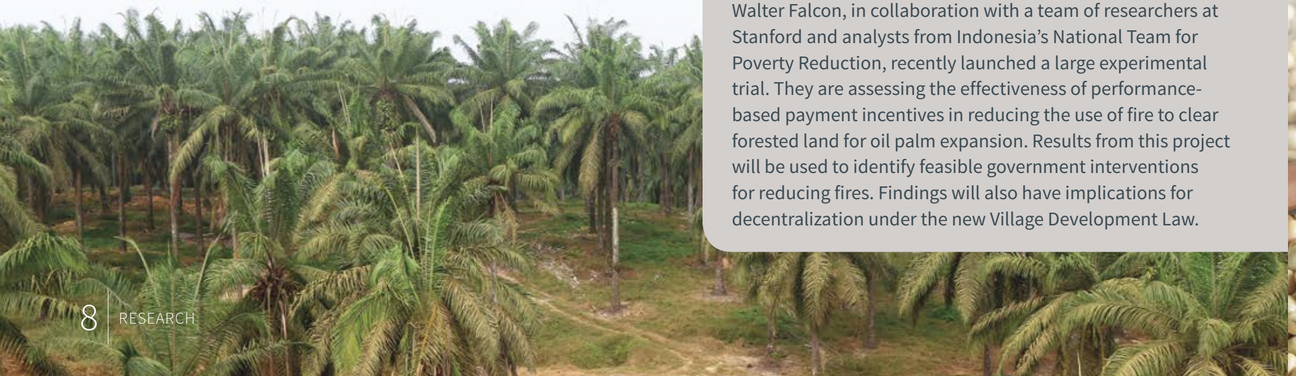
Photo: Marshall Burke

To provide relief to people living in poverty, it is first necessary to locate them. But that turns out to be a difficult task for much of the world. Marshall Burke and David Lobell, in collaboration with Stanford's Department of Computer Science, pioneered a system using satellite imagery to predict wealth at the village-level in four African countries. Comparing high-resolution daytime and nighttime satellite imagery, a computer algorithm "learned" to pick out predictive features of economic well-being, such as roads, buildings, and urban areas. The accuracy of the algorithm exceeded existing approaches in predicting poverty. Improved poverty maps have many applications and should be of great assistance to aid organizations and policymakers for project development and evaluation.

Tropical Oil Crops

The rapid expansion of tropical oil crop production calls for policies that address both poverty reduction among smallholders and environmental protection.

Palm oil, because of its many uses for food, fuel, and industrial products, is the fastest growing and most valuable tropical oil crop. Global exports of palm oil in 2016, nearly half of which came from Indonesia, equaled the global value of corn exports. Increased production has come at significant environmental costs due to forest clearing by fire, biodiversity loss, water pollution, and air pollution. Social tensions around land rights and poor labor conditions have worsened the issue. This combination presents major policy challenges, and to date there has been little success as poverty and environmental objectives have typically been addressed separately. Our researchers focus on approaches that improve both smallholder welfare and environmental outcomes.



Assessing the effectiveness of payment incentives to curb deforestation in Indonesia

Our research has focused on strategies that promote palm oil production and marketing chains that stimulate economic growth, and environmental sustainability. Roz Naylor and Walter Falcon, in collaboration with a team of researchers at Stanford and analysts from Indonesia's National Team for Poverty Reduction, recently launched a large experimental trial. They are assessing the effectiveness of performance-based payment incentives in reducing the use of fire to clear forested land for oil palm expansion. Results from this project will be used to identify feasible government interventions for reducing fires. Findings will also have implications for decentralization under the new Village Development Law.

Food, Nutrition, and Health

Photo: Marshall Burke

One in three people worldwide suffer from some form of malnutrition.

As the global population grows in numbers and wealth, so does the need to ensure access to nutritious food. In areas where basic calorie needs are met, protein and micronutrient deficiencies persist, with women and children the most affected. Worldwide, one-in-three women suffer from anemia, one-in-four children are stunted, and over 3 million children under the age of five die each year due to poor nutrition. Furthermore, obesity rates exceed hunger rates in many countries, including those in the developing world, as the cheapest foods available are high in starch, sugar, and fats. Our researchers focus on examining the linkages between food, nutrition, and health, and on finding public and private-sector solutions that provide everyone access to affordable, healthy foods.

Using solar-powered drip irrigation to boost food and nutrition security

Photo: Jennifer Burney

Working with the Solar Electric Light Fund, a US-based NGO, Roz Naylor and FSE visiting fellow Jennifer Burney designed a multi-year solar market garden project in Kalalé, Benin. The study, unique in both technology and scope, measured the impacts of solar-powered irrigation systems on farming household's food security, nutrition, income, health, and wellbeing. They found the solar market gardens increased food access, provided better nutrition, resulted in greater household incomes, and higher school-attendance rates. The study illustrates an innovative and scalable technology that improves nutrition security and economic development.

Climate Impacts and Adaptation

By 2030 climate change could force more than 100 million people into extreme poverty.

Climate change poses a growing risk to global food security within many regions of Sub-Saharan Africa and South Asia. The many consequences of climate trends include extreme weather events, natural resource depletion, increased disease transmission, lowered crop yields, depressed livelihoods, and reduced economic growth. Our researchers focus on understanding how changing patterns of heat, rainfall, and extreme weather impact human health, food security, and economies. With insight into these impacts, our team provides assistance to governments and other institutions on the integration of climate resilient initiatives into future food security strategies.

Understanding climate change impacts on vital crop yields

Photo: Marshall Burke

Rice, wheat, and corn provide over half the world's food energy and are central dietary staples for billions of people. To adapt sensibly to climate change, farmers and policymakers need a more precise understanding of how climate trends and variability affect these crops. In a recent compilation of wide-ranging studies, David Lobell and a team of interdisciplinary researchers found that negative impacts to global agriculture are much more likely, more severe, and more widespread than is assumed. Their study highlights several potential adjustment mechanisms, including using more heat tolerant crop breeds and varieties, adjusting sowing and harvesting dates to avoid high temperatures, and using new forms of small-scale irrigation.

Rural Education

In today's interconnected world, helping the rural poor secure a good education is critical for global prosperity and stability.

FSE is home to the Rural Education Action Program (REAP), a research and policy advocacy organization dedicated to bringing quality health and education to the rural poor in China. While China's urban population prospers, two-thirds of China's youth grow up in poor, rural areas with only 37 percent finishing high school. Partnering with key institutions in China, and experts in international academia and government we bring education, health, and nutrition policy solutions to millions of rural children and their communities. Our researchers focus on four key areas; early childhood development, technology and education, improved teaching, and health and nutrition.

Nutritious Lunch for 20 Million

Poor nutrition in children is known to impair mental abilities and reduce school attendance rates. To address this issue, Scott Rozelle and REAP researchers launched a project examining the prevalence of iron-deficiency anemia in elementary schools in poor areas of rural China. They found approximately 30 percent of students suffer from iron-deficiency anemia, inhibiting their learning and attention. REAP showed that a simple nutritional intervention led to reduced anemia and improved student grades. In response, China's central government launched a $20 billion national program that is delivering free, nutritious school lunches to more than 20 million poor students every day.

Educating future food security experts

Within the Stanford community we provide the academic foundation for a growing number of graduate and undergraduate students interested in the areas of hunger, rural development, sustainable agriculture, "big data" techniques, food and nutrition security, intensive food systems, climate impacts, food-energy linkages, and policy analysis. While we are not a degree-granting center, our faculty teach numerous courses including:

- World Food Economy
- Fundamentals of Modeling
- Human Society and Environmental Change
- Climate and Agriculture
- Field Survey Data Collection and Analysis
- Food and Security
- Feeding Nine Billion
- Topics in Earth System Science
- Data for Sustainable Development

Our faculty mentor and advise M.A. and PhD students working on wide-ranging topics, such as palm oil development in Indonesia, remote sensing applications in crop modeling, and fish farming in Kenya. We also offer elite postdoctoral fellowships to exceptional students who have demonstrated an ability to perform rigorous work on global food security.

Photo: Roz Naylor

Using science to inform and engage policy

We aspire to be the go-to center for policy advice on issues relating to food security, agricultural technology, remote sensing, and development. Our team focuses on long-term partnerships with key policymakers and governments, working in collaboration to create innovative solutions. Our science and policy advising includes work with national, state, and sub-national governments, international development organizations, and other groups such as the Consultative Group for International Agricultural Research, the United Nations Food and Agricultural Organization, non-profit organizations, and private-sector firms.

Our key strategies include partnering with governments, disseminating research briefs to key decision-makers about new scientific findings, convening dialogues among public and private stakeholders, and collaborating with private sector, non-profits, and other institutions on key topics in food policy. Our graduate students often provide the new knowledge for these interactions.

Photo: Casey Valentine

LEADERSHIP

Rosamond Naylor is the Gloria and Richard Kushel Director of the Center on Food Security and the Environment, William Wrigley Professor in Earth Science, and Professor of Economics (by courtesy) at Stanford University. She received her B.A. in Economics from the University of Colorado, her M.Sc. in Economics from the London School of Economics, and her Ph.D. in Applied Economics from Stanford University. Her research focuses on economic and biophysical dimensions of food security and environmental impacts of crop and animal production.

David Lobell is the Deputy Director of the Center on Food Security and the Environment, a Professor at Stanford University in the Department of Earth System Science and a William Wrigley Senior Fellow at the Stanford Woods Institute for the Environment, and the Freeman Spogli Institute for International Studies. He received his Sc.B. in Applied Mathematics from Brown University, and his PhD in Geological and Environmental Sciences from Stanford University. His research focuses on agriculture and food security, specifically on generating and using unique datasets to study rural areas worldwide.

Walter Falcon is the former Deputy Director of the Center on Food Security and the Environment, former Director of the Freeman Spogli Institute for International Studies, Farnsworth Professor of International Agricultural Policy and Economics at Stanford University, and Senior Fellow at Stanford University. He holds a PhD from Harvard in Economics and is the winner of numerous scholarly and public service awards. He is a specialist on food policy, especially in Asia, and has also played important leadership roles in international agricultural research organizations.

Marshall Burke is a Fellow at the Center on Food Security and the Environment, Assistant Professor in the Department of Earth System Science, and Research Fellow at the National Bureau of Economic Research. He received his B.A. in International Relations from Stanford, and his PhD in Agricultural and Resource Economics from the University of California, Berkeley. His research focuses on social and economic impacts of environmental change, and on the economics of rural development in Africa.

Scott Rozelle is the Helen F. Farnsworth Senior Fellow and the Co-Director of the Rural Education Action Program. He received his B.S. in Labor Relations from the University of California, Berkeley, and M.S. and PhD in Agricultural Economics from Cornell University. His research focuses on China and is concerned with agricultural policy; the emergence and evolution of markets and other economic institutions in the transition process and their implications for equity and efficiency; and the economics of poverty and inequality, with an emphasis on rural education, health, and nutrition.

DONORS

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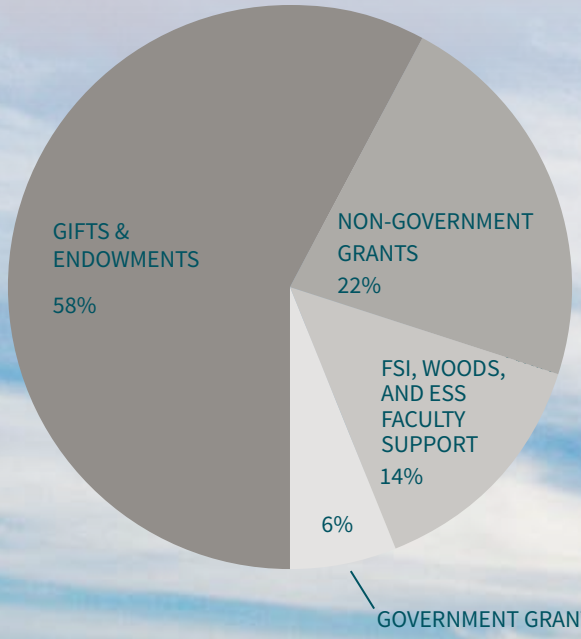

During 2016-17, FSE had expenditures that totaled about $4 million. These funds came from a variety of sources, which permitted both breadth and independence of our research.

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