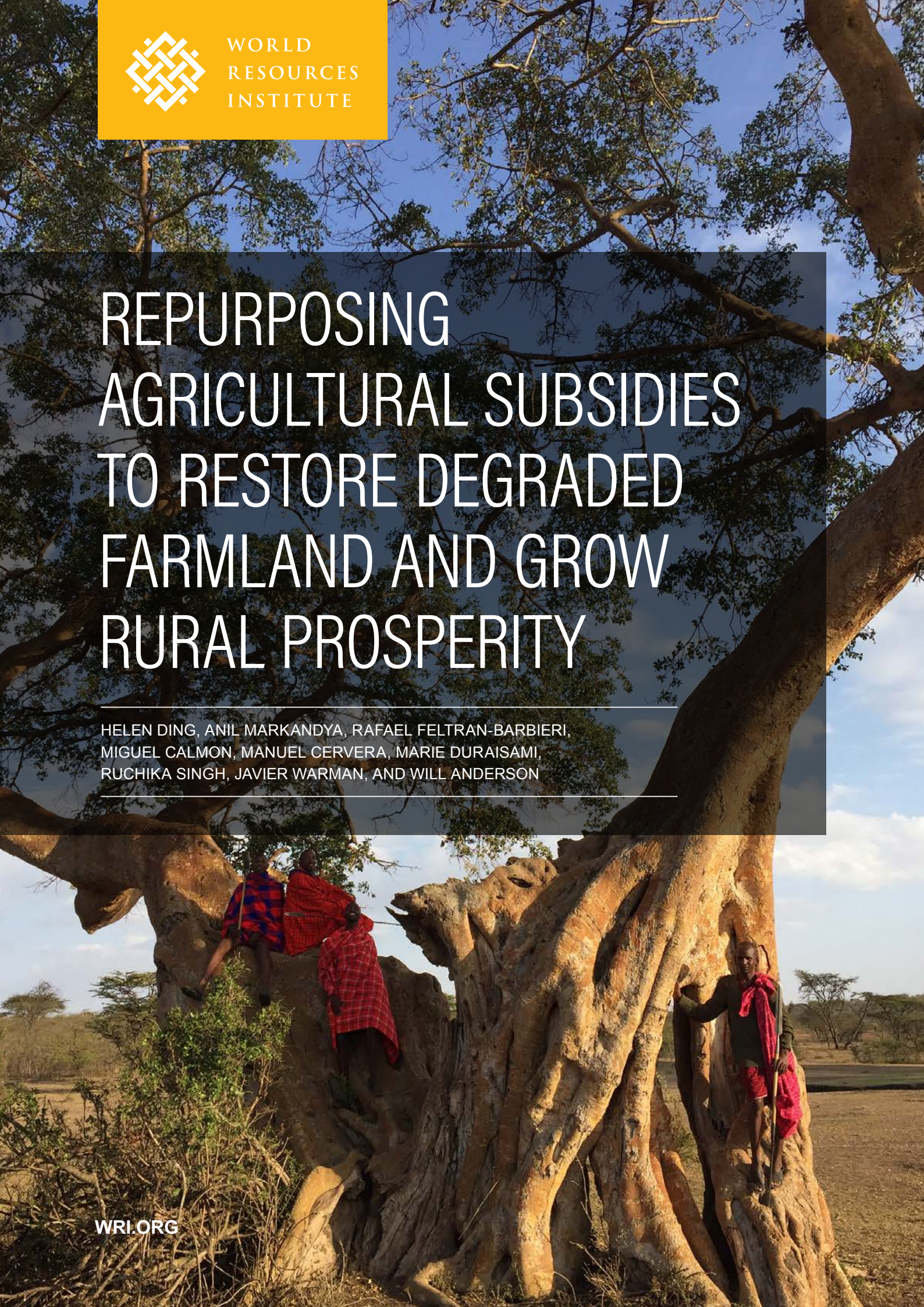

WORLD RESOURCES INSTITUTE

REPURPOSING AGRICULTURAL SUBSIDIES TO RESTORE DEGRADED FARMLAND AND GROW RURAL PROSPERITY

HELEN DING, ANIL MARKANDYA, RAFAEL FELTRAN-BARBIERI, MIGUEL CALMON, MANUEL CERVERA, MARIE DURAISAMI, RUCHIKA SINGH, JAVIER WARMAN, AND WILL ANDERSON

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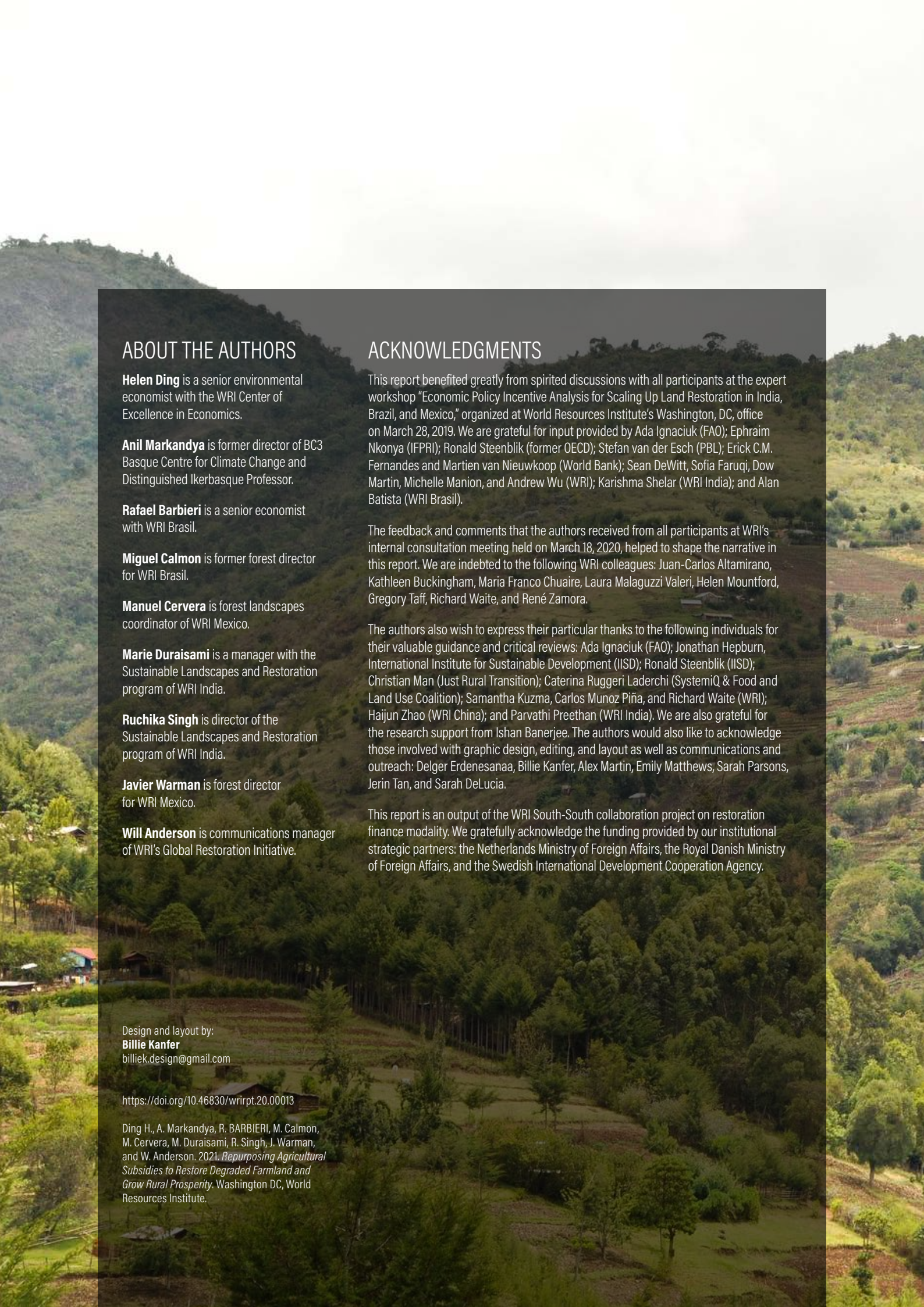

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ACKNOWLEDGMENTS

This report benefited greatly from spirited discussions with all participants at the expert workshop "Economic Policy Incentive Analysis for Scaling Up Land Restoration in India, Brazil, and Mexico," organized at World Resources Institute's Washington, DC, office on March 28, 2019. We are grateful for input provided by Ada Ignaciuk (FAO); Ephraim Nkonya (IFPRI); Ronald Steenblik (former OECD); Stefan van der Esch (PBL); Erick C.M. Fernandes and Martien van Nieuwkoop (World Bank); Sean DeWitt, Sofia Faruqi, Dow Martin, Michelle Manion, and Andrew Wu (WRI); Karishma Shelar (WRI India); and Alan Batista (WRI Brasil).

The feedback and comments that the authors received from all participants at WRI's internal consultation meeting held on March 18, 2020, helped to shape the narrative in this report. We are indebted to the following WRI colleagues: Juan-Carlos Altamirano, Kathleen Buckingham, Maria Franco Chuaire, Laura Malaguzzi Valeri, Helen Mountford, Gregory Taff, Richard Waite, and René Zamora.

The authors also wish to express their particular thanks to the following individuals for their valuable guidance and critical reviews: Ada Ignaciuk (FAO); Jonathan Hepburn, International Institute for Sustainable Development (IISD); Ronald Steenblik (IISD); Christian Man (Just Rural Transition); Caterina Ruggeri Laderchi (SystemiQ & Food and Land Use Coalition); Samantha Kuzma, Carlos Munoz Piña, and Richard Waite (WRI); Haijun Zhao (WRI China); and Parvathi Preethan (WRI India). We are also grateful for the research support from Ishan Banerjee. The authors would also like to acknowledge those involved with graphic design, editing, and layout as well as communications and outreach: Delger Erdenesanaa, Billie Kanfer, Alex Martin, Emily Matthews, Sarah Parsons, Jerin Tan, and Sarah DeLucia.

This report is an output of the WRI South-South collaboration project on restoration finance modality. We gratefully acknowledge the funding provided by our institutional strategic partners: the Netherlands Ministry of Foreign Affairs, the Royal Danish Ministry of Foreign Affairs, and the Swedish International Development Cooperation Agency.

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https://doi.org/10.46830/wrirpt.20.00013

Ding H., A. Markandya, R. BARBIERI, M. Calmon, M. Cervera, M. Duraisami, R. Singh, J. Warman, and W. Anderson. 2021. *Repurposing Agricultural Subsidies to Restore Degraded Farmland and Grow Rural Prosperity*. Washington DC, World Resources Institute.

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FOREWORD

Agriculture and land use change account for up to a quarter of global greenhouse gas emissions and are a major cause of deforestation and ecosystem degradation. The problem is even worse in regions like Latin America, where agriculture and land use change account for almost 60 percent of emissions, much of it tied to deforestation. The misallocation of farm subsidies—which have risen globally from an annual $325 billion in 2000 to $619 billion today—is driving much of this destruction.

When harmful subsidies incentivize the expansion of farms and grazing land at the expense of forests, grasslands, and other natural ecosystems, communities lose critical ecosystem services like healthy soil that underpin rural prosperity and build resilience to the effects of the changing climate.

Sadly, many farm policies fail to achieve their stated economic development goals, like boosting crop yields and creating jobs. Instead, they reward farmers for practices that exhaust the land and threaten the long-term health and vitality of farming communities. Without reform, these misallocated subsidies will render vast expanses of healthy land useless, making it impossible to feed the world's 10 billion people by 2050.

Over the past decade, many countries have realized that misallocated agricultural subsidies can harm the environment and economy, and some have started the process of reform. Learning from experiences across Africa, Asia, and Latin America, this report out a clear path governments can take to redirect farm subsidies to meet their economic development goals while reducing emissions and protecting vulnerable ecosystems.

How? First, countries should phase out subsidies that encourage the expansion of agriculture into natural forests and other ecosystems. Then, they should shift that funding into innovative policies, such as payments for ecosystem services, that reward farmers for sustainable practices. Finally, they should invest in systems that measure these impacts and share their experiences with peer policymakers around the world.

The report shows how policymakers in national agriculture, finance, and planning ministries, as well as local government officials, can follow this path and counterbalance the agriculture sector's greenhouse gas emissions by locking carbon in growing plants. For example, farm subsidies that support growing trees with crops (agroforestry) or on rangeland (silvopasture) reduce the need for chemical inputs and protect and restore the soil and biodiversity. These actions also help rural communities and small farmers twice—when they receive the subsidy and when their actions boost their future incomes. That is an important consideration for national governments as they seek ways to deliver on their Nationally Determined Contributions to the Paris Climate Agreement.

The opportunity for restoration is timely, as policymakers look for the largest possible returns on their public investments in the aftermath of the COVID-19 crisis: Every $1 invested in restoring land can lead to returns of $7 to $30 for rural communities. One study cited in the report shows that revitalizing 150 million hectares of the world's degraded agricultural land could create at least $85 billion in economic benefits, $30–40 billion per year in added income for smallholder farmers, and additional food for close to 200 million people. By investing in techniques like agroforestry, silvopasture, and low-carbon agriculture, governments can support sustainable farming that increases the incomes of their constituents.

The benefits of farmland restoration are vast, but they take time to realize. A tree doesn't grow in a day. That's why governments should invest heavily now by redesigning farm subsidies. Every public dollar spent on restoration today avoids far higher costs in the future.

During the United Nations Decade on Ecosystem Restoration (2021–2030), there has never been a better opportunity to repurpose agricultural subsidies. This report offers policymakers the data they need to make the case for reform, and practitioners the practical guidance they need to get on with it.

Ani Dasgupta
President and CEO
World Resources Institute

EXECUTIVE SUMMARY

Conventional agricultural incentive programs are designed to boost food security and alleviate poverty, but they often fail to reach their desired outcomes. Reinvesting underperforming agricultural subsidies to restore degraded and marginal farmland can help farmers grow food—and their incomes—while protecting the environment.

Highlights

- Globally, agriculture is among the largest recipients of government subsidies, estimated at about US$708 billion ($619 billion net transfers) per year between 2017 and 2019.
- Conventional farm supports, while well intentioned, often damage the environment and tend to benefit large farms while neglecting small farmers.
- As government budgets tighten following the COVID-19 pandemic, governments have an opportunity to redirect agricultural subsidies in a way that will better support landscape restoration programs, which can simultaneously meet their economic development, food security, climate, and biodiversity goals.
- Investment in technical breakthroughs that will significantly improve the productivity of farmland and investment in protecting and restoring soil health to sustain that long-term productivity are equally crucial.
- Agricultural budgetary support of $425 billion per year could be repurposed to foster markets that pay farmers for ecosystem services generated on their land. Governments could simultaneously disincentivize deforestation and degradation and help plug the $300 billion to $400 billion annual gap in finance for protecting and restoring nature.
- Every dollar invested in restoration can create up to $30 in economic benefits, in terms of improved ecosystem services, employment, gross domestic product (GDP) growth, and poverty alleviation.
- Incentive design must pay particular attention to poor and disadvantaged smallholder farmers, especially women farmers.

Background

Food security and human well-being are threatened by the ongoing degradation of agricultural land. Modern agriculture, notably since the Green Revolution, has enabled us to produce food at productivity levels unthinkable in the past (Dasgupta 2021). New high-yielding varieties of food grains (especially wheat and rice) were introduced into developing countries in the mid-20th century. Since then, the developing world has witnessed extraordinary growth in yields despite increasing land scarcity and rising land values (Pingali 2012). Between 1960 and 2000, yields across all developing countries rose 208 percent for wheat, 109 percent for rice, 157 percent for maize, 78 percent for potatoes, and 36 percent for cassava (FAO 2004). By 2015, global agricultural production had tripled (FAO 2017a), with positive impacts on food security, economic growth, and poverty reduction.

However, these high yields also require the application of large amounts of chemical fertilizers and pesticides, raising concerns about cost and potential environmental harms, including land degradation and loss of biodiversity and soil carbon (Pingali 2012). About 23 percent of the global land surface is suffering from reduced productivity due to land degradation (IPBES 2019), and each year, about 24 billion metric tons of fertile soil is lost, largely due to unsustainable agriculture practices (GEF n.d.). Cropland soils have lost 20–60 percent of their organic carbon content compared to the soil state prior to cultivation (Olsson et al. 2019). If things continue at this alarming rate, 95 percent of the earth's land area (excluding desert, mountain, tundra, polar, and other areas unsuitable for human use or settlement) could suffer from substantial human impacts by 2050 (IPBES 2018). This, in turn, would lead to crop yield reduction of 10 percent globally on average, and up to 50 percent in certain regions under continuous climate change impacts (IPBES 2018). Consequently, degradation-driven losses in agricultural production, through erosion, soil fertility loss, salinization, and other processes, pose a risk to food security, threatening the well-being of at least 3.2 billion people around the world (IPBES 2018). Food scarcity also makes societies more vulnerable to socioeconomic instability, especially in dryland areas, where years of extreme low rainfall have been associated with an increase of up to 45 percent in violent conflict. According to

estimates, 50 to 700 million people may be forced to migrate by 2050 (IPBES 2018).

Agricultural subsidies sometimes make the problems worse. Land degradation can be avoided through sustainable land and agriculture management. However, current agricultural subsidies are provided in a way that often rewards unsustainable land use and production. For instance, India provides an average of $22.6 billion in input subsidies for irrigation, fertilizers, and electricity every year, accounting for over one-third of its domestic support for agriculture (Glauber et al. 2020). In Indonesia and Brazil, agricultural subsidies are identified as contributing significatively to these countries' losses in tropical forests (McFarland et al. 2015); during one peak, between 2010 and 2012, they were estimated at $27 billion and $10 billion per year, respectively.

Globally, governments spent over $708 billion ($619 billion in net transfers) per year between 2017 and 2019 on agricultural subsidies (OECD 2020a). However, the costs of deforestation and land degradation could be nine times as much as the total subsidy spending, reaching $6.3 trillion a year in terms of lost ecosystem services. These include, but are not limited to, agricultural productivity, the provision of clean air and freshwater, and regulation of the climate (Sutton et al. 2016). In contrast, incentives to encourage the production of more sustainably produced land-based commodities are often low or nonexistent (IPBES 2018). One study shows that revitalizing 150 million hectares of degraded agricultural land around the world could generate at least $85 billion in net benefits to national and local economies, $30 billion to $40 billion a year in extra income for smallholder farmers, and additional food for close to 200 million people (GCEC 2014).

Many agricultural subsidies could be redirected to support more sustainable agriculture and land use. We believe that it is time to encourage the transition to more sustainable land use systems by repurposing public support for agriculture. Change is essential if the world is to grow enough food within planetary boundaries to feed the global population of 9.8 billion people projected by 2050. If designed and implemented properly, public support in agriculture could not only effectively reduce the incentives for unsustainable agricultural expansion and intensification that are harmful to the environment but also provide more incentives to encourage the broad uptake of sustainable land management practices. Sustainable practices include "climate smart" intensification, conservation agriculture, agroecological practices, agroforestry, grazing pressure management, and silvopastoral management. Together, these practices can avoid and reduce degradation of existing croplands and grazing lands, effectively restore soil health, and increase yields on existing land, thus avoiding further agricultural expansion into native habitats.

About This Report

To test this hypothesis, this report, built on a systematic desk-based review, addresses two research questions:

1. Have agriculture subsidies always achieved their intended policy goals?
2. Do alternative incentive schemes other than input and output subsidies exist to increase land productivity and rural income while reducing negative environmental impacts?

The report shows where existing agricultural policy incentives or subsidies have fallen short of their objectives, failing to increase agricultural productivity, boost rural incomes, or improve food security. Additionally, it also demonstrates, through country examples, where innovative policy incentives have effectively encouraged the adoption of sustainable agricultural and land use practices, such as landscape restoration. Restoration practices can improve soil health and lead to a global average increases in crop yields of 2 percent by 2050 compared to a baseline scenario,[1] with significant increase in agricultural productivity in the Middle East and North Africa (10 percent), Central and South America (5 percent), and sub-Saharan Africa (5 percent) (PBL 2021).

We posit that by shifting underperforming agricultural subsidies to protect and restore degraded farmland, they can better support local communities and help countries achieve their climate, biodiversity, and rural development goals. The report highlights programs in Africa, Asia, and Latin America that have followed this path toward sustainability and makes key recommendations intended to help policymakers create balanced and restorative agricultural subsidies. As rural areas recover from the economic crisis caused by the COVID-19 pandemic, restoring degraded farmlands is a win-win for people and nature.

Key Findings

Conventional agricultural incentive programs are designed to boost food security and alleviate poverty, but they often fail to reach their desired outcomes.

- Traditional farm subsidies, such as market price supports, payments based on output, and payments based on the unconstrained use of variable inputs, largely do not improve farm efficiency and productivity per hectare.
- Output subsidies that directly subsidize the incomes of farmers by the produced amount and market price supports that set price floors on key crops often disproportionately benefit large producers. These subsidies can lead to increased food prices, hurting consumers, and therefore should be reformed to better target social and economic gains.
- Subsidies that provide supposedly yield-boosting inputs to farmers, like chemical fertilizers and pesticides, in some cases can encourage farmers to overapply them, harming soil health and long-term crop yields. When these subsidies do not deliver the intended policy goals, they should be considered candidates for repurposing.
- Sometimes these subsidies do not boost farmer incomes at all. Indian fertilizer subsidies have been as high as $15 billion per year (Mustard 2014), but they have not contributed to agricultural growth and poverty reduction since the early years of the Green Revolution. This is because they disproportionately subsidize nitrogen, polluting the water that farmers rely on and lowering crop yields. The result is that soil fertility and crop yields have declined for years.
- In some countries, input subsidies did not increase land productivity as expected. After a period of poor weather and food shortages, the Malawi government created a farm input subsidy program in 2005 that absorbed about 60 percent of the agricultural budget at its peak (Jayne and Rashid 2013). Although the fertilizer increased maize yields at first, its impact (and crop biodiversity) declined over time, all while damaging the soil with inorganic chemicals.
- In other countries, subsidies have incentivized deforestation. Despite their good intentions, several agricultural support programs in Brazil have been linked to the expansion of beef and soy production into forests. For instance, the state-led rural credit portfolio, about 225 billion reais ($61 billion) in 2018–19, accounts for almost 40 percent of the total agricultural production in Brazil (BACEN 2020). These public finance rates are credited with significantly reducing the costs of producing beef in Brazil.

Reinvesting underperforming agricultural subsidies in restoring degraded and marginal farmland can help farmers grow food—and their incomes—while protecting the environment.

- The right agricultural policy incentives can help restore damaged forests and farms, while disincentivizing deforestation.
- Investing in restoration such as agroforestry (trees on farms), silvopasture (trees on grazing land), and low-carbon agriculture (no-till farming and cover crops, for example) is still investing in agriculture and farming, just a low-carbon version that can provide sustainable returns for decades. It can increase per hectare yield gains on existing agricultural lands through restored soil fertility, thereby reducing pressure to expand into existing forests. Additionally, these nature-based solutions can increase water retention in the soil, reduce topsoil losses and erosion, and increase food security.
- Restoration incentives can be provided in the form of payments for ecosystem services, earmarked tax-revenue transfers, and ecological fiscal transfers. These innovative financing mechanisms can help bridge the gap in finance needed to achieve current government pledges to restore more than 210 million hectares of land by 2030 under the global Bonn Challenge, AFR100 in Africa, and Initiative 20x20 in Latin America and the Caribbean.
- Investing in restoring degraded land alone will not meet the challenges of climate change and rural poverty in any country, but it has clear benefits for people and the planet. Targeting agricultural subsidies more effectively can help governments meet their food security, rural development, and environmental goals.

Restoring farmland can help lead a just transition to sustainable rural economies after the COVID-19 pandemic.

- As government budgets tighten following the COVID-19 pandemic, they need to support programs that simultaneously meet multiple goals. Investing in land restoration opportunities has the potential to maximize the effectiveness of agricultural budgets, putting them to work on food security, human well-being, and biodiversity goals. Government stimulus programs that invest in restoring farmland, especially those put in place during and after the COVID-19 pandemic, can accelerate rural economies and create job opportunities in the short run, and boost farmer incomes and help close the climate finance gap in the long run. For instance, one study estimates that, by directing less than 5 percent of the total stimulus to date ($552 billion) into nature-based solutions like land restoration, world leaders could create 7 percent more jobs and 8 percent more short-term domestic economic activity than conventional stimulus spending (Vivid Economics 2020).

Recommendations

This report recommends four key action areas to help policymakers build strong rural economies.

Recommendation #1: Repurpose existing agricultural incentives to work for people and the planet. First, governments should consider reducing or gradually phasing out input subsidies where they deplete soil and do not boost total factor productivity on degraded farmlands. These input subsidies can be replaced with other forms of income support that will encourage farmers to adopt nature-based farming practices. Regenerative agricultural practices, soil conservation, agroforestry, and intercropping can enhance soil quality and water flow, improve yields, and diversify livelihood opportunities for farmers. Second, governments should phase out market price support and output subsidies that encourage the expansion of agriculture into natural forests. Such subsidies discourage technical improvements on existing cropland and reinforce behaviors that lead to degradation, overgrazing, and deforestation. If paired with new subsidies to incentivize nature-friendly intensification on existing farmlands, such programs can increase per hectare productivity and reduce pressure on primary forests.

Recommendation #2: Enable markets for ecosystem services. To incentivize restoration, governments need to step in to help pay people for the services provided by their land. When restoration doesn't pay, it doesn't happen. Governments also need to support and regulate those markets to ensure that the value of ecosystem services is properly reflected in price signals, boost the confidence of both buyers and sellers, reduce transactional risks, and secure long-term income sources for local farmers and communities.

Recommendation #3: Design incentive programs that target smallholder farmers. Existing subsidies often disproportionately benefit large landowners and corporations. Governments must carefully design incentive programs to ensure that they reach smallholder farmers (as intended). To make that possible, governments need to improve recognition of small farmers' land rights by granting them title over ancestral lands. To avoid putting smallholder farmers at a disadvantage, one potential solution is grouping individual farmers together in cooperatives or producer organizations at the community and landscape levels and organizing payments through those intermediaries.

Recommendation #4: Invest in systems to measure progress and enable peer-learning. Examples presented in this report show that some countries have already begun to reform their agricultural subsidies and seen the effectiveness of newly implemented policy incentives. These best practices and successful stories in one country can inspire new policies in other countries through peer-learning, which can encourage senior policymakers to come together to solve challenging problems at the intersection of environment and agriculture. We also encourage policymakers to build systems to track the impact of their policy incentives, remove incentives in places where they have failed to achieve intended policy goals, and reward positive results. Armed with high-quality, locally relevant satellite data, policymakers can adjust their programs to reach more farmers and improve outcomes.

CHAPTER 1

INTRODUCTION

In many cases around the world, agricultural subsidies have not increased land productivity as expected. By shifting these policy instruments to restore degraded farmland and improve soil health, governments can boost crop yields, rural income, and food security in the long run.

The competing needs of agriculture, forestry, and pasture, as well as energy production and the extraction of raw materials, have put increased pressure on land resources (UNCCD 2012). Globally, in 2018 alone, tropical forest area the size of Belgium was lost to agriculture, fire, logging, mining, and other pressures (Weisse and Goldman 2020). Between 2001 and 2015, large-scale agriculture, such as for palm oil, soy, and beef, was responsible for roughly 25 percent of forest cover loss, while smaller-scale agriculture was responsible for approximately another 21 percent (Curtis et al. 2018). Meanwhile, local varieties of domesticated plants and animals are fast disappearing. This loss of diversity poses a serious risk to global food security by undermining the resilience of many agricultural systems to threats like pests, pathogens, and climate change (IPBES 2019).

Today, more than 75 percent of the earth's land is significantly altered by humans, and 23 percent of the global land surface is suffering from reduced productivity due to land degradation (IPBES 2019). This has a major economic consequence: Deforestation and land degradation can harm forest and agricultural productivity, costing the world as much as US$6.3 trillion a year (Sutton et al. 2016).

Historically, agricultural subsidies are the easiest and quickest policy instruments that most countries have used to support rural development. These subsidies seek to increase commodity prices, boost crop yields, improve technical and logistical efficiency in processing and marketing, stabilize supply and prices, and secure employment. However, in many cases, these subsidies did not increase land productivity as expected, and excessive use of farm inputs has accelerated land degradation and harmed soil health in the long run.

Nevertheless, governments in high-deforestation countries continue to heavily subsidize agricultural products that contribute significantly to deforestation through market price supports and production output subsidies (Haupt et al. 2018). They have encouraged the expansion of agricultural and grazing lands at the expense of natural forests. Annual subsidies to the agricultural sector in Indonesia and Brazil—the countries that have suffered the greatest losses in tropical forests since 2000—were estimated at an average of $27 billion and $10 billion, respectively, between 2010 and 2012, representing 3 percent of Indonesia's gross domestic product (GDP) and 0.6 percent of Brazil's at the time (McFarland et al. 2015). However, the deforestation rates in Brazil decreased significantly after 2005 (Silva Junior et al. 2021), partially due to reduced agricultural support, from over 0.7 percent of GDP in 2000–2002 to 0.3 percent in 2017–19, while support to producers decreased from 7.6 percent of gross farm receipts to 1.6 percent during the same period (OECD 2020b). In comparison, Indonesia's primary forest loss continued to increase through 2016 (Forest Declaration 2019), while the country increased agricultural support from 1.4 percent of GDP in 2000–2002 to 3.2 percent in 2017–19 and support to producers increased significantly in the 2000s, from 7 percent of gross farm receipts in 2000–2002 to 24 percent in 2017–19 (OECD 2020b). Additionally, growth in global demand for these agricultural commodities[2] also drives producer countries to increase agricultural subsidies to boost production and supply billions of consumers.

Underperforming Agricultural Subsidies

Despite their contribution to crop yield gains and food security during the 20th century, subsidies for farm inputs, in many cases, have also encouraged the excessive use of fertilizers and the overextraction of water for irrigation. Agriculture is now responsible for more than 70 percent of global freshwater withdrawal, jeopardizing the livelihoods of the two billion people who have trouble accessing enough of it (FAO 2017b).

The overapplication of fertilizers and pesticides on farms can reduce the supply of clean water and further intensify water stress (Boretti and Rosa 2019). This stress is particularly felt in India, where the largest share of budgetary transfers to agricultural producers is to subsidize fertilizers and electricity to pump irrigation water (OECD 2019). Increasing subsidy support for agriculture inputs, however, does not always lead to the expected productivity gains. In 10 sub-Saharan African countries, the costs of input

subsidy programs, which provide farmers with below-market-price fertilizers, range from $0.6 billion to $1 billion a year and account for 14–26 percent of the combined annual public expenditures on agriculture (Jayne et al. 2018). These subsidies did not remove the key constraints to growth of crop productivity. Instead, they further degraded the soil, undermining food security and disproportionally affecting the disadvantaged farmers who are supposedly the target recipients (Jayne et al. 2018).

The few benefits accruing from support programs went in great measure to larger farmers, who also have access to more water and other resources, giving them a head start when applying for new programs. As a result, most of these subsidies have failed to achieve their objective of improving the livelihoods of subsistence farmers or low-wage tenant farmers. Subsidizing the production of staple crops and commodities can discourage farmers from growing foods, including fruit, vegetables, milk, meat, and eggs, that can help them diversify their incomes and provide insurance if the prices of subsidized crops fall (Ramaswami 2019).[3]

This report systematically reviews major forms of policy incentives in agriculture through 18 detailed country examples. We show where perverse agricultural policy incentives have had undesirable effects on agricultural productivity and hindered opportunities for improving rural incomes. We also provide examples of innovative policy incentives that have effectively encouraged sustainable agricultural and land use practices and improved rural incomes. As an important policy recommendation, the report highlights that shifting inefficient agricultural subsidies to protect and restore degraded farmland and pasture can help countries achieve their climate, biodiversity, and rural development goals—all at once. The need for such agricultural subsidy reform is timely, especially when all countries are trying to recover from the economic crisis caused by the COVID-19 pandemic.

Shifting agricultural subsidies to restore land is cost-effective for two reasons:

First, it does not mean that part of the total budget allocation to the agricultural sector will be reallocated to other ministries. Shifting subsidies away from inefficient agricultural production to activities that focus on restoring soil health can ensure the long-term productivity of farmland and improve rural income and food and nutritional security, especially for women-led farming households.

Second, reducing subsidies that promote agricultural expansion will make deforestation less financially attractive to large producers and hence lower the opportunity costs of keeping forests standing. This can reduce deforestation and land degradation, as well as their associated greenhouse gas emissions, and protect forest ecosystems and biodiversity.

To realize these benefits, innovative policy instruments need to be developed. This report sheds light on existing policy innovations (not limited to the agricultural sector) to inspire policymakers to act. It targets five types of stakeholders:

- **The legislative body of a country** that can influence the reshaping of policy initiatives and has the executive power to pass and implement new policy legislation.
- **Staff in finance ministries and government agencies** that are in charge of allocating government budgets and aligning public spending with international policy commitments.
- **Staff in agricultural ministries and agencies** who seek to improve the efficiency of their incentive programs and reduce environmental degradation while increasing agricultural productivity.
- **Staff in environment and natural resource ministries and agencies** whose policies have an impact on rural development and who seek financial resources to support tree-based interventions that restore degraded landscapes and improve land connectivity.
- **Civil society organizations** that work locally to influence governments on agricultural and environmental policies.


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CHAPTER 2

AGRICULTURAL POLICY INCENTIVES AND THEIR IMPACTS

Governments enact agricultural support programs to meet a variety of goals, from boosting crop yields to alleviating poverty. While well-intentioned, these subsidies often undermine policy objectives by reducing farm efficiency and productivity.

This section examines seven in-country case studies that illustrate this, discusses three perverse effects of agricultural policy support, and highlights possible solutions to reverse them.

2.1 Approach and Methodology

This report is built on a systematic review method. We undertook a high-level review of primary research to identify, select, evaluate, and synthesize the findings of high-quality research evidence concerning our particular research questions and make the available evidence more accessible to decision-makers. This report addresses two key questions:

- To what extent have agricultural subsidies achieved their intended policy goals?
- What alternative incentive schemes could improve achievement of agricultural policy goals, such as increasing land productivity and rural incomes, and reducing environmental impacts?

We selected research literature according to a number of criteria:

- Use of ex post economic analyses involving quantitative methods (e.g., randomized control trials) to assess the impacts and effectiveness of agricultural subsidies and alternative incentive schemes (e.g., ecological fiscal transfers, payments for ecosystem services) that have been implemented in different countries around the world.
- Relevant historical data that could show the effectiveness of past policy implementation.
- Geographic coverage to include countries from the global South, including ones in Africa, Asia, and South America, as well as countries in the global North, such as European Union (EU) member states, the United States, and Canada.
- Publication year of the primary quantitative study should ideally be later than 2010 to track the latest research.

To determine the case study countries, we focused on both the largest world economies that have provided the highest agricultural subsidies (e.g., Brazil, China, India, Indonesia, United States, European Union) and the poorest economies that have implemented large agricultural subsidy schemes in recent decades (e.g., Malawi, Mali). We then searched for key words, such as "ex-post agricultural policy assessment," "agricultural subsidies," "effectiveness," "randomized control trial," and "agricultural subsidies," to identify quantitative studies that have assessed the effectiveness of agricultural subsidy programs. In addition, we combined use of "randomized control trial" and "payments for ecosystem service schemes," "innovative financing mechanisms for forest conservation," "impact assessment," and so on, to select quantitative studies that have assessed the effectiveness of innovative incentive schemes in the selected countries.

The reviewed literature included peer-reviewed journal papers; conference proceedings; and research reports published by government agencies, international organizations, and renowned research institutions. We consulted documents published in English, Spanish, and Portuguese, which are the principal languages used in publications of most countries covered in this report.

2.2 An Overview of Agricultural Policy Goals and Forms of Policy Support

Globally, public agricultural support is substantial. Fifty-four countries—Organisation for Economic Co-operation and Development (OECD) members and major emerging economies—provided *net* transfers to their agricultural sectors of $619 billion (€542 billion) per year between 2017 and 2019 (OECD 2020a). Of the total transfers, $425 billion (€373 billion) was earmarked for budgetary spending for various support programs; the remainder was for market price support (OECD 2020a).

Governments enact these programs for a variety of reasons, from boosting crop yields and food security to alleviating poverty. Table 1 summarizes key agricultural policy goals as well as different forms of policy support available to help deliver them. Across economies, three main cross-cutting agricultural policy goals are common (even though the concrete objectives may vary in practice): higher farm incomes, improved crop productivity, and rural development.

Governments may also prioritize different policy goals over time, depending on the major challenges they are facing at a given time. For instance, at an early stage of a country's economic growth, retaining self-sufficiency in food-grain production and ensuring adequate farming supplies at affordable prices are important for food and nutritional security, poverty alleviation, and sustainable development (Hoda and Gulati 2013). When the economy is transitioning to a fast-growing phase, governments often shift agricultural policy goals to focus more on structural reforms that can improve farmer incomes (DACFW 2020). By contrast, in more developed

economies, agricultural goals are geared toward improving agricultural income, reducing income equality between rural and urban populations, and protecting the environment.

In pursuit of these policy goals, governments exercise different forms of policy support as listed in Table 1. For instance, in most countries, market price support and tariff protection are used in combination to encourage domestic production in order to benefit local farmers or increase food security (Searchinger et al. 2020). Depending on a government's experience and capacity and the political context, one form of support may be preferred over another.

Developed economies have been gradually shifting from market price support policies that are tied to production (and distort prices on the international market) to environment-based payments that encourage more sustainable farming practices. Traditionally, market price support programs are the core of income transfers that the U.S. government directly provides to farmers. Researchers have found, however, that such payments distort market prices for commodities like maize, soybeans, wheat, rice, cotton, milk, and sugar (Smith 2018; Glauber et al. 2020). Countries have learned from that experience. Between 1986 and 2016, for example, the EU Common Agricultural Policy replaced market price support with performance-based payments tied to environmental protection (Glauber et al. 2020). This has led to a drop in market price support from 92 to 27 percent, a reduction in nitrogen oxide emissions from fertilizer use by 17 percent, and an increase in average crop yield of 28 percent (Laborde et al. 2019). Similarly, Japan replaced price supports with price-based countercyclical income support tied to production-limiting provisions (Glauber et al. 2020).

By contrast, developing economies tend to subsidize inputs that boost crop yields, like chemical fertilizers and pesticides, to help smallholder farmers achieve self-sufficiency and food security. The largest input subsidies are provided through policies that govern the supply of fertilizers, electricity, and water (Wossen et al. 2017; Glauber et al. 2020). For instance, India provides an average of $22.6 billion in input subsidies for irrigation, fertilizers, and electricity every year, accounting for over a third of its domestic support for agriculture (Glauber et al. 2020). In Nigeria, the e-Voucher-Based Input Subsidy Program has provided a 50 percent subsidy on a 50-kilogram (kg) bag of fertilizer and a 90 percent subsidy on a 50-kg bag of improved seeds for maize or rice (Wossen et al. 2017). In Mexico, the Rural Development and Agriculture Ministry created the Programa de Fertilizantes (Fertilizers Program) in 2019 with an initial budget of 1.5 billion pesos (around $75 million) to support smallholder farmers owning land of five hectares or less who grow priority crops (maize, beans, and rice). Each such farmer can receive up to 600 kg of fertilizer per year.

Table 1 | An overview of agricultural policy goals and forms of policy support

AGRICULTURAL POLICY GOALS	DIFFERENT FORMS OF POLICY SUPPORT
■ Achieving high levels of self-sufficiency in production ■ Ensuring domestic food security and livelihoods ■ Improving income from agriculture with more equitable distribution among farmers ■ Reducing income inequality between rural and urban areas ■ Increasing agricultural productivity ■ Improving efficiency in the processing and marketing chain ■ Ensuring supply and price stability ■ Improving rural development ■ Improving environmental performance ■ Increasing export and employment, reducing costs, and adding value to raw crops ■ Poverty alleviation and sustainable development	■ Concessional loans and rural credit lines ■ Market price support ■ Import and export tariffs ■ Interest-rate subsidies ■ Production input subsidies ■ Tax rebates (or exemptions) ■ Performance-based payments ■ Production output subsidies ■ Insurance against lost income for producers or processors ■ Public investments in supply chain infrastructure or equipment

Sources: Hoda and Gulati (2013); Glauber et al. (2020).

As of October 2020, the program had benefited over 340,000 smallholder farmers, of whom 43 percent were women (SADER 2020).

Additionally, other inputs such as seeds, machinery, credit, and crop insurance are also supplied at subsidized prices. Rural credit in Brazil is the main source of financing for agriculture, at around $40 billion annually. However, only about 12.5 percent of that credit is subsidized, while the remaining serves as a guarantee fund to support agricultural lending (BACEN 2020). Agricultural support tied to production and prices is also common in many developing countries (e.g., China), but the primary goal is to promote high levels of self-sufficiency.

2.3 The Unintended Consequences of Agricultural Policy Support: Country Case Studies

Conventional agricultural incentives often inadvertently lead to undesirable outcomes. More than half of the market price support, payments based on output, and payments based on unconstrained variable inputs are found to be *negatively* associated with farm technical efficiency and total factor productivity (DeBoe 2020).[4] This is because such policy support can directly affect farmers' choices of what to produce and how to produce it. It also reduces incentives to produce efficiently or adopt productivity-enhancing innovations. Evidence has shown that input subsidies often distort production choices in favor of subsidized input use and away from technically efficient input combinations (DeBoe 2020).

Subsidies provided to traditional agriculture can inhibit the adoption of a more diversified production structure, which is essential for raising rural incomes in the long run, by discouraging farmers from growing alternatives to core staple crops (Ramaswami 2019). Income support policies, such as subsidies tied to inputs and outputs, can incentivize agricultural expansion that clears marginal land for agriculture, converts fallow or low-intensity agricultural land uses toward more intensive uses, and overapplies pesticides (DeBoe 2020).

Below we review in-country agricultural subsidy programs to illustrate where agricultural policy support has led to unintended outcomes that undermine the policy objectives of productivity, sustainability, and resilience. We also discuss trade-offs between policy effects on the environment and the rural economy and identify where policies have helped and harmed farmers and ecosystems.

India

India has increased the production capacity of its agricultural sector through a high level of intensification that has relied heavily on government input subsidies for water, power, and fertilizer.

First, Indian fertilizer subsidies have been as high as $15 billion per year (Mustard 2014). **However, these subsidies have inefficiently contributed to agricultural growth and poverty reduction after the early years of the Green Revolution** (Searchinger et al. 2020). This is because they more heavily subsidize nitrogen than other nutrients, including micronutrients, resulting in an inefficient balance of fertilizer application (Gulati and Banerjee 2015).[5] That fertilizer can pollute water with nutrients, which reduces the total amount of surface- and groundwater suitable for agricultural use and leads to yield reductions (Mali et al. 2015). **This phenomenon has had an adverse, long-term impact on soil fertility, resulting in observed reductions in the response of crop yields to increased fertilization (Huang et al. 2017).**

Second, half of India's arable land is irrigated (Searchinger et al. 2020), supported by large electricity subsidies of up to $12 billion per year as well as by free access to water (Mustard 2014). These subsidies, which cover 85 percent of the average cost of water, are critical for maintaining farmers' incomes, especially among the rural poor (Badiani and Jessoe 2019; Ramaswami 2019). But they also increase demand for already stretched groundwater resources that are abused over much of India, encourage the production of water-intensive cash crops in arid and other water-stressed areas, and have the potential to reduce agricultural output in the long run (Ramaswami 2019). Badiani and Jessoe (2013) investigated the impacts of changes in agricultural electricity subsidies on groundwater extraction and found that **a 10 percent reduction in the average subsidy, which amounts to roughly a 50 percent increase in the subsidized price of electricity, would lead to a 6.6 percent reduction in water extraction.**

As a solution, these electricity subsidies need to be restructured to encourage the efficient use of power and groundwater

and curtail aggregate groundwater withdrawals. Additionally, restructuring these subsidies can allow farmers to decide whether to change to more drought-resilient crops, invest in water-saving technologies, or both. For instance, in response to the alarming depletion of water resources, key stakeholders, such as the National Bank for Agriculture and Rural Development (NABARD), have called for realigning cropping patterns and shifting policy goals from increasing land productivity to boosting the efficiency of water use (Sharma et al. 2018). However, such measures may require high capacity-building costs and strong political will to support their implementation. Some governments have started: Two Indian states with diminishing groundwater resources, Punjab and Haryana, have begun trying to incentivize farmers to replace water-intensive crops, like paddy rice, with maize or other less water-intensive crops. The impact of this shift remains to be seen.

In the last few years India has also announced schemes like the National Energy-Efficient Agriculture Pumps Program, or Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). PMKSY consists of two central policies, the Per Drop More Crop program (Minor Irrigation) and the Micro Irrigation Fund, which promote water-use efficiency in irrigation by subsidizing microirrigation techniques (Beaton et al. 2019). There are also innovative schemes that seek to provide income to farmers who conserve water. At present, a related scheme operates in India through the Pani Bachao, Paisa Kamao ("save water, make money") program, linked to the consumption of electricity by rural households. The current scheme allocates a certain number of kilowatt-hours of electricity to a farmer. If farmers do not use all of their allocation, the government pays them for what they save (PSPCL 2019). In this way, farmers are incentivized to save water but at the same time need not lose income. The long-term impact of these schemes, such as the Kisan Urja Suraksha evam Utthaan Mahabhiyan–funded programs, on reducing resource depletion has yet to be analyzed (World Bank 2020).

Malawi

Malawi's Farm Input Subsidy Program (FISP) was introduced in 2005 and administered through a series of coupon vouchers that enabled households to purchase fertilizer, hybrid seeds, and pesticides at greatly reduced prices. The program gave priority to vulnerable groups, especially households headed by women. Each voucher entitled a household to 50 kg of maize fertilizer at 8 percent of the market price, along with free seeds—either 2 kg of hybrid maize seeds or 4 kg of open pollinated variety seeds (Holden and Lunduka 2013).

Regarding FISP's effectiveness, Chibwana et al. (2014) show that maize yields are positively associated with the amount of fertilizer used (but at decreasing rates). This suggests that fertilizer subsidies may boost yields to a certain level but then growth in yields declines, constrained by the capacity of soil to absorb and respond to fertilizers. The overapplication of fertilizer may also damage soil quality in the long run and accelerate erosion. The same study also suggests that if the subsidies had been shifted from fertilizers to support sustainable farming practices, such as promoting more productive hybrid seeds, the program would have doubled the maize yields from the previous level (447 kg/hectare). Government interventions can facilitate economically efficient allocation of resources by allowing the sale of seeds to their most productive use through market allocation.

Regarding FISP's impacts on forest losses, the results are mixed. Although fertilizer subsidies may have reduced land clearing in many areas as a result of agricultural intensification, they were also applied to more profitable cash crops such as tobacco, which led to tree clearing to build drying sheds for tobacco, reducing landscape connectivity.

As far as the distributional effects are concerned, the subsidy program largely benefited those with sufficient land to become eligible for the subsidized seed and fertilizer. Few vulnerable farm households took advantage of the program. Households led by women were the intended recipients but were found to be less likely to benefit from the program than households led by men. This may be because women are not perceived as more deserving farmers in their communities or because they may have less bargaining power with the village chiefs who distribute the subsidies (Chibwana et al. 2014). Additionally, resource-poor households in the two communities included in the experiment tended to benefit less, as they were not the primary beneficiaries of subsidized inputs.

Mali

Rice in Mali is almost exclusively farmed by women and used for households' own consumption. Only about 30 percent of women use fertilizer, even with government price subsidies of around 33–43 percent. Beaman et al. (2013) analyzed the impacts of subsidized fertilizer on yields from women-controlled plots in southern Mali. There was no evidence that profits increased with greater fertilizer application. This is partly because in order to maximize outputs, women would need to reallocate their spending to buy additional inputs, like herbicides and hired labor, instead of pocketing the savings. **This finding suggests that subsidies targeting fertilizer might not always generate the income improvements their proponents expect**, as other inputs that women buy may be more costly than fertilizer per unit of increased yield. That reduces their total profit margin.

Providing subsidized fertilizers may seem like a straightforward way to make inputs more affordable to the poorest farmers and boost yields, but they have mixed results, especially among the poorest smallholder farmers. An alternative low-cost, but likely more effective, solution is to grow native plant species that can improve soil fertility on farms. For instance, the Sahelian Areas Development Fund Program (FODESA) and World Agroforestry Centre (ICRAF) launched a parkland agroforestry initiative in Mali that grows native trees with staple food crops, such as millet and sorghum. The initiative promotes soil fertility and water conservation while increasing access to native tree species that provide food, medicine, fuel, and building materials to locals. As of August 2014, the initiative had made one of its greatest impacts by growing *bourgou*, a native, nutritious grass used to feed livestock, and by leading to the planting of 4,562 kilometers of hedges and 36 hectares of a mix of local and nonlocal tree species (Foodtank 2014).

Zambia

Until the early 1990s, the government offered subsidized maize inputs to farmers on credit, purchased maize from farmers at a fixed price, and sold the maize to consumers at subsidized prices. This program was replaced in 2002 by a large-scale, targeted maize-fertilizer subsidy program, the Farmer Input Support Program (Smale and Jayne 2003). The aims of FISP are to improve household and national food security, incomes, and access of small-scale farmers to agricultural inputs.

The government spent approximately $184 million, equivalent to 0.8 percent of the country's GDP, to provide nearly 182,500 metric tons of fertilizer and 9,000 metric tons of hybrid maize seeds to participating farmers at subsidized prices (Jayne and Rashid 2013). Zambian smallholder farmers use approximately 96 percent of their fertilizer on maize. However, the majority (55 percent) of FISP fertilizer went to the wealthiest 27 percent of households, which cultivate larger areas (Mason et al. 2013). The program encouraged farmers to convert fallow land to active farms but produced very limited impact on productivity gains, partly because maize did not respond well to the fertilizer. As a result of low maize-fertilizer response rates, poor targeting, crowding out, and diversion of fertilizer intended for the program, program losses for FISP (i.e., program costs minus benefits of incremental maize production based on their estimates of crowding out or leakage and maize-fertilizer response rates) were substantial, ranging from $39.8 million to $71 million (equivalent to 7–13 percent of total public expenditures in the agricultural sector) for the 2010 and 2011 crop years, respectively (Mason et al. 2013). **This suggests that FISP fertilizer did not achieve its intended policy goals of improving household income and increasing accessibility to agricultural inputs for smallholder farmers.**

Zambia's fertilizer program also resulted in more severe soil degradation, threatening the land's long-term productivity. The program reduced the extent of leaving land fallow for short periods of time and mixing maize with other crops, both of which contribute to the long-term maintenance of crop production and soil fertility (Morgan et al. 2019). At the same time, subsidized maize fertilizer encourages monoculture and continuous cultivation on the same plot, both of which are known drivers of soil degradation and the proliferation of crop-specific pests. In other words, Zambia's maize-fertilizer subsidy program may have disincentivized sustainable intensification rather than promoted it. Similar evidence was also reported by Holden (2001).

Brazil

The state-led rural credit portfolio, which was worth roughly 190 billion reais ($40 billion) in the 2019–20 agricultural year (BACEN 2020), has supported almost 40 percent of the total agricultural production in Brazil. The level of subsidized rural credits has declined compared to its peak in the 1970s (Assunção and Souza 2019) and since 2012 access to rural credit additionally requires compliance with the Environmental Rural Registry, a mandatory digital registration (OECD 2020b).

From the mid-1960s to the 1980s, a combination of subsidies for production drove Brazilian agricultural expansion. These included subsidized rural credit for working capital and investments in machinery through the National Rural Credit System, regulated minimum producer prices, the development of regional limestone production centers,[6] and significant government investments in infrastructure and logistics. It also included induced demand for agricultural products as a result of import substitution policies, such as Proalcool, which aimed to produce ethanol from sugarcane to replace some of the imported gasoline used in the country's passenger cars (Dias and Amaral 2001).

Broad programs were established to encourage workers to migrate to less populated areas, increase production and productivity, develop economies in rural regions and states, and increase demand for commodities (such as biodiesel) derived from soy (McFarland et al. 2015).

The provision of this subsidized rural credit peaked at approximately 237 billion reais in 1979 (converted to 2020 reais, approximately $50 billion) (Santana and Nascimento 2012) and then declined sharply in the late 1980s as a side effect of macroeconomic decisions aimed at combating inflation (Helfand and de Rezende 2015). In the mid-1990s, the government resumed inflationary control and brought the amount of credits back to the current level, which is equivalent to 78 percent of 1979's peak level, but their share in the total subsidies provided by the government has shrunk sharply. Today, rural credit in Brazil's official system, formalized annually in the Plano Safra, plays a much more important role as a financial guarantee[7] for production than do direct subsidies themselves.

Currently, Brazil provides one of the lowest levels of subsidies as a percentage of the value of its output, measured at 3.2 percent, compared to the world's leading producers of agricultural commodities, such as Japan (55 percent), the United States (27 percent), the European Union (25 percent), China (15 percent), and India (2.7 percent) (OECD 2020b). In 2019, subsidies for agriculture totaled $708 billion (net transfer $619 billion) worldwide, half of which were provided in the United States and the European Union, while China, Japan, and India together accounted for 45 percent. Subsidies in Brazil reached only $5 billion (OECD 2020a). Policies that guarantee minimum producer prices in Brazil are much stricter than in Europe in both the total amount of subsidies and the number of crops supported (CONAB 2017).

However, despite the low level of agricultural subsidy support, the production of beef and soy in Brazil has continued to grow rapidly in recent decades, largely due to the abundance of cheap land converted from forest. Additionally, cheap land resources, partially caused by low purchase prices and land property taxes (another form of policy support), are a major driver (in some regions of Brazil) of the country's low level of technical efficiency in agricultural production, in comparison to the leading producers of agricultural commodities globally (Stabile et al. 2020).

Additionally, agriculture subsidies have disproportionally benefited large producers in Brazil, despite some supposedly being made to support the investment of small farmers. For instance, the credit provided to farms with less than 10 hectares corresponded to 6 percent of the value of production, whereas the loans granted to large farms (i.e., those with more than 10,000 hectares) were equivalent to 75 percent of the production value (Santana and Nascimento 2012). Different from the United States, interest relief financed by tax guidance was limited to fewer credit lines aimed at the poorest producers or smallholders (BACEN 2020).

Ecuador

Between 1990 and 2010, about 99 percent of deforestation in Ecuador was driven by conversion to agricultural land, mostly for intensively farmed monoculture crops and livestock (Castro et al. 2013). Palm oil production is a leading

contributor to deforestation, especially in primary tropical forests. The amount of land area under oil palm cultivation increased by approximately 78 percent between 2000 and 2013. Exports of palm oil increased by 30 percent between 2008 and 2013 (Kissinger et al. 2015) and reached 60 percent of the country's crude palm oil production in 2019 (Chain Reaction Research 2019).

Ecuador has implemented 27 tax and financial incentives in the agricultural sector, including grants, tax concessions, and preferential lending rates (Kissinger et al. 2015). They are all intended, to some extent, to encourage palm oil production, with apparently no consideration given to the effects the program can have on deforestation, degradation, or conservation of carbon stocks (Kissinger et al. 2015).

At the beginning of June 2020, Ecuador's National Assembly overwhelmingly passed the Oil Palm Law. The new legislation establishes mechanisms for the commercialization of palm oil, which could include price stabilization, the creation of a technical committee to promote the sector, and a series of sanctions for noncompliance with the environmental regulation. However, experts say that the law ignores the true environmental and social context of palm oil cultivation, including its impacts on nearby communities, the contamination of water sources, deforestation, and soil degradation (Borja 2020).

In fact, most of the incentives and policy supports are weighted toward producers to help reduce production costs, and some are geared toward crop intensification and improving productivity. No incentives require that producers conserve the environment as a condition for receiving support. While most fiscal incentives developed in Ecuador have aimed to improve both productivity and yields, increases in production have come from expanding the size of oil palm farms, while each farm's productivity has generally declined (Kissinger et al. 2015).

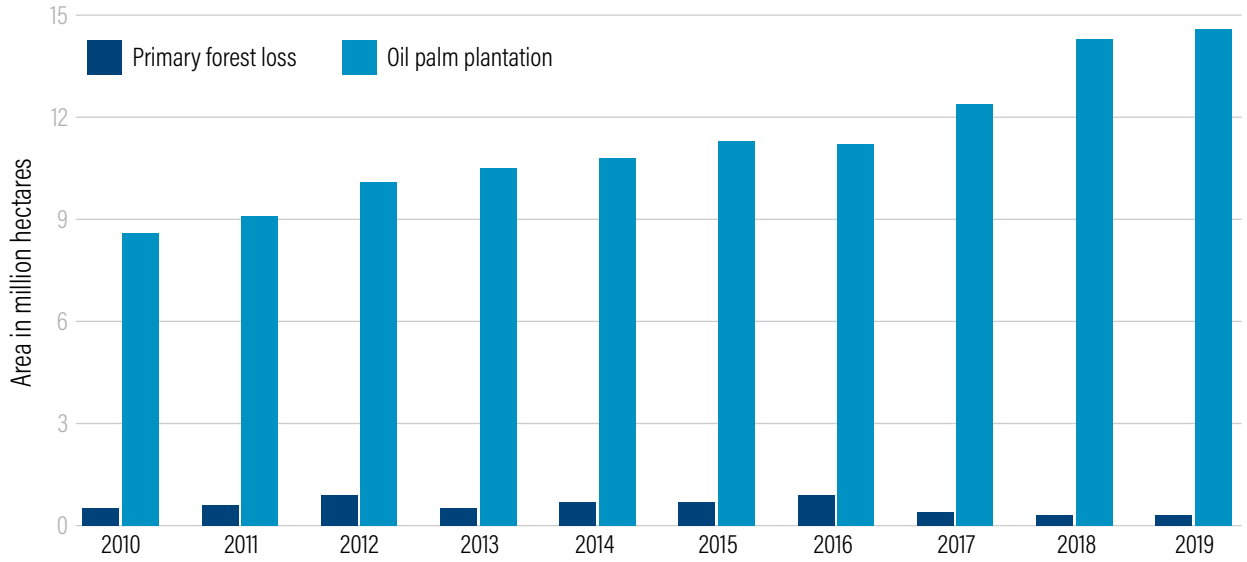
Seven out of the 27 identified incentives are linked to a high probability of deforestation, as they are provided to producers in the form of subsidies or tax exemptions for fertilizers, pesticides, and credit lines that support access to or acquisition of rural land. The money that companies save by paying lower taxes will be more likely spent on purchasing land rather than directed toward more environmentally and socially sustainable production. **These programs in turn can accelerate deforestation and soil degradation, which jeopardize long-term agricultural productivity and affect the livelihoods of local communities that are surrounded by oil palm plantations.**

Indonesia

In 2010, the government of Indonesia signed a $1 billion deal with Norway to curb carbon dioxide (CO_2) emissions by preserving Indonesia's rainforests. Consequently, Indonesia passed legislation protecting over 69 million hectares of primary forest and deep peatlands from land use change under the Forest Moratorium, while allowing palm oil expansion across primary forests already licensed and forests degraded by logging (Lim et al. 2019; Busch et al. 2015). In particular, Indonesia developed a number of economic development objectives, such as the Masterplan for the Acceleration and Expansion of Indonesia's Economic Development, which covers 2011–25, with a focus on expanding palm oil production and timber harvesting (Government of Indonesia 2011). Indonesia's total agricultural support amounts to around 3 percent of GDP per year, with support to agricultural producers increasing significantly in the 2000s, from 7 percent of gross farm receipts to 24 percent (OECD 2020a). Every year, nine agricultural subsidies valued at $20.4 billion have, to some extent, contributed to increasing palm oil production (McFarland et al. 2015).

In short, Indonesia made nominal commitments to addressing forest loss, while it pursued economic development plans that subsidized commodities driving forest loss. Although additional research is required to determine the links between specific subsidies and forest loss, evidence suggests that rural credits, tax exemptions, and concessional loans for investors and smallholders have encouraged further investment in palm oil production to the detriment of natural forests. For example, between 2002 and 2020, Indonesia lost a total of 9.75 million hectares of primary intact forests (Global Forest Watch n.d.), whereas oil palm plantations increased from 2 million hectares in 2000 (FAO 2019) to 14.6 million hectares in 2019 (Statista n.d.), becoming the largest single driver of the country's deforestation in the same period (Austin et al. 2019). Figure 1 shows primary forest cover loss and oil palm expansion since 2010, after the signature of the forest protection deal with Norway. Between 2006 and 2013,

Figure 1 | Land cover change in Indonesia



Sources: Global Forest Watch (n.d.); Statista (n.d.).

a total of 213,852 hectares of oil-palm estates were financed directly through the Credit for Bioenergy Development and Estate Revitalization (Pramudya et al. 2017).

In Indonesia, government finance schemes have been consistently used to promote economic development rather than to achieve a balance between economic development, environmental protection, and social equity (Pramudya et al. 2017). Support for palm oil production in Indonesia occurs through both subsidies targeted specifically at palm oil production and broader support of the agricultural sector or general economic development (McFarland et al. 2015). However, most of the subsidies have gone to large palm oil companies. It is estimated that between 2015 and 2019, the government fund collected 47.2 trillion rupiah ($3.3 billion) in revenue and handed 71 percent of it back to biodiesel producers and less than 5 percent to small farmers for a forest restoration program (Jong 2020).

Despite the economic development objectives, agricultural subsidies have not contributed to the Indonesian economy as expected. Research has found that of all the economic sectors in Indonesia, the agriculture, animal husbandry, fishery, and forestry sectors (which include palm oil and timber) pay the lowest levels of tax in relation to their contributions to GDP across all sectors, a gap of over $14.5 billion per year in comparison to the average (Prastowo 2014; McFarland et al. 2015).

2.4 Three Lessons Learned from Past Agricultural Subsidies

The previous section highlighted evidence from developing countries that the agricultural support tied to certain commodities were not achieved as much income growth, poverty reduction, productivity gains, or rural development as expected. At the same time, these subsidies exacerbated environmental problems. In some cases, food security and rural development goals were advanced at the expense of groundwater overextraction, soil degradation, and deforestation. In this section, we identify three perverse effects of agricultural policy support and then discuss the possible policy solutions to reverse them.

#1: The perverse effect on rural income and poverty

Agricultural supports, such as price support payments and trade barriers, are often implemented to bolster rural development efforts intended to boost the incomes of small farmers. In practice, the evidence suggests that such supports typically benefit larger farms or wealthier landowners, reducing the likelihood that smallholder farmers will increase their productivity (Searchinger et al. 2020; Chaturvedi et al. 2019). For example, in the United States, the top 3 percent of family farms (in terms of household wealth) received more than 30 percent of the agriculture subsidies and insurance payments (Bakst 2018). In Europe, 80 percent of support goes to the 20 percent wealthiest farmers (EU Factcheck 2020).

In many countries of Africa, fertilizer subsidies have been provided ostensibly to help the poor access technology, expand agricultural output, and reduce poverty. However, an analysis published in 2002 found that only half of the poor farmers in Benin and Kenya benefited from fertilizer subsidies in the 1990s, and in sub-Saharan Africa as a whole, only one-third of the poor farm households benefited (Kherallah et al. 2002). Similarly, Malawi's input subsidies program has mostly benefited larger landowners, with only a few small farming households receiving them (Chibwana et al. 2014). In Brazil, a comparison of the last two agricultural censuses (2006 and 2017) shows that access to public subsidies concentrates land ownership and exacerbates inequality in rural areas (IBGE 2009; IBGE 2019). And in Indonesia, in response to the COVID-19 crisis, the Indonesian government allocated $195 million in July 2020 to subsidize large producers of palm oil biodiesel over smallholder farmers (Jong 2020).

Solutions for effect #1

Policymakers should reform existing agricultural subsidies to strengthen food security and promote more rewarding rural livelihoods. Policy solutions that aim to improve the distribution of agricultural subsidies and farmers' incomes should pay particular attention to three factors (Kherallah et al. 2002; Searchinger et al. 2020). First, a lack of cash and credit has limited the adoption and use of fertilizer among the poorest farmers with low cash income. Second, fertilizer use tends to be concentrated in the high-potential zones with greater rainfall and better soils, which are often the places with economic advantages as well. Third, the lack of land ownership among smallholder farmers also has constrained their eligibility to receive aid, as subsidies tied to outputs or inputs (for seeds, fertilizer, water, electricity, etc.) are designed to reduce costs for landowners.

In response, policy design must incorporate mechanisms that can ensure that subsidy benefits effectively reach the intended program beneficiaries. Governments can consider raising the overall supply of formally traded fertilizer in economically disadvantaged areas to increase access. But it is equally important that governments assume a role in facilitating distribution of fertilizer to some of the poorest and most remote areas and providing technical assistance to encourage adequate application of fertilizer on individual farms. Moreover, more rigorous participation requirements and limits on subsidized fertilizer distribution may be needed to ensure that small and marginal farmers can access the program. Finally, governments need to continue efforts to improve recognition of land rights for small farmers.

#2: The perverse effect on agricultural production and profitability

In some countries, input subsidies did not increase land productivity or boost the bottom line as expected due to the high costs of other chemical inputs that need to be coupled with fertilizer application. For instance, in Mali, even with government price subsidies at around 33–43 percent, increased fertilizer application did not increase farmers' profits from rice, because they needed to buy other supplementary inputs that are more costly than fertilizer and thus reduced their profit margins. Evidence from other African countries also shows that fertilizer subsidy programs can be expensive for the government, and the fiscal and administrative burdens of subsidized fertilizer distribution in the 1970s and 1980s far exceeded those associated with other inputs (Kherallah et al. 2002).

In other cases, while the impacts of subsidized fertilizers and other inputs on yields are largely positive, they pursue short-term gain at the expense of long-term sustainability and prosperity. African governments spend more than $1 billion a year on input subsidy programs, yet the returns from these programs have been disappointingly low in several countries due in large part to poor crop responses to inorganic fertilizer (Jayne and Rashid 2013; Jayne et al. 2015). More specifically, Malawi's FISP spent about 60 percent of the total agricultural budget to provide inputs to farmers at affordable prices (Jayne and Rashid 2013). Although the subsidized fertilizer helped increase maize yields at first, the gains in land productivity declined over time due to soil damage caused by inorganic chemicals. Similarly, India spends $15 billion per year to subsidize fertilizers (Mustard 2014). However, these subsidies have not contributed to agricultural growth and poverty reduction as much as expected since the early years of the Green Revolution (Searchinger et al. 2020). In part, this is because they disproportionately subsidize nitrogen, which pollutes the water that farmers rely on, leading to the long-term decline of soil fertility and crop yields.

Solutions for effect #2:

Policy responses should limit fertilizer use in places where the marginal gains of agricultural production are low and soil degradation is already severe. Applying fertilizers in these places is associated with economic inefficiency, that is, low returns for high-cost subsidy programs due to the low yield responses to inorganic fertilizer.

The money saved from a switch to a more targeted fertilizer subsidy program could be reinvested to support sustainable farming practices, such as restorative agriculture or soil-conservation measures to help farmers maximize productivity levels while reducing chemical inputs. This can restore soil health and increase future yields while safeguarding livelihoods (WEF 2020). Restorative agriculture has its pros and cons. Due to the long time needed for soil to restore itself, it must be practiced in combination with other technical solutions, such as the use of hybrid seeds, which could also boost yields in the short term to feed local people and secure rural income.

Finally, reducing the concentration of price support to individual commodities could improve both the sustainability and the market efficiency for food and agriculture. Significant progress has been made in developed regions, such as the European Union, which has cut back price-support measures in favor of direct payments over the past decades.

#3: The perverse effect on the environment and sustainable rural development

Although policy support for the delivery of public goods is essential, support that distorts markets can undermine the achievement of public policy goals if it exacerbates negative environmental impacts by, for example, increasing deforestation or greenhouse gas emissions, promoting the unsustainable use of natural resources like water, or harming biodiversity (Glauber et al. 2020).

Subsidizing fertilizers and support for other inputs, such as electricity and water, can lower the price paid by farmers and lead to inefficient use and overexploitation of those resources. In India, for example, electricity subsidies of up to $12 billion per year cover 85 percent of farmers' water costs. This reduced water cost has encour-

aged the extraction of groundwater for irrigation and increased pressure on fragile aquifers.

Additionally, subsidies have promoted the intensification of rice and wheat at the expense of other cereals and crops and damaged natural ecosystems. Zambian farmers received subsidized fertilizer and hybrid maize seeds at only 25–50 percent of the market price, which encouraged farmers to intensify cultivation by clearing more fallow land, where natural vegetation is essential for maintaining yields and soil fertility on farms.

Agricultural incentives to promote soy, beef, and timber production also have led to large-scale land conversion from natural forests to agricultural land in tropical forest countries such as Brazil, Ecuador, and Indonesia. For instance, in Brazil low property taxes for agricultural land (another form of policy support) have encouraged forest conversion to agricultural uses. As we discussed above, Ecuador has implemented 27 tax and financial incentives in the agriculture sector, 7 of which are linked to deforestation, as they make it easier to acquire rural land and purchase fertilizers or pesticides. In Indonesia, despite national commitments to reduce forest loss, subsidies have encouraged further investment in palm oil production, a major driver of deforestation. Between 2002 and 2020, Indonesia lost a total of 9.75 million hectares of primary intact forests (Global Forest Watch n.d.), whereas oil palm plantations increased from 2 million hectares in 2000 (FAO 2019) to 14.6 million hectares in 2019 (Statista n.d.).

Agricultural support may also discourage the adoption of sustainable land use and management practices. In Brazil, the Rural Territorial Tax Imposto Territorial Rural; ITR) has disincentivized landowner investments in improving yields on their land. With the ITR amounting to less than $1 per hectare per year for each hectare of land cleared, the marginal cost of obtaining one additional hectare of deforested land has become much cheaper than the investment required to increase productivity. In the United States, an increase in government payments as a share of farm revenues between 1982 and 1992 was found to increase soil erosion by 0.55 tons per acre (Goodwin and Smith 2003).

Solutions to reverse perverse effect #3:

To reverse these perverse effects, governments should attach environmental conditions to any agricultural subsidies to prevent deforestation and the excessive use of fertilizer. Assunção et al. (2020) examined the impacts of credit constraints introduced in 2008, when the provision of rural credit in the Brazilian Amazon was made conditional on meeting stricter legal and environmental requirements. By looking at deforestation between 2003 and 2011, their study found that conditions on rural credit curbed deforestation, especially in municipalities where cattle ranching is the main economic activity.

The European Union's Common Agricultural Policy reduced market price support from 92 to 27 percent of the value of its agricultural produc-

tion between 1986 and 2016 while gradually increasing support for agroecological programs. As a result, nitrogen oxide emissions from fertilizer use fell by 17 percent and yields increased by 28 percent over the same period (Laborde et al. 2019). Currently, the United Kingdom is shifting its agricultural support policies from area-based agricultural support to payments for environmental land management (FOLU 2021). China is also phasing out support for fertilizers and learning how to avoid the overapplication of fertilizer without compromising yields (FOLU 2019). These measures will help improve soil fertility and protect natural pollinators, both of which can improve agricultural productivity.

At the same time, governments could incentivize agricultural productivity gains through farming practices like sustainable soil management that can also reduce negative environmental externalities. A good example is Brazil's Low-Carbon Agriculture (Agricultura de Baixo Carbono; ABC) Plan, released in 2010. The ABC Plan includes a low-interest loan program for sustainable intensification and encourages the restoration of degraded pasture, the adoption of no-till cropping systems, and integrated crop-livestock-forestry systems (Searchinger et al. 2020). The program is also expected to avert deforestation and reduce methane emissions per kg of beef produced. During its first phase of implementation, visible environmental improvement has been observed. As of 2018, more than 4 million hectares of degraded pasture were recovered, about 5.8 million hectares of farmland have adopted integrated crop-livestock-forestry, and a no-tillage systems was adopted on nearly 10 million hectares of farmland, contributing to a CO_2 emission reduction of between 100 and 154 million tons (Souza Piao et al. 2021). The ABC Plan was expanded in the 2020–21 season, reducing loan interest rates to their lowest levels since the plan was launched.

Alternatively, governments can increase credit for restorative agriculture in places particularly vulnerable to the effects of climate change. They can also raise credit limits and facilitate access to capital for producers who comply with environmental regulations. Policies such as attaching sustainability requirements to credit eligibility have possibly reduced forest clearance, but they have not always served the purpose of supporting farm incomes (Searchinger et al. 2020), particularly where the cost of meeting the sustainability requirements has exceeded the benefit of the subsidized credit. Vulnerable farmers' short-term outlook leads them to prioritize near-term goods like food security over longer-term goods like soil health. Balancing near- and long-term needs is central to policy reform efforts.

CHAPTER 3

REINVESTING UNDERPERFORMING SUBSIDIES IN FARMLAND RESTORATION

Although landscape restoration interventions can generate key economic and environmental benefits for the agricultural sector, they remain largely underfinanced. We share seven exemplary financing instruments from the global South and discuss what else is needed to bolster sustainable land management. By redirecting underperforming agricultural subsidies to landscape restoration, governments can unlock the funding required to revitalize degraded farms and make them suitable for production once again.

3.1 A Triple Win: Restoring Degraded Farmland for Social, Economic, and Environmental Gains

The world is facing rising food demand, especially from developing economies. However, it is likely that most of the demand will be met through domestic production linked to an expansion of farmland where crop yields are lower than the global average (Searchinger et al. 2019). Although large-scale agricultural intensification is expected to increase in most parts of Latin America, the gap between growth in demand and stagnating agricultural productivity gains in many developing countries means that land conversion will likely continue (Searchinger et al. 2019). This will contribute to further deforestation and harm biodiversity (DeFries et al. 2010). In sub-Saharan Africa, demand for food is likely to drive the expansion of cropland and pastureland by 100 million hectares and 150 million hectares, respectively, between 2010 and 2050 (Searchinger et al. 2019).

The threats presented by land degradation cost a great deal to the economy

Globally, 2 billion out of 7.8 billion hectares of land suitable for food production are already degraded, and, of these 2 billion, 0.5 billion hectares have been totally abandoned (UNCCD 2015; Ramankutty et al. 2018). Land degradation will continue as a result of a combination of different factors, including climate change, unsustainable farming practices, and the inefficient use of farming inputs. If this land were restored to vitality, the per hectare yield gains on degraded and marginally productive agricultural lands would be increased. In turn, that would reduce pressure on existing natural land while helping to meet growing demand for food (Gibbs and Salmon 2014).

Deforestation and land degradation will cost the world as much as $6.3 trillion a year in lost ecosystem services, including (but not limited to) soil fertility, provision of clean air and freshwater, and the regulation of the climate. Together, the lost ecosystem service value is more than three times larger than the entire value of agriculture in the market economy (Sutton et al. 2016). Giannini et al. (2015) estimate that the services provided by pollinators in Brazilian agriculture alone are worth about $12 billion a year, representing 30 percent of the income derived from the main pollination-dependent crops. Land degradation poses major threats to local communities and leads to rural unemployment, mass migration, and civil conflict, as productive and healthy land becomes increasingly scarce (Potapov et al. 2017; Hansen et al. 2013; Venter et al. 2016). Unchecked landscape degradation is likely to increase the amount of land needed to feed growing populations if declines in crop, grass, and fiber production continue (PBL 2017). New agricultural land will often be cleared from intact forest areas, leading to still more biodiversity loss and carbon emissions from soils and vegetation.

Restoring degraded land can contribute directly to local economies but is largely underfunded

To reverse this trend, a number of initiatives have been developed. The Bonn Challenge, launched in 2011, is a global effort to restore 150 million hectares of the world's deforested and degraded land by 2020 and 350 million hectares by 2030. Since its inception, the Bonn Challenge, through its regional initiatives such as the African Forest Landscape Restoration Initiative (AFR100) and Initiative 20x20 in Latin America and the Caribbean, has attracted commitments from national governments, states, and regional programs to restore about 210 million hectares of land and has leveraged billions of dollars of public and private finance for implementation on the ground (Bonn Challenge n.d.).

Land restoration interventions are very broad, ranging from active restoration—such as reforestation, forest conservation, agroforestry and silvopastoral practices, and soil conservation practices—to passive restoration, such as farmer-managed natural regeneration and natural forest regrowth (Ding et al. 2017). Revitalizing 150 million hectares of degraded agricultural land could generate $85 billion in net benefits to national and local economies (GCEC 2014). About 90 percent of this value is market-related, providing $30 billion to $40 billion a year in extra income for smallholder farmers and additional food for close to 200 million people (GCEC 2014). Additionally, restoration interventions can also generate important ecosystem benefits. It is expected that achieving the 350-million-hectare goal would generate about $170 billion a year in net benefits from watershed protection and improved crop yields. The resulting forest products could also sequester up to 1.7 gigatons of carbon dioxide equivalent annually (BonnChallenge n.d.).

Despite these benefits, land restoration remains largely underfinanced. Globally, annual public climate finance flowing into agriculture-, forest-, and land-related protection projects has doubled, from an average of $9 billion in 2015–16 to $18 billion in 2017–18, but its share of total climate finance remains small, rising from just 2 percent in 2015–16 to 3 percent in 2017–18 (Buchner et al. 2019). Funding for restoration-specific projects was a small fraction of the land use category during these years. These amounts fall far short of the $300 billion to $400 billion in annual funding required to meet the restoration commitments made under the Bonn Challenge (Credit Suisse et al. 2014; Ding et al. 2017).

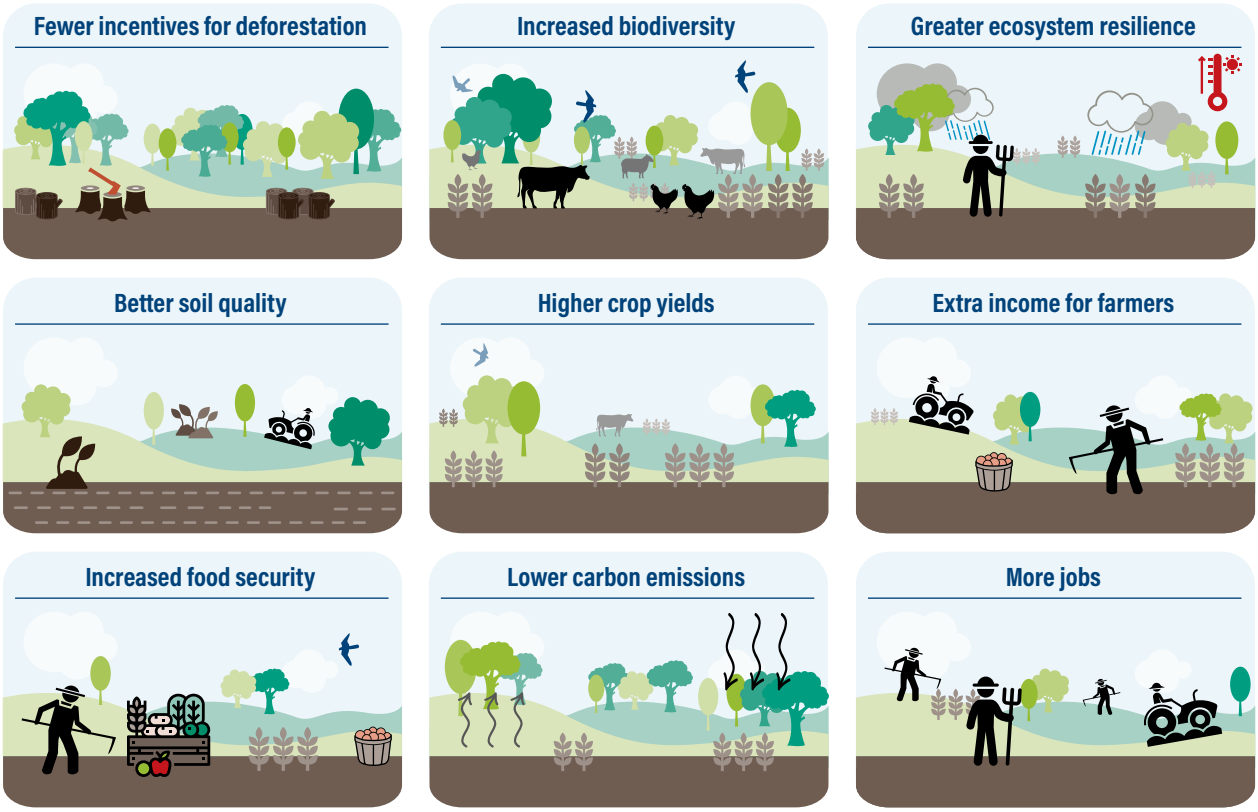
Restoration finance can be partially unlocked by repurposing agricultural subsidies

Ding et al. (2017) identified seven key barriers blocking finance flowing toward land restoration interventions, of which two relate to agricultural policies. First, governments provide incentives for continued land degradation by promoting and subsidizing the unsustainable agricultural practices already described. Second, funding for restoration often comes from public environment budgets, which are typically much smaller than agricultural budgets. The funding situation will become even more challenging as many countries struggle to emerge from the COVID-19 pandemic.

Against this background, the need to rethink and reform the existing subsidy structure and improve policy coherence across and within governments has never been as urgent as it is now. Repurposing inefficient agricultural subsidies to support sustainable agricultural practices can create social, economic, and environmental value in the long term (Figure 2). It reduces total government spending by making such subsidies more targeted and effective in achieving the objective of increasing per hectare yield gains. Every $1 invested in restoration can lead to $7–$30 in economic benefits (Verdone and Seidl 2017), create jobs, grow GDP, and alleviate poverty. This investment can also help many governments facing tighter budgets develop a just transition to sustainable rural economies after the COVID-19 pandemic.

Repurposing agricultural subsidies can also discourage agricultural activities that drive further deforestation and land degradation, while providing incentives for those that are conserving and restoring land. Redirecting even a small portion of the $451 billion annually spent on subsidizing

Figure 2 | Shifting agricultural subsidies to restore land can lead to many benefits



Source: WRI authors.

agricultural activities that destroy nature (Deutz et al. 2020) to support restorative agricultural practices could help recover degraded land and boost crop production. By so doing, governments would have more resources at their disposal for achieving their national restoration pledges, without significantly changing their agricultural budgets. In return, these efforts can generate multiple ecosystem benefits, such as increasing water retention in the soil, reducing topsoil loss and erosion, and building resilience for the long-term sustainability of agroecosystems. Investing in restoring land is not a silver bullet for the challenges any country faces in responding to climate change and rural poverty, but there are clear connections. How can the transition from degradation to restoration happen?

3.2 Innovative Financing Instruments to Incentivize Forest and Landscape Restoration: Case Studies

Ecological fiscal transfers: Redistributing national government budgets toward protecting and restoring forests in multiple countries

Innovative financing mechanisms, such as ecological fiscal transfers (EFTs), have redistributed national government budgets to local authorities, where they have addressed important environmental problems. EFTs were introduced in the Brazilian state of Paraná in 1992 to cover administrative expenses associated with managing protected areas. They also compensated farmers for income lost when the government imposed land use restrictions in conservation and watershed-protection areas (Grieg-Gran 2000). This is an innovative instrument that changes how tax revenue is allocated by incorporating ecological indicators (e.g., the condition of protected areas) into the amount of funding that municipalities receive from national coffers (Droste et al. 2018). The capacity of local governments to manage these programs is very important to the success of this instrument.

Since the introduction of EFTs, municipalities within these protected areas have received a portion of the value-added tax revenues to compensate for the tax revenue they forgo when they forbid people from clearing forest for agricultural land. The program has become a popular incentive mechanism for conservation. Between 1992 and 2001, the total area in conservation units grew by over one million hectares in Paraná, a 165 percent increase. It also grew by slightly over one million hectares (62 percent) in Minas Gerais in five years (May et al. 2002). As of 2017, 17 of Brazil's 26 states had adopted EFTs (Droste et al. 2017a).

Brazil's EFTs have received international attention (May et al. 2002; Ring 2008; Farley et al. 2010) and have been replicated in France, Germany, India, Indonesia, Portugal, and Switzerland (Droste et al. 2018). Droste et al. (2017b) estimated the effects on conservation decisions of Portugal's introducing EFTs in 2007 and found that it led to an increase in the share of protected areas at both municipal and national levels. The grants that Indian finance commissions have given directly to *panchayats* (the lowest tier of governance) are another example of this transfer. Although until now the funds have been directed only to improving drinking water, rainwater harvesting, sanitation, and so on, similar funds could be created to target forest or soil restoration.

Additionally, EFTs can be managed by agriculture, planning, finance, or rural development ministries or departments. A state-level analysis by WRI India shows that some states have used EFTs innovatively to maintain and enhance forest and tree cover through the forestry and other ministries (Gangwal et al. 2019). For instance, in Maharashtra, the state government has increased support through an EFT to the Department of Tribal Affairs for enhancing the capacity of tribal communities to protect and restore forest cover in areas where community forest rights have been recognized. The case of India highlights the possible fiscal transfers that different government departments can use to support their common goal of increasing tree cover in rural areas.

EFTs have the potential to mobilize public finance for financing programs that help restore the ecosystem functions of agricultural land, such as soil and water retention, regulating the local water cycle, and moderating climate change, which in turn can boost agricultural productivity.

Tax-revenue transfers across departments or within the same department: Payments for environmental services boosted Costa Rica's economy

In addition to redistributing government budgets through EFTs, governments could also earmark a percentage of tax revenues for specific environmental expenditures. Costa Rica, for example,

assigns 3.5 percent of the revenue it earns from excise taxes on fossil fuels directly to its Payments for Environmental Services (PES) program. The earmark accounts for more than 86 percent of the program's financing needs (Russo and Candela 2006). The PES program pays private landowners who own land in forested areas in recognition of the ecosystem services their land provides. Two decades after establishing the PES program in 1997, some $500 million worth of fuel-tax revenues had been transferred to protect 1.25 million hectares of forest, nearly one-fourth of Costa Rica's territory (Ortiz 2018). The improvement of forest ecosystems has also boosted Costa Rica's nature-based tourism economy. The sector is expected to grow by more than 6 percent between 2017 and 2021. In 2016, the tourism sector directly contributed 5 percent of GDP and generated around 28 percent of direct and indirect employment (ICT 2008; OECD 2018). Earmarking revenues in this way represents an increased budget for environmental purposes but can potentially reduce increases in alternative budget priorities; these effects have not been adequately studied.

Additionally, tax revenues may be transferred within the agricultural department for repurposing agricultural subsidies as well. In particular, if certain components of agricultural subsidies are determined to be inefficient, that is, falling short of expected policy objectives like improving productivity, policymakers could consider repurposing them to support tree-based land restoration interventions (e.g., agroforestry) or other regenerative agricultural practices on farmlands. Depending on landscape and conditions, restorative or regenerative practices on farms—if well-chosen—could achieve the intended policy objectives by effectively restoring soil health, while providing many other co-benefits.

Payments for preventing deforestation: Protecting Amazon forests and improving local livelihoods in Brazil

PES schemes have been widely implemented in tropical forest countries. They serve as an economic tool to incentivize behaviors that avoid deforestation, while providing financial rewards to landowners and users who conserve and restore natural resources.

For instance, in 2018, an initiative called CONSERV was launched in Brazil by the Amazon Environmental Research Institute, the Environmental Defense Fund, and the Woodwell Climate Research Center to compensate farmers for protecting the 28 million hectares of primary forests that could be legally deforested under Brazil's Forest Law (Stabile et al. 2020). In the state of Mato Grosso alone, where the CONSERV program is initially focused, seven million forested hectares could legally be cleared. The initial funding support from the Norwegian and Dutch governments aims to leverage private finance and other incentives to protect these forests. This marks the first time that a program in Brazil has been fully devoted to farmers who could legally convert their lands to other uses. Participating farmers have agreed to keep forests standing in exchange for compensation for the critical ecosystem services, such as improved water availability and quality and carbon sequestration, that their lands provide.

Another example of such a payment is related to cassava cultivation in the Brazilian Amazon. There, rural communities rely on cassava produced in a swidden-fallow system that uses land cleared from forest areas. Evidence shows that two PES programs, Bolsa Floresta and Bolsa Verde, which were created in 2007 and 2011, respectively, have led to the intensification of cassava production on existing farmland rather than the expansion of farming into primary forests. Bolsa Floresta is a state-level public policy administered and implemented by the Fundação Amazonas Sustentável (Sustainable Amazon Foundation), a private nongovernmental organization developed in partnership with the Amazonas state government and supported financially by private and public sources (FAS 2017a). To date, Bolsa Floresta operates within 16 protected areas, covering 10.9 million hectares of Amazonian forests (FAS 2017b). It is calculated that the combined value of all Bolsa Floresta components is 1,360 reais ($421) per household per year (FAS 2017b). As of September 2017, this program had 9,601 enrolled rural households who had agreed to a voluntary commitment term to avoid primary forest clearance, enroll children in school, and participate in workshops on climate change and ecosystem services.

The Bolsa Verde program is run by the Brazilian federal government and, like Bolsa Floresta, also pays smallholders inside conservation areas if they agree not to clear primary forests. Rather than using several payment types, Bolsa Verde pays a monthly cash lump sum of 100 reais ($31) directly to each eligible household (MMA 2013).

Its aim is to incentivize environmental conservation practices, diversifying people's livelihoods while increasing income. As of 2018, more than 48,000 households were benefiting from this program across Brazil (MMA 2018).

To understand the household-scale economic impacts of avoided deforestation under these PES programs in Brazil, Alves-Pinto et al. (2018) interviewed 158 households from 32 communities in the state of Amazonas. Using regression models, they assessed which variables most influenced the production of *farinha* (flour from cassava) and calculated production costs and total revenues, with and without the PES program. Their findings suggested that revenue and net profits of *farinha* production in areas cleared from mature forests were greater than those cleared from secondary forests. However, total income from PES programs, when added to the secondary forest cassava profit, were high enough to compensate for the forgone production from primary forest areas. Therefore, livelihoods improved with the PES program. Furthermore, Alves-Pinto et al. (2018) also found that the indirect payments encouraged a switch in the production process from agriculture to other more sustainable resource management and extractive activities that do not depend on clear-cutting mature forests.

Payments for watershed services and biodiversity conservation: Protecting forests without compromising rural income in Mexico

The Mexican federal government, through the National Forestry Commission (CONAFOR), undertook two initiatives—the Hydrological Ecosystem Services Program in 2003 and the Program to Develop Ecosystem Services Markets from Carbon Sequestration and Biodiversity in 2004. In 2006, the two programs were merged into the national PES program (CONAFOR 2011), which was simplified over the years into two types of payments, one for watershed services and the other for services derived from biodiversity conservation (FAO 2013). The main funding sources that sustain the long-term PES program include contributions from water users, a budget approved annually by the legislature, state and municipal governments, and the private sector. These different funding sources are channeled to landowners through the Mexican Forest Fund.

Fixed payments of between $20 and $80 per hectare per year were collected from a surcharge on water fees to pay private or communal landowners through a five-year contract with CONAFOR to maintain or improve the provision of ecosystem services (FAO 2013). Beneficiaries pledge to build fences, control pests, or patrol for illegal logging in a land management plan submitted with the PES funding application.

Alix-Garcia et al. (2010) estimated the effects of the PES scheme using a propensity scoring method and found that the average reduction in the deforestation rate compared with what would have happened without the program was statistically significant, though small. The program seems to be more effective in the southern states and northeastern Mexico, where poverty levels are lower and opportunity costs were high among those who decided to participate. The PES program also increased sustainable land management activities, such as fire breaks, fences, nurseries, reforestation, patrolling, and soil conservation (Alix-Garcia et al. 2018). At the same time, conservation payments did not reduce unpaid, environmentally beneficial activities by crowding out the intrinsic motivation of local people. These results are important for global conservation efforts, as they demonstrate that it is possible to compensate communities for their stewardship efforts without harming social cooperation or undermining existing institutions. As PES programs mature, future inquiries should also focus on longer-term impacts, including possible changes in farmers' behavior after contracts are completed.

In 2018, a new PES national program was announced, the Environmental Compensation Program for Land Use Change in Forest Lands. The program allocated 1.03 billion pesos (approximately $51.5 million) to support 846 forest restoration and protection projects that span roughly 66,500 hectares for up to six years. In 2020, the government announced the allocation of an additional 1.5 billion pesos (approximately $68.2 million) to support forest restoration and protection projects on 50,600 hectares.

Payments for avoided soil erosion: Benefiting farmers and a hydropower company in Malawi

In 2005, Malawi allocated 10–15 percent of its national budget through the Farm Input Subsidy Program to ensure that smallholder farmers could access inputs at affordable prices. Fertilizer was made available at one-third of the market price, and improved seeds were provided free of charge to areas with very low yields. Approxi-

mately 1.5 million smallholders were expected to benefit from the program. However, studies have found that the program reinforced maize monoculture by reducing crop diversity and squeezing out other crops with limited market demand. This has led to the erosion of exposed topsoil, a key problem that affects Malawi's soil productivity, disrupts sediment flow in rivers, and ultimately damages fisheries and reduces hydropower generation.

To address this, the government created incentives to promote conservation agriculture (CA) and the ecosystem services it can provide. CA typically involves no or minimal tillage of soils, retention and mulching of crop residues, and intercropping or rotation with other crops, usually legumes (Andersson and D'Souza 2014). A meta-analysis of the long-term effects of CA on maize yields revealed that with crop rotation, soil cover, and high input use, maize yields under CA generally increase over time in low-rainfall areas (Rusinamhodzi et al. 2011). In years of high rainfall or in high-rainfall areas, however, mulch cover may lead to lower yields due to waterlogging (Chikowo 2011; Rusinamhodzi et al. 2011). The benefits of adoption are seasonal, agroecologically specific, and dependent on sustained investments (Andersson and D'Souza 2014).

Payments for sediment management in the Shire River Basin through CA were made by the hydropower company ESCOM, which implicitly embeds tariffs in billing consumers. However, farmers were slow to adopt the scheme, and CA practices were adopted on only 1–2 percent of the cropland (Bell et al. 2018). To encourage adoption among individual farmers, Bell et al. (2018) developed an innovative "agglomeration payment" scheme[8] and evaluated its effect using a randomized control trial. They contrasted a control (no payment) with a standard subsidy (for adopting the three CA practices: no-till cropping, mulching to control weeds and evaporation, and crop rotation) or an agglomeration payment (a smaller base subsidy plus a bonus payment for each adopting neighbor). The results of the experiment suggested that, on average across various treatments, the agglomeration payment increased adoption rates for CA by 170 percent above control.

If the agglomeration PES scheme were scaled up, this would drive a significant reduction in the amount of soil lost from fields. The estimated costs of avoiding sediment-loading through the PES scheme range from $7 to $2,000 per ton of sediment, less than 1.5 percent of the actual cost to the hydropower company of managing the sediment (which is estimated at $150,000 per ton of sediment, involving equipment rental, dredging, and scheduled shutdowns) (Bell et al. 2018). Clearly, the hydropower company would benefit from lower siltation. Over time, farmers would also benefit from the adoption of CA. In particular, the improvement in soil structure over progressive seasons reduces input needs and may boost yields. Finally, peer effects can reduce the payment scheme's operational costs: Additional incentives required to encourage new adopters become less important as CA fills the landscape and visible benefits reshape attitudes about the practice.

Payments for sustainable land and water management practices: Incentivizing farmers in Ghana

In Ghana, environmental degradation caused by wildfires has threatened local livelihoods. Between 2002 and 2012, nearly all fires in the country were human-caused, and most arose through land use activities such as farming (19 percent), hunting (15 percent), and charcoal production (10 percent) carried out in the forest (Agyemang et al. 2015). The frequency and burned area of wildfires declined rapidly between 2004 and 2011, owing to the inception of a wildfire-management project developed by the Forestry Commission of Ghana and the Netherlands government (MLFM 2006). The project also includes practices such as restoring degraded lands through developing forest plantations, along with enrichment planting and community forestry by the Forestry Commission (Agyemang et al. 2015).

To reduce further damage from forest fires, farms are encouraged to adopt more sustainable land-management practices, such as plowing residues rather than setting fire to them. In 2014, the World Bank approved a budget of $13.25 million to implement Ghana's Sustainable Land and Water Management Project (SLWMP), which aimed to reduce land degradation and enhance biodiversity in the Kulpawn-Sissili and Red Volta watersheds (World Bank 2014). One of the components of the project was developing a PES scheme in northern Ghana to encourage tree planting to address soil erosion, topsoil quality, and the overgrowth of weeds and grass.

Based on a uniform price auction experiment, researchers investigated farmers' reservation prices and willingness to participate in the PES scheme (Legovini 2018). The initial payment was set at 380 Ghanaian cedi, or $80, per farmer, and then lowered to just 200 cedi based on the result of the experiment (Legovini 2018). Farmers would be paid the full price if 75 percent or more of their trees were still alive at the end of the first year, and one-third of the full price if at least 37.5 percent of them survived. If fewer than 37.5 percent of the trees were still alive, the farmer was paid nothing. The payments for keeping 75 percent of trees alive were to be made in two instalments, with an initial one-third of the payment made after six months and the remainder at the end of the first year. Van Soest et al. (2018) studied the effects of PES on farmers' participation using a randomized control trial and found that the policy increased the rate of adoption by three times in the project areas where people were paid. To scale up the practices among more farmers, Ghana must develop alternative options to channel more financial resources to the SLWMP. Furthermore, the PES scheme must consider the differentials in per farmer costs and in the transaction costs in each community in order to achieve an optimal outcome (Legovini 2018).

Paying farmers to increase tree cover: Strengthening food security in Burkina Faso

In October 2012, the Reducing Emissions from Deforestation and forest Degradation (REDD+) program funded $30 million for a Forest Investment Program (FIP) to implement reforestation campaigns. The FIP pays community members located around targeted forests for their tree-planting activities based on the number of trees that survived after one year, at a rate of $0.70 per tree. Adjondon et al. (2019a) studied the effectiveness of the PES program using primary data collected 13 months after the start of the PES program among all 630 individuals in the treatment and control groups. They found that PES schemes not only wereeffective in promoting conservation but also increased households' food consumption expenditures by 12 percent and reduced the prevalence of moderate and severe food insecurity[9] by 35–60 percent. These results suggest that there is a "double dividend" associated with (conditional) conservation payments: increased environmental protection and reduced food insecurity.

The positive impact of the program on local livelihoods might be partially attributable to the timing of the payments. These were made during the lean season, when most farmers had exhausted their stock from the previous harvest. Disbursements were made to rural households through cash transfers, which were spent mostly on cereals, meat, and pulses. The individual payments ranged from about 840 CFA francs ($1.40) to 25,620 CFA francs (about $43), with an average of 8,300 ($14) CFA francs, representing approximately a week of food consumption for the median rural household in Burkina Faso (Adjondon et al. 2019b). Moreover, PES programs employed surplus farm labor and so did not compromise agricultural productivity (Adjondon et al. 2019b). Although tree maintenance activities occur throughout the year, including during agricultural seasons, productive land is scarce in targeted regions, hence farm labor was not displaced by PES programs.

3.3 Strengthening Regulations and Land Rights: Making Incentives Work

Clear liability can ensure continued payments for protecting and restoring degraded landscapes

The costs of environmental degradation and deforestation are significant and often borne by local communities, even though both internal and external drivers have contributed to the damages. To ensure that the benefits of restoration flow to people and communities, environmental laws that regulate the reallocation of the damage costs must be enforced and their implementation monitored. Examples include the evolving "polluter pays principle" (PPP) and the "provider gets principle" (PGP) in regulating agricultural pollution.

The PPP was developed at the OECD in the 1970s to provide a guiding principle for governments wishing to reallocate and internalize the social costs associated with environmental damage. It requires the polluter to bear the expense of preventing, controlling, and cleaning up pollution. The same principle can be applied to those causing environmental damage, including farmers who discharge pollution into the environment or produce in a swidden-fallow system that uses land cleared from forest areas. Because in many places no one is responsible for protecting natural forests, it is often harder to protect them from fires or encroachment by agriculture.

Due to the complex nature of agriculture, many national environmental laws do not require agricultural producers to internalize all pollution costs (Grossman 2017). The PPP is sometimes applied in the form of environmental taxes and charges, but these are used much less in agriculture than in other industries. This is partly because of difficulties in measuring diffuse pollution in the water and air, and partly because imposing restrictions or pollution charges on farmers could be seen as violating their property rights (Grossman 2017). There are also concerns about the impacts on farmers' livelihoods of applying the PPP.[10]

Since the early 1990s, OECD countries have recognized the seriousness of air and water emissions from agriculture, and some have enacted stricter environmental regulations, including the new rules for large livestock facilities in the United States[11] and the Nitrates Directive in the European Union[12] (Grossman 2017). The PPP can take the form of taxes on pesticides and commercial fertilizers, as well as charges for water use in many countries. Since 2003, the OECD has expanded the PPP measure, which includes not only the internalization of the costs of pollution prevention and control (the "strict sense" of the principle, or the "standard PPP") but also full internalization of environmental costs (the "broad sense" of the principle, or the "extended PPP") (Grossman 2007). For instance, by using a nonlinear programming model, Vatn et al. (1997) found that imposing a 100 percent tax on nitrogen in northwest Europe would be the least costly measure to reduce nitrogen leaching. Similar taxes could also be applied to control forest fires in the Amazon forests and hold farmers accountable for their forest-clearing activities.

An alternative to the PPP is the "provider gets principle" (PGP), where producers receive rewards for activities that positively affect the environment, either by avoiding harm or by providing environmental amenities. A typical example of such economic incentives is the PES, described earlier, which encourages the generation of positive environmental externalities. The choice between the PPP and PGP hinges on what the policymaker considers to be a fair distribution of the costs of limiting externalities.

Securing land and natural resource rights will attract private finance for restoration projects

Insecure land and natural resource rights are among the key factors responsible for the lack of investment in forest conservation and restoration (Davies et al. 2016). Under undefined (or unclearly defined) land and resource rights, everyone can benefit from ecosystem services such as clean air, nutrient cycling, flood and erosion control, and scenic beauty, but no one pays for them. This leads to the underprovision of natural capital and ecosystem services due to a lack of a market incentive to protect and restore them.

Strengthening land and nature resource rights provides incentives to both the suppliers and buyers of ecosystem services (Ding and Veit 2016). For service suppliers, that is, local communities and farmers, clear land rights incentivize them to provide the ecosystem services by guaranteeing that they receive compensation for their costs. Establishing clear land and resource rights also incentivizes service buyers, such as businesses, to invest in local restoration projects, as doing so can reduce the risk of disputes over who receives the most benefits from the investment. Clear title to land and resources also provides the legal basis for local communities and farmers who carry out land-restoration activities to be compensated fairly and equitably. When allocating property rights over resources, particular attention should be given to disadvantaged groups like households headed by women to ensure that their access to resources is treated on an equal footing with that of households headed by men. In many developing countries, significant efforts should be made to provide equal educational opportunities to girls and boys and empower women in decision-making processes.

California and northern Mexico provide good examples of how clearly assigned resource rights have incentivized the adoption of water-efficient technologies in agriculture. Farmers in California and northern Mexico have historically been offered water at much lower prices than other users. This has led to the overextraction of water. To incentivize sustainable use of water, governments did two things: They assigned property rights to water, with each user allocated a certain amount per growing season, and they created a market to allow farmers to sell the part of their

water allocation that they saved from efficient practices to other farmers or businesses (Rosegrant and Gazmuri 1995). In the San Joaquin Valley, California's largest farming region, water trading can lower the costs of managing demand by about 40 percent by enabling water to go to the most productive farmlands, protecting jobs for thousands of low-income families while ensuring that groundwater remains available for future generations (Hanak et al. 2020). Of course, it is not always possible for individuals or communities to turn resource rights into something "marketable," so some external financing from governments or other entities may still be required to promote conservation.

In the case of incentivizing sustainable land use and land-management practices, clearly defined land rights can help to justify when farmers should be liable for environmental harm and when they should be paid for environmental services beyond "good farming practices." Multiple studies in the Amazon forests have shown that land tenure security is an important contributor to reduced deforestation in the area. Ding et al. (2016) studied deforestation data between 2000 and 2012 and found that the average annual deforestation rates inside tenure-secure Indigenous lands were just one-third to one-half those of similar forests without secure tenure in Bolivia, Brazil, and Colombia. Similarly, Blackman et al. (2017) found that community titling of Indigenous lands significantly reduced both forest clearing and land disturbance in the Peruvian Amazon. Local communities should be adequately compensated for their efforts to safeguard forests.

3.4 A Conceptual Framework for Repurposing Underperforming Agricultural Policies for Restoration

Building on the examples of various financial instruments applied in different countries, we propose a conceptual framework (Figure 3) to illustrate when agricultural subsidies should be repurposed to support more sustainable land use and management practices and how financial resources within the public budget could be channeled toward land restoration.

By so doing, governments, acting largely but not exclusively through their ministries of agriculture, can develop better-targeted agricultural policies and incentives to support sustainable land management and rural development practices. This can help them achieve common policy goals set by environment, forest, and rural development ministries, which, in turn, will greatly improve the cost-effectiveness of agricultural policies as well as overall policy coherence in the pursuit of national sustainable development agendas, while combating climate change and the loss of biodiversity and natural resources.

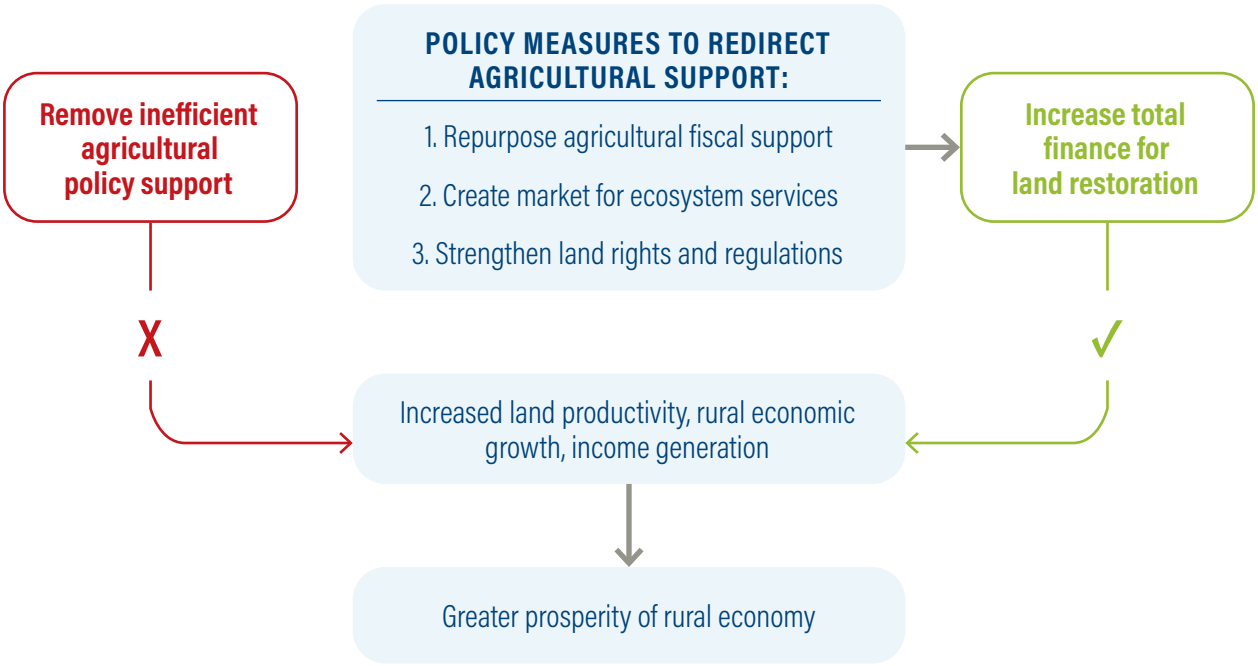
A few important lessons could be learned from the selected case studies.

- **Economic incentives must be provided in a way that ensures improvement in soil quality and health to maintain long-term productivity.** While it is essential to increase finance to restore degraded agricultural land, how that money is spent matters. Agricultural support must target both short-term solutions, such as genetic improvement of crop varieties, and long-term ones, such as regenerative agricultural practices and agroforestry. Together, these measures could help restore soil health, improve the productivity of marginal agricultural lands without increasing the pressure on intact forests, and build resilience to cope with the impacts of climate change.
- **Repurposing the most harmful agricultural subsidies to promote sustainable agricultural practices that restore land can make policies more cost-effective.** In situations where agricultural subsidies

are inefficient in boosting yield gains, or on farmland that does not respond well to chemical inputs, governments should consider reducing or eliminating these input subsidies. Instead, policies should incentivize the adoption of forest and landscape restoration interventions, for example, low-carbon agricultural practices, soil conservation, agroforestry, or intercropping, through direct performance-based payments to support farmer incomes. The payments could be made in the form of cash transfers, which will not only encourage more participation but also support local livelihoods during the lean season, providing additional resources to spend on cereals, protein, and pulses, thereby increasing food security.

- **A functioning market for ecosystem services can help people restore more land—and provide more ecosystem services.** When designing payment schemes that help farmers restore land, governments need to establish rules to regulate the market and ensure that ecosystem services are properly valued. Strengthening land and natural resource rights is critical, as they provide signals to both the suppliers and buyers of ecosystem services. Properly regulated markets can then be set up and in turn can boost the confidence of both buyers and sellers, clarify participants' responsibilities, reduce transactional risks, and secure long-term income sources for local farmers and communities.
- **Design programs to last.** It is important to take a long-term view of how funding of the program will be managed to ensure a sustainable flow of ecosystem services. The longevity and continuity of the payments, as well as the competency of the local governments to manage the program, are essential to consider when planning for long-term success.

Figure 3 | Options for redirecting agricultural policy support to land restoration



Source: WRI authors.

CHAPTER 4

REPURPOSING AGRICULTURAL SUBSIDIES FOR POST-COVID-19 RECOVERY

In the wake of the COVID-19 pandemic, governments have the opportunity to reinvest ineffective subsidies in more sustainable agricultural practices. Restoring farmland is key for a just transition to sustainable rural economies, job creation, and climate resilience: When agricultural subsidies are designed efficiently, they can help achieve these goals without harming the farmers involved.

The COVID-19 pandemic reduced global GDP by 4.4 percent in 2020 (IMF 2020), causing the greatest economic recession since the Second World War. To emerge from the health and economic crisis, governments around the world have earmarked as much as $13 trillion for COVID-19 rescue and recovery packages (as of December 2020), of which approximately $3.7 trillion will be pumped directly into sectors that have a large and lasting impact on nature (Vivid Economics 2020). These flows present an opportunity to protect and restore nature, increasing resilience in the face of the coupled climate and biodiversity crises. However, government responses have largely failed to harness this opportunity.

In the case of forested land, the current trend is not positive. Since the start of the pandemic, annual forest loss rates have risen by more than 50 percent across Asia, Africa, and Latin America (Gross et al. 2020) as a result of illegal logging and forest conversions. In Indonesia, forest clearance in March 2020 alone was up 30 percent compared with the three-year average deforestation rate for March in the period 2017–19. This rate of clearance, caused by illegal logging and forest conversion for palm oil and coffee plantations, where production was heavily subsidized through different forms of agriculture support, was the greatest recorded forest loss of any country that month (Farand 2020). The situation could further decline if the Indonesian government pushes through an omnibus bill that encourages unsustainable uses of land.[13]

These governments are missing an opportunity. The need for a post-COVID economic stimulus is an opportunity to redirect harmful and ineffective subsidies from agriculture to more restorative and regenerative agricultural practices. Restoring farmland is key for a just transition to sustainable rural economies and creating jobs after the COVID-19 pandemic. By investing in restoring farmland, government stimulus programs, especially those put in place during the COVID-19 pandemic, can both accelerate rural economies in the short run and support their long-term sustainability.

4.1 Repurposing Agricultural Subsidies Can Achieve More with Less

As government budgets tighten following the COVID-19 pandemic, they need to support programs that simultaneously meet their economic development, food security, climate, and biodiversity goals. Empirical evidence has suggested that reducing agricultural supports for intensified input use (especially of water, pesticides, and inorganic fertilizers) while increasing support for the adoption of technologies and sustainable farming practices that reduce the need for inputs or enhance productivity will increase per hectare *total factor productivity* and lead to positive environmental impacts (DeBoe 2020). Additionally, shifting agriculture policy incentives away from economic activities that drive deforestation can also reduce the financial attractiveness of deforestation (Chaturvedi et al. 2019). At the same time, some of the benefits of current subsidies, like their goals of supporting rural incomes and increasing agricultural output, can be retained if they are targeted at and made conditional on protecting and restoring nature.

Although it is essential to continue investing in technical breakthroughs that will significantly improve per hectare productivity of land, protecting and restoring soil health to sustain that long-term productivity is equally crucial. The latter element, however, is often overlooked, as the important ecosystem services provided by nature are taken for granted and public awareness about the impact of soil degradation on food is still very low. As a result, very little finance has been made available. Globally, about $78 billion to $91 billion is being spent annually on nature conservation, which includes all sorts of activities to protect both natural environments (such as forests) and human-managed systems (such as farmland) (OECD 2020c). This sum is just over 10 percent of global agricultural subsidies, estimated at more than $700 billion gross per year between 2017 and 2019 (OECD 2020a), some of which supported agribusiness activities that have caused the land degradation plaguing us today.

In a post-COVID era where frugal government financial policies are needed, it is critical and timely to rethink agricultural subsidies, as governments will face conflicting priorities when choosing how to allocate their limited budgets. Shifting subsidies away from agricultural activities that are harmful to nature and repurposing them to support sustainable farming practices to restore soil health can generate significant savings in the long run by avoiding the economic and social costs of land degradation. Without increasing the overall agricultural budget, governments could achieve multiple policy goals while contributing to national and global climate and biodiversity goals.

Globally, about $425 billion (€373 billion) of the $619 billion net transfer to agricultural sectors (OECD 2020a) was earmarked for budgetary spending on various agricultural support programs and could be repurposed. If a portion of this were shifted to support restorative and regenerative agricultural practices, it could help address the $300 billion to $400 billion finance gap that must be bridged to achieve land conservation and restoration targets (Ding et al. 2017).

Reforming subsidy schemes, however, must be seen primarily as a way to boost food security and rural livelihoods, both of which have been weakened by the pandemic in most developing countries. Governments must prioritize policy responses that will improve the resilience of food systems (Laderchi et al. 2020). Agricultural subsidy reform can help farmers harmed by the pandemic, while freeing funds for investing in nature-based solutions like forest protection and landscape restoration (WEF 2020). These environmental factors cannot be ignored. When nature is ignored, zoonotic pandemics like COVID-19 come knocking at the door.

For once, all governments around the world are facing the same development challenge: rebooting economic development and creating jobs to recover from the economic crisis caused by the pandemic. The risk is that many governments will prioritize short-term business opportunities that undermine their long-term sustainability goals, in the name of saving jobs in key economic sectors that are proven to be unsustainable. However, the latest research has shown that, by directing less than 5 percent of the total stimulus to date ($552 billion) into nature-based solutions like land restoration, world leaders can create 7 percent more jobs and 8 percent more short-term domestic economic activity compared to the scenario where stimulus money is spent on conventional recovery activities (Vivid Economics 2020). Land restoration, combined with technical solutions for improving productivity, will necessarily form part of the package of solutions to meet the policy objectives of ensuring an inclusive and food-secure rural economic recovery and protecting forests and biodiversity. Those policies can specifically help the marginalized and poor farmers who feed the world.

4.2 Restorative Agriculture Policies: Four Recommendations for Policymakers

What can policymakers do to shift agricultural studies and help build strong rural economies? Here are our four recommendations.

Recommendation #1: Repurpose existing agricultural incentives to work for people and the planet

Governments should consider reducing or gradually phasing out input subsidies that do not boost total factor productivity on degraded farmlands or that deplete natural resources like water and soil. These subsidies should be replaced with other forms of income support that will encourage farmers to adopt nature-based farming practices like regenerative agricultural practices, soil conservation, agroforestry, and intercropping that can enhance soil quality and water flow, improve yields, and diversify livelihood opportunities for farmers. More specially, cash payments can be given to participating farmers based on their performance. The case studies presented in Section 3.2 showed that this kind of support was helpful for incentivizing sustainable farm practices. That is especially true for poor smallholder farmers, who have little money to spend on unsubsidized complementary inputs that must be applied to realize the full benefits of subsidized fertilizers. Cash payments can also serve as an important source of household income after the harvest season, improving food security and local livelihoods. Governments can increase rural credit lines or concessional loans to farmers who want to restore their farms, and create well-regulated markets to allow farmers to sell ecosystem services generated on their farms.

Governments should also reduce agricultural support, such as market price support and output subsidies, that encourages the expansion of agriculture into natural forests. Officials have justified them by arguing that expanding cropland is the only way to ensure food security. In practice, these subsidies have discouraged technical improvements on existing cropland and reinforced behavior that leads to degradation, overgrazing, and deforestation. Phasing out these subsidies will reduce the economic incentive for converting primary forests to farms. If paired with new subsidies to incentivize nature-friendly intensification on existing farmlands, govern-

Figure 4 | Policy Elements to Boost Both Agriculture and Land Restoration

Source: WRI authors.

ments can increase per hectare productivity and reduce pressure on primary forests. For forest countries, this could be an important low-cost policy to achieve their national climate and biodiversity targets, reducing deforestation without compromising yields. As shown in Section 3.2, in many cases, these payments successfully compensated farmers for their forgone revenues from clearing forest. Improved forest ecosystems may also create new business opportunities to boost rural economies and grow income. For instance, Costa Rica's nature-based tourism economy is expected to grow by more than 6 percent over the period 2017–2021. In 2016, the tourism sector directly contributed 5 percent of GDP and generated around 28 percent of direct and indirect employment (OECD 2018).

Recommendation #2: Enable markets for ecosystem services

One of the key barriers to scale up restoration efforts is the lack of market value for the many ecosystem services that are generated through restoration (Ding et al. 2017). To incentivize restoration, governments need to step in to help pay people for the services that their land produces. When restoration doesn't pay, it doesn't happen.

Governments also need to support and regulate these markets to ensure that ecosystem service values are properly reflected in price signals. Properly regulated markets can boost the confidence of both buyers and sellers, reduce transactional risks, and secure long-term income sources for local farmers and communities. Clearly defined land-tenure security among the local communities is a critical precondition to ensure that compensation schemes work, and governments play a fundamental role in clarifying and establishing tenure rights (Section 3.4). Examples of market-based mechanisms include PES, which we covered extensively in Section 3.2, as well as certification schemes such as eco-labels, in which the value of ecosystem services is reflected in the price premium of sustainably produced commodities. These measures have encouraged farmers to grow more trees on their land and adopt low-carbon agriculture, boosting rural incomes and food security while sequestering carbon and conserving biodiversity.

Recommendation #3: Design incentive programs that target smallholder farmers

Policymakers must be aware that the costs of environmental degradation—and ecosystem restoration—are often borne by local communities, which also need access to incentives more than large farmers do. However, large landowners and corporations often benefit disproportionately from existing subsidies. Governments must carefully design incentive programs to ensure that they reach smallholder farmers as intended. To make that possible, governments need to improve recognition of land rights for small farmers, by granting them legal title over ancestral lands, for example (Weber and Buckingham 2016; Ding and Veit 2016). Without legal title, they are often

ineligible for subsidies and cannot legally claim payment for the improved ecosystem services from their restored land according to either performance-based or result-based criteria. Incentives that economically benefit rural communities should be inclusive and equitable. Program designers need to think beforehand whether programs can exacerbate existing inequalities and power relationships. Particular attention should be paid to vulnerable farm households, especially those led by women, who often find it difficult to access subsidy programs.

PES schemes that encourage small farmers to restore their land have been successful in creating extra sources of income. For instance, Burkina Faso paid community members through the Forest Investment Program to grow trees, which not only restored land but also allowed households to spend 12 percent more on food on average, reducing food insecurity by 35–60 percent. As rural economies look to recover from COVID-19, these programs can serve as inspiration. However, PES programs need to be carefully designed to avoid putting smallholder farmers at a disadvantage. Grouping individual farmers together in cooperatives or producer organizations at the community and landscape level and organizing payments through those intermediaries is one potential solution.

Recommendation #4: Invest in systems to measure progress and enable peer-learning

Policymakers should build systems to track the impact of their policy incentives, removing incentives in places where they have failed to achieve intended policy goals and rewarding positive results. Armed with high-quality, locally relevant data, policymakers can adjust their programs to reach more farmers and improve the outcomes of their policies over time. Recent improvements in mapping techniques are helping governments better monitor and measure where trees are growing on farms and pasture.

Some governments are using a mixture of remote sensing, artificial intelligence, and field-collected data to measure progress. In Malawi, the government has developed a framework to monitor the impact of its National Restoration Plan (Republic of Malawi 2018), built from a technique laid out in *The Road to Restoration* guidebook (Buckingham et al. 2019). That plan is creating thousands of jobs for young farmers. In El Salvador, the Sustainability Index for Landscape Restoration is showing how one restored landscape is benefiting both local people and the environment (Zamora et al. 2020). The index allows governments to measure the health of their landscapes on a simple 0–1 scale. And in India's densely populated and economically poor Sidhi district, researchers used a program called Collect Earth, together with a participatory assessment approach, to assess where farms and other land could be restored (Singh et al. 2020; Arakwiye et al. 2021). By combining the best in satellite data and local knowledge, they highlighted areas where farmers could benefit from growing more trees.

Improving the efficiency and effectiveness of agricultural subsidies has been a long-term policy challenge for many countries, but the new digital era can provide policymakers with new opportunities that have never been seen before. Policymakers can harness new technologies and learning opportunities, taking advantage of high-speed internet connection and international restoration alliances like AFR100 in Africa and Initiative 20x20 in Latin America. Peer-learning programs across countries and within government agencies can also encourage senior policymakers to come together to solve challenging problems at the intersection of environment and agriculture. For instance, a recent pilot in Latin America, the Restoration Policy Accelerator, has successfully brought together officials from the agriculture and environment ministries of five Latin American countries to create new agroforestry incentive policies (or shift their existing programs) (WRI 2020).

If agricultural subsidies are well-targeted and efficiently designed, they can be a positive instrument for both farmers and the environment. Redirecting where some subsidies go could provide food for millions while protecting and restoring the world's forests and farms. To meet their climate, biodiversity, and sustainable development goals, governments should embrace the power of restorative agriculture. Smarter subsidies and incentives can achieve more with less. They can help governments achieve these important policy goals without harming the farmers who are the backbone of rural economies.

ABBREVIATIONS

ABC	Agricultura de Baixo Carbono (Low-Carbon Agriculture Plan, Brazil)
CA	conservation agriculture
CONAFOR	National Forestry Commission (Mexico)
CONSERV	a private, voluntary mechanism that compensates rural producers for conserving native vegetation on their property that could be legally deforested (Brazil)
EFT	ecological fiscal transfers
FIP	Forest Investment Program (Burkina Faso)
FISP	Farm Input Subsidy Program (Malawi)
GDP	gross domestic product
ITR	Imposto Territorial Rural (Rural Territorial Tax, Brazil)
OECD	Organisation for Economic Co-operation and Development
PES	payments for ecosystem/environmental services
PGP	provider gets principle
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana (National Energy-Efficient Agriculture Pumps Program, India)
PPP	polluter pays principle
REDD+	Reducing Emissions from Deforestation and forest Degradation in developing countries; and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries
SLWMP	Sustainable Land and Water Management Project (Ghana)

ENDNOTES

1. In the baseline scenario, it is projected that pressure on land continues to increase at the cost of natural areas. More specifically, the global demand for crops is expected to increase by some 45 percent and demand for cropland to expand by close to 20 percent (~300 million hectares) between 2015 and 2050. Agricultural expansion comes at the cost of natural areas, with biodiversity declining by an estimated 6 percent compared to 2015, also because of more intensive production in existing agricultural areas and due to climate change.
2. For instance, as of 2019, India is the largest market for palm oil in the world (21.9 percent of all imports), followed by China (16.7 percent) (Workman 2020). Over the past decade, China has emerged as the largest market for internationally traded soy (60 percent) and beef (17 percent) (IDH 2020).
3. In June 2020, India announced a slew of reforms, such as an amendment deregulating the prices of agricultural commodities like cereals and pulses covered under the Essential Commodities Act of 1955, and approved an ordinance that would facilitate barrier-free trade in agriculture produce and not bind farmers to sell their produce to licensed traders under the Agricultural Produce Marketing Committee. The impact of these reforms on incentivizing production of income-elastic foods needs to be assessed.
4. Total factor productivity is a measure of productivity, defined as a ratio of outputs to inputs, which includes all factors of production. When subsidized inputs are overused, total factor productivity falls even if production grows or production per worker grows.
5. In 2014 India launched a soil health card scheme under the national mission for sustainable agriculture that promotes integrated nutrient management through judicious use of chemical fertilizers in conjunction with organic manures and other biofertilizers. Subsidies continue to be given to farmers to buy chemically manufactured fertilizers.
6. Tropical soils, especially in Brazil, are too acid and rich in aluminum (Al+3). Limestone has been used to neutralize soil acidity to improve agricultural productivity.
7. Credit guarantee schemes compensate for imperfections in the collateral market and can improve financing conditions (such as lower interest rates, greater amounts, and longer maturities). They are different from other forms of agricultural subsidies that are paid to agribusinesses, agricultural organizations, and farms to supplement their income, manage the supply of agricultural commodities, and influence the cost and supply of such commodities. This means that rural credits cannot be redirected in the same ways as subsidies. However, they can improve farmers' credit access and remove the financial constraints facing smallholder farmers who consider more sustainable options that could lead to higher productivity.
8. An agglomeration payment is an innovative two-part incentive designed to encourage spatial coordination in the adoption of conservation practices. It consists of a conventional subsidy (in the form of a voucher that could be used to purchase agricultural inputs through a local input dealer network) in exchange for participation, along with bonus payments for any neighboring farmers who also participate.
9. Three common household-level food security indicators were used to capture broadly dietary diversity and consumption behaviors considered to be symptomatic of food insecurity. These include the household's food consumption expenditures, the household's dietary diversity score (an indicator that captures economic access to food), and the household's food insecurity access scale (an indicator of consumption behavior that infers food security status from people's responses to questions about consumption patterns, which are considered to be correlated with food insufficiency and anxiety).
10. The effect would be analogous to the impact of subsidies, except the mirror image: The initial owners of the land would see the sale and rental value of their land reduced, but later farmers' incomes would not be harmed, and some might simply avoid the tax by changing what they grow.
11. 40 CFR parts 122, 412.
12. Council Directive 91/676 concerning the protection of waters against pollution caused by nitrates from agricultural sources, 1991 OJ (L 375) 1.
13. The bill would scrap the obligation to carry out environmental and social impact assessments for new business licenses, remove a requirement for all regions to maintain a minimum of 30 percent of their territory as forested area, and eliminate a strict liability rule that compels companies to protect their land from fires.

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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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https://doi.org/10.46830/wrirpt.20.00013