BOARD FOR INTERNATIONAL FOOD AND AGRICULTURAL DEVELOPMENT

BIFAD

WORKING PAPER:
SYSTEMIC SOLUTIONS

FOR CLIMATE CHANGE ADAPTATION AND MITIGATION IN AGRICULTURE, NUTRITION, AND FOOD SYSTEMS

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Authors:
Edward R. Carr, Coordinating Author, Clark University
*Rahel Diro, Coordinating Author and Subcommittee Advisor, Tetra Tech
Tyrone Hall, Behavior Change Communications Author, Open Society Foundations
Lydia Mbevi, Gender, Youth, and Social Inclusion Lead Author, IFC Consultant
Dan Zook, Executive Director, ISF Advisors
Mary Beggs, Agriculture and Economic Growth Sector Director, Tetra Tech
Carmen Benson, Senior Counselor, BIFAD Support Team, Tetra Tech
Hayden Aldredge, Manager, ISF Advisors
Lauren Allognon, Research Assistant, Tetra Tech
Tommy Crocker, Research Assistant, Tetra Tech
Katie Liming, Research Assistant, Clark University
Nancy Mukupa, Research Assistant, University of Johannesburg
*Corresponding author: rahel.diro@tetratech.com

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ACRONYMS AND ABBREVIATIONS

ACRE	Agriculture and Climate Risk Enterprise
AFOLU	Agriculture, Forestry, and Other Land Use
ASAP	Adaptation for Smallholder Agriculture Program
BIFAD	Board for International Food and Agricultural Development
CCAFS	Climate Change, Agriculture, and Food Security
CGIAR	Consultative Group for International Agricultural Research
CH_4	Methane
COP	Conference of Parties
CRD	Climate-resilient Development
CRDP	Climate-resilient Development Pathways
CIMMYT	International Maize and Wheat Improvement Center
DFC	Development Finance Corporation
ECOS	Environmental Compliance Support Contract
EPA	U.S. Environmental Protection Agency
ESG	Environmental, Social, and Corporate Governance
FAO	Food and Agriculture Organization of the United Nations
FI	Financial Institution
GHG	Greenhouse Gas
$GtCO_2$	Gigaton of Carbon Dioxide
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
MDB	Multilateral Development Bank
MRV	Monitoring, Reporting, and Verification
NDC	National Determined Contribution
N_2O	Nitrous Oxide
PHL	Post-harvest Loss

R&D	Research and Development
SBTI	Science-based Target Initiative
SEC	Securities and Exchange Commission
SDG	Sustainable Development Goal
SME	Small- and Medium-sized Enterprise
SRF	Smallholder Resilience Fund
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WBCSD	World Business Council for Sustainable Development
WFP	World Food Program
WHO	World Health Organization

EXECUTIVE SUMMARY

The world is facing a perfect storm of circumstances in which supply chain issues, regional agricultural and nutrition challenges, the ongoing effects of the COVID-19 pandemic, and regional conflict have combined to form a looming food security crisis. At the same time, the effects of climate change on agricultural and food systems are becoming more and more visible, whether in the form of massive flooding in South Asia or severe droughts in East Africa. Governments and development planners must act strategically to address the real humanitarian crises that are ongoing today while at the same time working closely with global partners to facilitate changes that will bring about a more inclusive and resilient future under the increasing pressures of climate change.

In response to a request by the U.S. Agency for International Development (USAID) for guidance with these challenges, the Board for International Food and Agricultural Development (BIFAD), an advisory committee to USAID, formed a subcommittee[1] to provide evidence-based recommendations to accelerate inclusive systems change to achieve transformative climate change adaptation and mitigation outcomes in agriculture, nutrition, and food systems. As a key work stream guided by the subcommittee, BIFAD commissioned a study to inform its thinking. This document, a working paper, is being released for public discussion at the mid-point of the study process in advance of the 27th Conference of Parties (COP27). The full study will be completed in spring 2023.

Pathways For Inclusive Transformative Systemic Change

The Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report makes it clear that there is no pathway to a sustainable future without ambitious and comprehensive adaptation and mitigation measures in the agricultural sector. To achieve food security, nutrition, and overall net-zero targets, these measures must contribute to transformational change in this sector. The IPCC warns that the most vulnerable people and places will be most acutely affected by climate-related impacts on food and nutrition security, even if we achieve the highest improvements in yield retention technically feasible under existing farm management practices. The urgent need to understand and address the implications of climate change on sustainable development goal (SDG) gains motivates this working paper on *Systemic Solutions for Climate Adaptation and Mitigation in Agriculture, Food, and Nutrition Systems*.

[1] *Subcommittee on Systemic Solutions for Climate Change Adaptation and Mitigation in Agriculture, Nutrition, and Food Systems* https://www.usaid.gov/bifad/climatechange/subcommittee

This working paper explores the potential for deliberate, transformative, systemic change in the agricultural, nutrition, and food systems sector to address the challenges posed by climate change. Recognizing that these challenges, and any associated responses, will be experienced differently by different people, particularly those who are part of marginal or vulnerable groups, the working paper proposes considerations to ensure that climate action in agriculture is socially inclusive. The working paper also discusses specific opportunities and entry points to inform USAID's role in driving agricultural, nutrition, and food systems transformation and targeting climate finance to benefit smallholders.

Conceptual Framework

The working paper adopts the IPCC's Climate-Resilient Development (CRD) framework, which advances the alignment of adaptation and mitigation actions to achieve an inclusive, sustainable future. In the context of this study, mitigation is defined as low-emissions-development actions, and for adaptation we are using the definition in USAIDs Climate Strategy 'reducing climate vulnerability and improving resilience to climate impacts.' The working paper notes that budgetary and programmatic siloing of adaptation and mitigation within USAID and country governments makes implementing a CRD approach challenging. The working paper finds that CRD is not achieved by distributing effort and resources evenly across adaptation and mitigation but instead by focusing on either adaptation or mitigation, depending on the context. The decision to focus on either adaptation or mitigation should be informed by a consideration of tradeoffs and synergies. Therefore, the relative budgeting for adaptation and mitigation should reflect an agency's understanding of the leverage points it is most able to engage to bring about transformational change that moves agriculture, nutrition, and food systems toward climate-resilient development pathways (CRDPs). Finally, CRD provides an important framework for integrating climate adaptation and low-emissions development into non-climate development efforts, as CRDPs consist of decisions that align climate and development actions for the achievement of a climate-resilient future.

These findings are informed by a literature review, a series of key informant interviews, including with experts from vulnerable populations, an earlier public consultation, and contributions from subcommittee members and USAID staff through subcommittee meetings. The paper presents emerging findings and considerations across five broad categories of priority systems spanning the agriculture, food, and nutrition sector:

1. Production Systems
2. Demand/consumption systems
3. Processing and post-processing systems
4. Land tenure and land use systems
5. Soil systems

High Potential Leverage Points to Catalyze Transformational Change

The working paper also offers a preliminary set of ten high-potential leverage points for transformational change and their implications for adaptation, low-emissions development, and inclusive sustainable development outcomes. The ten initial leverage points defined and contextualized in the working paper include:

Summary of High Potential Leverage Points

1. **De-risking Agriculture and Food Systems:** De-risking entails sufficiently mitigating and managing these risks for smooth production and consumption outcomes. Climate-related risks result not only in the loss of crops and livestock, food insecurity, negative health and nutrition outcomes, and reduced incomes (IPCC, 2022), but the uncertainty due to climate change drives hedging against risk and creates a disincentive to adopting improved technology and agricultural practices. De-risking is an important leverage point that could transform these systems toward CRDPs.

2. **Integrated Soil Management and Health:** Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans (USDA, 2022). Improving soil health is at the nexus of the soil-human health-environment trinity (Lal, 2020b). Soil health is important to adaptation (improved productivity) and mitigation, with the potential to sequester significant percentages of GHG emissions. Transformations in soil health could enable potentially transformational shifts toward greater and more stable food availability in many parts of the world, thus moving us toward the achievement of SDG2 and, indirectly, SDG1.

3. **Empowering women and other marginalized groups to make climate change adaptation and mitigation decisions.** Agency of marginalized groups to make decisions and implement changes for climate change adaptation and mitigation is an element of many systems where targeted actions can lead to transformational change. The increasing ability of a greater set of actors in global food systems to take climate change adaptation and mitigation actions is made more effective when women, youth, Indigenous communities, and other marginalized groups have equal access to and agency over resources (e.g., finance, land and natural resources, technology, and information) and participate equally in decision making and leadership (UN, 2022). In many ways, empowerment of women and other marginalized groups is noted as a precondition to realizing the full impact of interventions responding to each of the other leverage points in this paper.

4. **Carbon Markets Linked to Regenerative Agriculture[2], Soil Health, and Forest Conservation:** Carbon markets are exchanges where carbon credits are traded. Carbon markets are both a potential source of additional income as well as an incentive for the adoption of more sustainable agriculture, agroforestry, or regenerative agriculture. Carbon markets can reward farmers for management practices that store soil carbon. Additionally, proceeds from carbon credit sales can increase the economic viability of climate projects in challenging markets by allowing for another securitized source of up-front investment, further incentivizing private sector investors and agri-businesses to make the long-term investments often necessary in this space.

5. **Food Waste and Post-Harvest Loss:** Food waste and losses from post-harvest handling are a significant contributor to Greenhouse Gas (GHG) emissions and represent a tremendous lost opportunity to support global food security. Reducing food loss and PHL improves the value and efficiency of crops produced per input and hectare. This, in turn, stabilizes food availability in the face of climate-related and other shocks and stressors (Hansen, 2022; Vaughan et al., 2019). At the same time, reducing food loss and PHL can prevent cropland expansion, leaving more land available for carbon sequestration (Global Panel, 2020).

6. **Research and Development (R&D) for Climate Action:** R&D is perhaps the most important leverage point for climate action across the full spectrum of interventions as many of the solutions, technologies, and frameworks for both adaptation and mitigation efforts are still in early stages, . Research toward innovation for intensification, producing more food on less land, should be developed considering the sustainability of such intensification, considering not only the potential to increase productivity (i.e., increased yields, reduced variability) and environmental sustainability (i.e., conserving biodiversity, protecting water supplies, and promoting soil health) but also assess innovations along the three other domains presented in the sustainable intensification framework: social, economic, and human (Musumba et al., 2017). Research is also important in terms of understanding and measuring the real risks of climate change at a very local level, which will feed into resilience and adaptation efforts, and even access to finance and investment decisions.

7. **Multinational Corporation Environmental, Social, and Governance (ESG) and Net Zero Commitments:** These refer to corporations' commitments to generally self-defined Environmental, Social, and Governance (ESG) issues. "Net Zero" is the state where GHG emitted that sequestered. MNCs can act as key catalysts for

[2] *Regenerative agriculture is* defined as a farming system that rebuilds soil organic matter through soil biology, diversifies crop systems, and improves water retention and nutrient uptake. Regenerative agriculture is "crop neutral" that is, it is applicable to almost all crops and farming systems (Dahm & Listman, 2022)

adaptation transformation in their supply chains, including at smallholder farmer and agri-small and medium enterprise (SME) levels. Seventy-six countries and over 1200 companies have pledged to zero out net emissions by 2050. If these commitments are realized, they will cut 76% of global emissions.

8. **Low emissions Livestock Development:** Low-emissions livestock development refers to a production system that reduces GHG emissions while achieving greater production of outputs. Livestock are one of the highest emitters of non-CO2 GHGs, estimated at 6% of global emissions and 60% of agricultural emissions. At the same time, demand for animal protein is expected to grow as per capita income and the global population increase. The livestock sector is key to addressing climate change adaptation and mitigation outcomes, and there are substantial opportunities for transformation.

9. **Synergies Between Agriculture and Forest Cover**: Synergies between agriculture and forest cover refer to integrating trees into agricultural landscapes and the relationship between agriculture and forest conservation. Increasing and/or maintaining trees in agricultural landscapes also brings multiple benefits, including enhanced soil quality, reduced erosion, cooling effects, and diversified revenue generation opportunities. Combining trees with agriculture is part of an integrated land-use approach that can be applied at multiple landscape levels (community level, watershed level).

10. **Climate Services:** Effective weather and climate services can contribute to increased food availability and stability of the food supply, thus advancing SDG2 (Hansen et al., 2022). In some cases, they can facilitate the cultivation of more diverse crops, improving nutritional diversity in food systems- another contribution to SDG2. Tailored climate services that account for the needs and pathways of use of diverse potential users in a context can empower marginalized groups to identify and address challenges in their agricultural production and livelihoods more broadly.

Private Climate Finance to Catalyze Adaptation and Mitigation Actions in Agribusiness

The working paper identifies climate finance as a critical tool to catalyze transformations in the food system that can build climate resilience for the most vulnerable people and communities globally. Despite the environmental, social, and political importance of addressing climate change impacts on food systems, cumulative tracked financing for the agriculture, forestry, and other land use (AFOLU) sector only represents approximately 3% of total global finance. Of that, only half (approximately $10B) of those funds are targeted at small-scale agriculture. The level of investment is even lower in regions where agriculture plays a more vital social and

economic role. This paves the way for three primary categories of intervention for USAID to play a high potential catalytic role: market enabling, pipeline development, and direct capital participation.

Technical Interventions Versus the Sociocultural Dimensions of Transformation

While this working paper prioritizes the presentation of these systems in terms of their potential contributions to the achievement of climate adaptation and mitigation goals, transformations in all these systems will require deep engagement with their social dimensions. First, the impacts of climate change tend to compound other social and economic vulnerabilities and inequalities. Therefore, it is not surprising that these impacts fall disproportionately on women, youth, Indigenous Peoples, and other marginalized populations. Second, each of these systems engages not only activities and resource use, but also how people understand the world and their place in it. Transforming systems not only invokes technical solutions, but also transformations in incentive structures, governance, and local institutions, as well as changes in behaviors, norms and power relations. Because its focus is on the preliminary identification of systems that, if transformed, could move us toward climate adaptation or mitigation goals, and the leverage points that might transform those systems, this working paper spends relatively little time on the discussion of the sociopolitical aspects of those systems and their transformation. The social dimensions of transformation are central to the goals of this report, but difficult to identify, articulate, and address at the scale of the system. Therefore, while this preliminary working paper notes technical barriers to inclusive transformation in agriculture, nutrition, and food systems, the sociocultural dimensions of systems transformation will be taken up in greater depth in the final report, which will explore prioritized leverage points and interventions, making these discussions more concrete.

Emerging Opportunities and Entry Points

The sheer scale of the transformations needed to produce climate-resilient agriculture, nutrition, and food systems, the direct connection of these systems to Sustainable Development Goals, the risk of climate solutions that exacerbate the challenges of the most vulnerable, and the deeply social character of the systems and transformations we need all require a whole-society approach. We have identified nine *emerging opportunities* and entry points. In the following months, as the study team solicits feedback and continues analysis, we will refine these opportunities into concrete recommendations and intervention areas.

The CRD approach provides a framework for USAID missions to integrate climate change more systematically into their strategies, plans, and activities and is already

built into the USAID Climate Strategy. This CRD approach enables USAID to layer multiple climate-specific and non-climate-specific development investments into locally driven efforts to build climate resilience and achieve SDGs. CRD broadens the scope and considerations of a project's life cycle to fully integrate mitigation and adaptation concerns, the relative tradeoffs between various choices, and considering the impacts of production over short and longer time horizons to accommodate the rapidly changing climate.

The budget and programming siloing of adaptation and mitigation into separate activities makes implementing a CRD approach more difficult. Adaptation programming that uses targets and indicators without including mitigation goals risk programming activities that compromise mitigation goals and vice versa. At a minimum, the relative budgeting for adaptation and mitigation should consider adaptation and mitigation efforts and their expected benefits side by side. However, the most effective work on CRD will take both adaptation and mitigation impacts of any intervention under consideration. This will allow for the identification and management of tradeoffs between adaptation, mitigation, and development goals.

The Global Food Security Research Agenda can be utilized to develop the knowledge and tools needed to enable the effective prioritization of adaptation and mitigation activities while managing tradeoffs between them. There is a significant knowledge and tools gap related to weighing the relative value of adaptation and mitigation actions, and without means of comparing the costs and benefits of adaptation and mitigation actions, it is difficult to effectively identify and manage tradeoffs. Weighing these tradeoffs is further complicated by the need to consider the adaptation deficits of marginalized and highly vulnerable populations, whose baseline development needs and climate change adaptation needs may be higher to begin with and should be prioritized alongside other measurements of benefit or impact. The Agency, and the climate change community more broadly, needs a wider set of comparative measures and tools to facilitate work on tradeoffs.

Forming coalitions across government, donors, and private sector actors is a key success factor for climate action. Consistent with the emphasis on partnerships and collaboration in USAID's Climate Strategy, this preliminary study confirms the need to form coalitions across government, donors, civil society, and private sector actors to deliver inclusive climate adaptation and mitigation at scale and speed. Collaboration efforts should be built into activity design, as well as analysis, and work planning during the first six months, and clearly tracked and monitored over time. In these efforts, USAID can draw from the wealth of available resources and tools.

Leverage points for systemic change are linked to unique attributes of particular contexts, require up-front analysis as well as adaptive management, and, most

importantly, must be co-identified and co-designed with local actors and communities. While the study team is in the process of identifying likely starting points to achieve impact and potential interventions, the most effective leverage points for a given context will be identified through analysis of specific country contexts and identified and designed by the country governments, country firms, and local communities that will own and implement them. Therefore, utilization of tools and approaches for identifying leverage points, such as USAID's Market Systems Development frameworks, may be as valuable as the identification of current leverage points themselves.

Women, youth, Indigenous Peoples, and other marginalized groups have a leading role to play in climate change adaptation and mitigation. Transformative approaches need to factor in women's and girls' time poverty and lack of agency, as well as the youth bulge and the opportunities that this creates, particularly in Africa. People from marginalized groups can bring forward inclusive solutions to specific or widely experienced challenges. In an appropriate enabling environment, they can serve as agents of change, bringing innovation or their traditional knowledge to their roles and responsibilities in society and identifying barriers to needed transformations and ways to overcome them. The most critical development programming to facilitate CRD may not be about the climate as much as it is about including and empowering marginal groups to participate fully in markets, political processes, and CRD planning processes for the future.

USAID should be an active player in the financial markets to de-risk investments and mobilize capital, with a specific focus on inclusivity. USAID has an opportunity to use direct capital participation in high-impact areas of the market to serve as both a catalyzing force as well as a targeting force to ensure the impact is focused on key inclusive goals. Specific areas in which USAID can do this include co-investing in new or existing funds that have a climate focus (and particularly an adaptation focus) and funding project preparation facilities and/or investment advisory assistance for early-stage projects or solutions (with a particular focus on the climate ag-tech space). For USAID, engagement can help to ensure climate financing policy and activities are focused on achieving more inclusive benefits for smallholders, agribusiness, and marginalized communities, than might happen through purely market mechanisms.

Support the development of investable pipeline opportunities to de-risk investments and mobilize capital, while considering inclusive development objectives. Well-funded and highly capable financial intermediaries often face key barriers at the capital-recipient level (e.g., smallholders and agri-small and medium enterprises (SMEs)). Donor-supported capacity development to build investable pipeline opportunities could be a key catalyst for incremental capital entering the market, especially in areas where capital is already looking to be deployed. USAID can play a role in scaling these models and markets by

supporting and de-risking experimentation that leads to proof of concept, investing in research that provides evidence for these changes, convening key stakeholders that need to be bought into these actions, and using USAID's leverage and advantages in partnerships to keep a focus on inclusive impact goals.

Support local governments with policy, procedural, and regulatory reforms, aligned with CRDPs. National and sub-national governments have a clear opportunity and need to reorient policy, regulatory, and incentive frameworks to support agriculture and food system transformation toward more sustainable practices. There are significant levers that domestic governments currently use in the form of agricultural subsidies and targeted tax policies that can be reoriented toward low-emission and negative agricultural productivity-enhancing technologies and practices. USAID could play a role by supporting robust long-term policy processes that lead to meaningful transformation. For instance, USAID could strengthen government capacity in scenario planning that accounts for climate change uncertainties and complex interactions that underpin agriculture and the food system.

Next Steps for The Climate Change Study

The analysis presented in this working paper will evolve as the study is informed by further insights from the literature and interviews. Those insights will be organized around the final set of prioritized systems that might deliver maximum transformational benefit. Understanding which systems are the highest priority for achieving transformational change will, in turn, allow for the prioritization of leverage points that might serve as catalysts of change in those systems, and the interventions that might work on those leverage points to bring about those changes. Finally, by linking priority systems to leverage points and interventions, the final report will identify appropriate targets for USAID's efforts to enhance food and nutrition security under climate change.

1. INTRODUCTION

1.1 Background

The Board for International Food and Agricultural Development (BIFAD) is a presidentially appointed seven-member advisory board to USAID established in 1975 under Title XII of the Foreign Assistance Act, as amended, to ensure that USAID brings the assets of U.S. universities to bear on the development challenges in agriculture, nutrition, and food security and supports their representation in USAID programming. BIFAD's thought leadership and ability to convene the U.S. university and research communities, along with international partners, positions the Board to develop evidence-based recommendations on pertinent issues of global importance.

The most recent Intergovernmental Panel on Climate Change (IPCC) report demonstrates that climate change already has a widespread impact and that those impacts are intensifying. Climate change profoundly impacts the food and agriculture system, with climate-related extremes already stressing production systems and negatively affecting livelihoods, and food and nutritional security. Vulnerable groups, such as women, youth, children, Indigenous Peoples, and other minority groups will face the most severe impacts of climate change due to unequal access and control over resources. At the same time, agriculture is one of the few sectors that offers potential for both mitigating emissions and removing carbon from the atmosphere.

In light of the urgency for climate action and USAID's priority in addressing the crisis, BIFAD formed the BIFAD Climate Change Subcommittee (Subcommittee). The Subcommittee has been tasked with providing recommendations to BIFAD to accelerate systems change to achieve transformative climate change adaptation and mitigation outcomes in agriculture, food systems, and nutrition. These systemic changes should enable and empower women, youth, rural communities, and other marginalized groups as agents of change. BIFAD asked the Subcommittee to provide specific recommendations to enhance USAID's support for improving the benefits of climate finance to smallholders in line with the Global Food Security Strategy - Refresh (GFSS-R), USAID's Climate Strategy 2022-2030, and other sectoral policies.

As a key work stream under the Subcommittee, BIFAD commissioned a study to focus on systemic solutions for climate change adaptation and mitigation in agriculture, nutrition, and food systems. Through reviewing existing evidence and consultation with subject matter experts, the study will achieve three main objectives:

1. Suggest realistic 2030 targets and intermediate results to guide USAID program design for the agriculture, food, and nutrition sectors.
2. Identify priority leverage points for transformative systemic change and scaling climate finance to achieve the targets and intermediate results for the sector.
3. Prioritize areas for USAID action in the sector and recommend interventions.

The study will be undertaken between July 2022 to March 2023. However, with the momentum building ahead of the 27th Conference of Parties (COP27), USAID and BIFAD wanted to seize the opportunity to test some emerging concepts and solicit public feedback.

To this end, this document presents emerging opportunities and entry points with the explicit purpose of gaining more feedback and testing ideas ahead of COP27. The study team will continue to undertake research in the months ahead, and welcome public comments and ideas. The working paper also includes a deep dive into climate finance solutions for inclusive systemic transformative change in the agriculture, food, and nutrition systems.

This working paper is a product of background literature review, key informant interviews (KIIs), and the contributions of subcommittee members and USAID staff through subcommittee meetings. It presents, for public discussion, emerging findings and considerations regarding:

1. Climate-resilient pathways for inclusive, transformative systemic change in agriculture, nutrition, and food systems;
2. Key systems for inclusive transformation in food, agriculture, and nutrition;
3. Barriers to inclusive transformation in agriculture, nutrition, and food systems;
4. Priority leverage points for transformative systemic change; and
5. Climate finance solutions to catalyze inclusive adaptation and mitigation actions in the agriculture, food, and nutrition sector.

This preliminary document does not include an analysis of targets or explicitly recommend key interventions in depth. Both will be incorporated into the full study. Further, because its focus is on the preliminary identification of systems that, if transformed, could move us toward climate adaptation or mitigation goals, and the leverage points that might transform those systems, this document spends relatively little time on the discussion of the sociopolitical aspects of those systems and their transformation. The social dimensions of transformation are central to the goals of this report, but difficult to identify, articulate, and address at the scale of the system. The next draft of the report will bring forward these critical social factors as it prioritizes systems and leverage points and identifies specific interventions to work on those leverage points.

It is relatively unusual for a study team to present findings so early in the process. We caution that the research is still ongoing. After the prioritization of systems and leverage points is complete, the study team may remove or change the systems and leverage points as it presents more comprehensive findings. Therefore, this document should be treated as a preliminary working draft. If you would like to provide feedback on the initial study findings or recommend the study review specific literature, please write to: rahel.diro@tetratech.com, cc to bifadsupport@tetratech.com.

1.2 Study Methodology

○ Definition of Terms

A **system** is a group of interacting elements that act as a unified whole. **Agriculture and food systems** involve activities and individuals engaged in the production, processing, transportation, and consumption of food, fiber, and energy from the earth's natural resources. Like all systems, the elements of agriculture and food systems can evolve independently or through deliberate action. This Working Paper explores deliberate **transformative systemic change in response to climate change** and details a selection of **leverage points** through a range of **interventions**. These three considerations are defined as follows:

Transformative systemic change: This includes changes to the fundamental attributes of systems in response to actual or expected climate and its effects on people, often at a scale and ambition greater than incremental activities. It includes systems changes toward a climate-resilient development pathway (CRDP) that addresses climate change over timescales.

Leverage points: Processes, interactions, or elements of a system or systems where targeted actions could lead to transformational change.

Intervention: Any activity or a set of activities organized in a project or program designed to influence positive economic, social, and behavioral change.

○ Methodology and Analytical Framework

The study is based on a synthesis of evidence on the transformation of agriculture, food, and nutrition systems to achieve climate adaptation and mitigation outcomes. The approach prioritizes systems within agriculture, food, and nutrition that, if transformed, would result in changes at the scale and depth needed to address the climate crisis. This prioritization draws from a review of recent assessments (i.e., IPCC AR6) and articles to leverage existing systematic reviews of the state of climate change knowledge. This desktop review was augmented by inputs from the subcommittee and KIIs. Both the desktop review and the inputs from the subcommittee and key informants were analyzed with attention to barriers to transformation.

From this review, the study is prioritizing the systems identified by three major factors:

1. The scale of impact relative to what is needed to address the climate crisis and the adaptation, mitigation, and/or development benefit offered by the system if barriers to transformation are overcome. This was assessed both through evidence from the desktop study, KIIs, and expert judgment.
2. The depth of potential transformation needed in socioeconomic and cultural systems and the amount of evidence and experience that exists for successful engagement. This will be assessed both through evidence from the desktop study and through expert judgment.
3. The alignment of potential transformational outcomes with USAID policy goals.

2. PATHWAYS FOR INCLUSIVE TRANSFORMATIVE SYSTEMIC CHANGE

2.1 Climate-resilient Development Pathways

Despite advances to eliminate hunger and ensure global food security, feeding the world's rapidly growing population remains a challenge. Between 702 and 828 million people were affected by hunger in 2021, while 2.3 billion people were moderately or severely food insecure (Food and Agriculture Organization of the United Nations [FAO] et al., 2022). Access to safe and nutritious food will be further reduced due to the direct climate change impacts (Bezner Kerr et al., 2022). At the same time, the food system is a major driver of greenhouse gasses (GHGs), accounting for 16-18 Gt $CO_{2eq}yr^{-1}$ (Crippa et al., 2021; Tubiello et al., 2021). The social cost of current food system-related GHG emissions associated with current food systems is projected to exceed USD 1.7 trillion per year by 2030 (FAO et al., 2022).

Protecting food production is a central objective of the United Nations Framework Convention on Climate Change (UNFCCC, 1992). The urgency to limit climate change and ensure that our food system is resilient to the increasing climate risk and impacts faced by communities worldwide is unprecedented. It is also increasingly apparent that this goal cannot be achieved through incremental changes in our food, agriculture, and nutrition systems. This means action must go beyond piecemeal responses around soil management, animal husbandry, or transportation networks (Carter et al., 2021). For example, the growth of agriculture production under current practices will not offset expected productivity losses under projected climate scenarios across time-horizons, making it even harder to meet the growing global demand for food (Bezner Kerr, et al., 2022; Carter, et al., 2021, Global Panel on Agriculture and Food Systems for Nutrition, 2020).

Globally we must pursue systemic shifts in our food systems to make them more adaptable, resilient, and inclusive. We must also transform our food systems from drivers of climate change to carbon sinks—i.e. from one of the largest sources of GHGs to sequestering carbon and reducing atmospheric GHG. Realizing this vision means we need a clear understanding of the changes we require in how we raise, cultivate, harvest, transport, market, and consume food in a changing climate and a planning framework to get us there. This framework must accommodate the inherent uncertainty of a future under climate change and avoid promoting actions that fail to align with emerging conditions over time in seeking a singular vision of the future.

CRDPs provide an understanding of how climate change will evolve under different scenarios and a framework for development planning that integrates mitigation, adaptation, sustainability, and inclusion goals. Climate-resilient development (CRD), first outlined as a framework to

achieve sustainable development in the Fifth Assessment Report (AR5) of the IPCC, and amplified in the IPCC's Warming of 1.5 Degrees Report, is also a central concept in the Sixth Assessment Report (AR6). The Working Group II Contribution to AR6 defines CRD as "a process of implementing GHG mitigation and adaptation measures to support sustainable development for all" (Schipper et al., 2022). Following this definition, CRDPs are "development trajectories that successfully integrate mitigation, adaptation and sustainable development," with the aim of supporting "sustainable development for ensuring planetary health and human wellbeing" (Schipper et al., 2022). In this framing, sustainable development provides a broad goal to which adaptation, mitigation, and development actions should contribute.

The CRD approach provides valuable opportunities for development practitioners and policymakers, including:

- Allowing communities, governments, and other stakeholders to consider **mitigation actions** to reduce GHG emissions and preserve natural resources to avoid further contributions to climate change while also planning **adaptation actions** that enable people to thrive in the changing climate.
- Considering the **tradeoffs and opportunities** that emerge among mitigation, adaptation, and development goals in any policy, project, or intervention context.
- Building a **complex multi-stakeholder system** that combines government, private sector, communities, research, and support services, which evolve and respond over time as circumstances change and the impacts of climate change increase.
- **Considering how climate variability and extremes will impact development**, adaptation, and mitigation outcomes. This informs efforts to build climate risk management capacities that limit losses and damages and enable people, businesses, and communities to seize opportunities for green growth.
- Providing **a platform for locally driven climate action, adaptation, and development**, where local stakeholders define their vision of a climate resilient future that their partners can support them to achieve.
- Systematically **integrating, gender equality, social inclusion, equity, and climate justice** into climate change and development planning.

Rather than serving as step-by-step instructions for achieving a just, sustainable future, CRDPs help stakeholders envision and choose their future options, setting a direction for their development planning that responds to the changing climate. The approach requires regular periods of pause and reflection, where stakeholders review the climate change state of knowledge, as well as, any progress, successes, and challenges on the path toward a desirable future. This process allows stakeholders to constantly adapt and reorient their development actions to account for the changing world in which development is taking place. Through this

process, stakeholders can identify the leverage points or changes to their systems with the most significant potential for the achievement of CRD. Finally, by taking a long-term perspective on adaptation and fostering multi-stakeholder collaboration and ongoing adaptive management supported by research, the climate-resilient pathways framework helps to increase the sustainability and durability of actions, reducing the risks of maladaptation[3].

2.2 Empowering Women, Youth, Indigenous Peoples, and Underrepresented Groups for Inclusive Transformative Systemic Change

USAID has demonstrated a commitment to gender-responsive climate action, as evidenced, for example, through its commitment to double its spending on gender to $2.6B by 2023. USAID's climate strategy commits to support partners to achieve systemic changes that increase meaningful participation and active leadership in climate action of Indigenous Peoples, local communities, women, youth and other marginalized and underrepresented groups in at least 40 countries. USAID's Diversity Equity, Inclusion, Accessibility (DEIA) Strategy and USAID internal climate justice reforms include increasing the diversity of climate staff at USAID and its partners and assessing how climate change affects marginalized populations, including lesbian, gay, bisexual, transgender, queer, and intersex (LGBTQI+) populations.

Indigenous peoples, women, girls, and other marginalized populations are often the most affected by climate change impacts for various reasons. These vulnerable populations are also uniquely affected since climate impacts and risks worsen preexisting vulnerabilities and inequalities, including unstable incomes, poor infrastructure and weak access to markets. Rising temperatures and changing and/or irregular precipitation are felt most acutely in rainfed smallholder systems, where the yields are 50% lower than irrigated fields. This low productivity of rainfed agriculture systems is the main factor that accentuates hunger, poverty, unemployment, and migration in Central America and other regions in Latin America (Jaramillo et al., 2020). Gender and other inequalities and power relationships shape vulnerability, adaptive capacity, and resilience to climate. As a result, climate impacts also reinforce pre-existing patterns of marginalization with dire implications for the human security of the most vulnerable (United Nations Environment Program [UNEP] et al., 2020; Carr & Thompson, 2014). In times of climate crisis, women are often hit the hardest—in drought they walk farther to find water; in famine they eat less to feed their family; and in times of natural disasters, children cannot attend school, leaving their mothers to care for and educate them (Dupont, C. 2012; Dankelman, Irene, ed., 2010). Some of these impact pathways are direct. For example, women

[3] Maladaptation refers to "actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence." (IPCC, 2022)

in agriculture often lack access to productive resources and are therefore unable to adopt climate-smart agricultural practices. There are also labor productivity losses when farmers under severe heat stress slow down and take more breaks to rehydrate and cool down (Parsons, 2014; Kjellstrom et al., 2009; Sahu et al., 2013). In some contexts, women, notably older women, are particularly disadvantaged due to lower access to credible information about climate issues and their absence from the domains in which climate interventions are generally implemented (Archer, 2013; Carr et al., 2020; Nyasimi & Huyer, 2017). Additionally, women do not have sufficient access to financing aimed at covering water-related losses, nor do they have funds to service adaptation and mitigation technologies (United Nations Women Watch, 2009). In the decision-making pathway, women are not represented equally in the key climate-change sectors of science as skilled workers, professionals, or decision makers. They are a minority in fields that are vital for the transition of sustainable development such as energy, engineering, transportation, information technology and computing—which is useful for warning systems, information sharing and environmental monitoring (UNESCO, 2015). Other pathways are more complex and less considered. For instance, there is evidence that explicitly links climate change related extreme weather and climate variability with increasing violence against women, girls and vulnerable groups including LGBTQI (IPCC, 2022). Heightened household stress due to fluctuating temperatures related to climate change has also been linked to increases in GBV prevalence in Australia, the US and Bangladesh (Flato, 2017). Vulnerability to climate change has also been connected to human trafficking (IOM, 2016) and child marriage (Ahmed et al., 2019). Similarly, a 2020 United Nations High Commissioner for Refugees [UNHCR] and Postdam Institute for Climate Impact Research report shows that transgender, intersex, and non-binary people often face increased protection risks during and after natural disasters due to unequal access to emergency reliefs and shelters (UNHCR and PIK, 2020). This means they are at risk of suffering from violence, coercion and deprivation of basic goods and services during a humanitarian crisis.

Today's youth will experience the worst effects of climate change (Commonwealth Secretariat, 2021), and therefore must be engaged in climate adaptation and mitigation (Bullock and Crane, 2020). One of the major coping strategies to the challenges posed by climate change is migration to urban and peri-urban areas (Amsler et al., 2017), leaving the elderly and young women in rural areas to navigate harsh weather conditions, and workload at both community and household levels. Although measures are being taken to address climate adaptation in agriculture to climate change, a failure to capitalize on the youth demographic dividend could result in youth disenfranchisement and increased climate mobility. Migration (understood as climate mobility in this instance) is not a choice but a necessity. Investing in sustainable rural development, climate change adaptation, and resilient rural livelihoods is therefore an important part of the global response to the current migration challenge (FAO, 2016).

What does inclusive transformative systemic change look like?

All sectors and all levels of society—from local to national, rural to urban—require new ways of working to adapt to climate change. This is more than technical and material change. Each of the systems considered in this document, and in the larger report, engage issues of identity, institutions, and power through which people make sense of the world. Emerging research and program insights from Indigenous informants in both Belize and Tanzania suggests that engagement and communications for climate transformation require broad population engagement that spans age, gender, community-level group memberships (e.g., farmers, fishers, weavers, transport groups), and other markers of social diversity in appropriate spaces and around issues relevant to the group or cohort. For example, there is growing recognition that supporting women's empowerment and traditional knowledge in climate change policy and programming results in more successful, sustainable, and equitable climate change action. In this context, women and other marginalized groups are also potential agents of transformational change toward CRD, particularly when living in enabling environments that allow them to use their knowledge and capacity (Carr, 2020; Plan International Australia, 2018). However, insights from indigenous groups in both Tanzania and Belize suggest that such change is transformative when women are provided with not only opportunities to innovate and lead, but also the technical skills and financial capacity to hold leadership positions and move innovations forward.

Investing and engaging young people in adaptation and mitigation strategies will significantly increase their potential to be resilient (Bullock et al., 2020). The social networks that youth are embedded in (in person and virtually) often mediate agency and their ability to kickstart, participate in, and benefit from CSA initiatives. In Kenya for example, youth participating at various stages of a sustainable dairy intensification value chain either as laborers, providers of value addition such as milk ATM centers or as owners of dairy animals are challenged some of the harmful gender practices that restrict women's ownership of dairy animals and participation in farmers' networks (Bullock and Crane, 2020). Whereas in Belize, insights suggests that attentiveness to the differences in agricultural engagement across genders among youth offers an opportunity for nuanced engagement that is consistent with how communities organize themselves.

The evidence presented above show that transformations to CRD will not succeed unless they are inclusive of women and other marginalized groups in the identification of challenges to be addressed and the design, and implementation of solutions. Transformative changes require an enabling and gender sensitive legal framework; people centered institutions are key to deliver gendered responses on inclusive climate action.

2.3 Implications for USAID

CRD pathways present a useful organizing framework for fostering just and equitable transformational changes in agriculture, food, and nutrition systems to address climate change. CRD pathways are not long-term prescriptions for achieving sustainable development. Instead, they emerge as people, communities, and countries take actions, assess the impact of those actions on their new situation, and then make new decisions and take new actions. As projects are completed and their impacts assessed, project developers can take stock of how food security, markets, and the climate have changed, what actions are most needed as a result to continue down a pathway toward a climate-resilient future, and design subsequent projects accordingly. However, in putting the notion of CRDPs forward, the IPCC (Schipper et al., 2022) makes it clear that effective climate actions are those that incorporate adaptation and low-emissions development in a manner that promotes sustainable development. This framing has two implications for USAID. First, while not every climate action must work on both adaptation and low-emissions development to further CRD, all effective actions in one arena will have, at the design stage, accounted for and addressed any tradeoffs that might be produced in the other arena. Under its current organizational and budget structure, USAID faces challenges in designing and implementing CRD efforts. Differences in mandate and budget lines make it challenging for mitigation and adaptation programming to be scoped, designed, and implemented together. Second, CRD can serve as a strong argument for meaningfully integrating climate change into development programs with their own funding. In a changing climate, achieving development goals will require attention to low emissions development and adaptation, with the relative importance of each shaped by the specific context. This opportunity, however, can be lost if climate actions are not effectively mainstreamed into other development programs, as mainstreaming is not the same thing as integration. Careful program design is needed to avoid situations where every project claims a climate benefit without developing a clear adaptation or mitigation rationale. The final report, which will present prioritized systems, leverage points, and interventions, will draw upon that prioritization to make specific recommendations regarding organizational structure and budget.

3. KEY SYSTEMS FOR INCLUSIVE TRANSFORMATION

3.1 Trends in Agriculture, Food, and Nutrition

The world is facing a series of challenges that have escalated into a global food and humanitarian crisis. The compounded impacts of the war in Ukraine, the COVID-19 pandemic, and increases in the number and severity of climate change events such as Hurricane Ian in Florida, the flooding in Pakistan, or the severe drought in the Horn of Africa have pushed us further away from achieving sustainable development goals (SDGs). Rates of undernourishment, which had been largely stable since 2015, increased by nearly 20% during the pandemic, from 8.2% to 9.8% globally (FAO et al., 2022) — the highest rate since 2009. Access to nutrient-rich food is even more limited, as recent estimates suggest healthy diets are unaffordable for 3.1 billion people (FAO et al., 2022). Globally, (56%) 372 million preschool-aged children and (69%) 1.2 billion non-pregnant women of reproductive age are deficient in micronutrients (Stevens et al., 2022). In absolute terms, between 702 million and 828 million people are currently experiencing undernourishment. The FAO estimates that, when compared to pre-pandemic scenarios, the pandemic will result in an additional 78 million people experiencing undernutrition in 2030 (FAO et al., 2022). The war in Ukraine will exacerbate this trend, with the effects of the war on food and fertilizer availability increasing the prevalence of undernutrition by between 1% and 1.8% globally (FAO et al., 2022). Global environmental shocks such as heat waves also impact nutrition, as a 2°C rise in temperature increased child stunting by 7.4% in West Africa (Blom et al., 2022).

While the pandemic and war on Ukraine are both drivers of increased food insecurity and reminders of the complex, interdependent world in which threats to food security emerge, these global shocks have simply exacerbated longer-term trends in food security at a global or regional level (FAO et al., 2022). Africa, Latin America and the Caribbean, and Asia have seen steady increases in both severe and moderate food insecurity since 2014. These trends reflect, among other things, already-realized impacts of climate change on productivity, storage, transportation, and consumption of food products that stress food systems (Pörtner et al., 2022). For example, both the reliability of harvests and yield growth for many crops have already been compromised by the effects of climate change (Pörtner et al., 2022).

Neither the impacts of climate change nor current food insecurity and undernutrition outcomes are evenly distributed within regions, countries, communities, or even households. Figure 1 illustrates that in 2021, before the War on Ukraine started, the African population already experienced a substantially greater rate of undernutrition than those in other world regions (FAO et al., 2022).

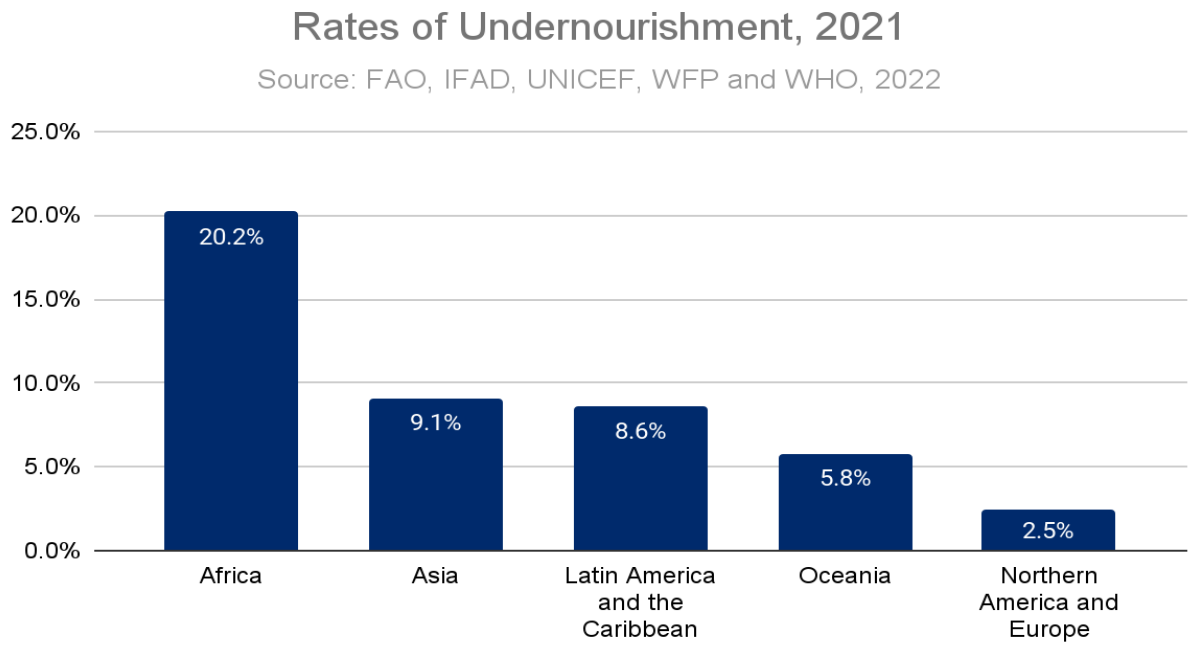


Figure 1. *Rates of undernutrition by world region, 2021 (FAO et al., 2022)*

Within regions, there is also substantial variability. Figure 2 demonstrates that while 26.2% of the African population experienced severe food insecurity in 2021, this challenge was unevenly distributed across the continent.

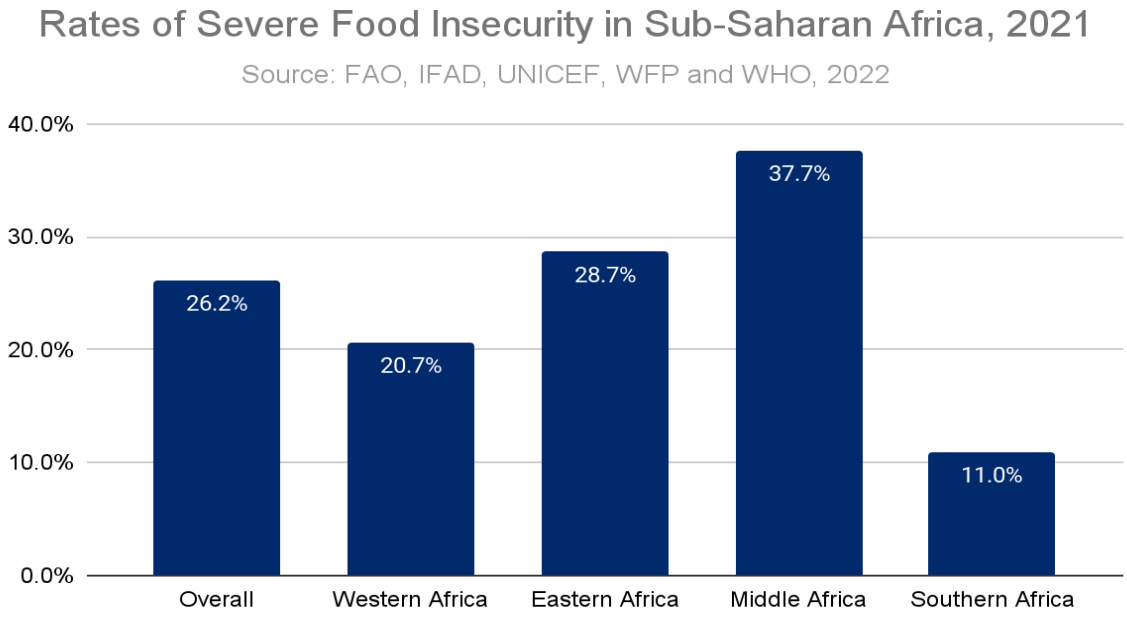


Figure 2. *Regional variation in severe food insecurity in sub-Saharan Africa, 2021 (FAO et al., 2022)*

Within regions and countries, social differences including gender, age, ethnicity, and livelihoods create variable experiences of climate change and its impacts. For example, across regions, smallholders are among those most impacted by climate change due to their direct dependence on agricultural production for their food and livelihoods (Bezner Kerr et al., 2022). Women, the elderly, and children in low-income households; Indigenous Peoples; minority groups; small-scale producers and fishing communities; and people in high-risk regions more often experience higher rates of malnutrition, livelihood loss, and rising costs (Pörtner et al., 2022; Bezner Kerr et al., 2022). These unequal impacts contribute to differences in food security outcomes across social groups. FAO notes that the gender gap in food insecurity grew in 2020 and 2021, reaching 4.3%. While food security outcomes are a product of roles, responsibilities, and entitlements associated with place-specific intersections of different identities, such as gender, age, ethnicity, and income, the impacts of climate change tend to exacerbate existing inequalities and vulnerabilities at all scales (Carr & Thompson, 2014; Hlahla et al., 2022; Asfaw & Maggio, 2018).

While central to human well-being, agriculture and other food- and nutrition-related activities are also important contributors of emissions that drive climate change. The IPCC estimates overall anthropogenic emissions from food systems to be between 10.8 and 19.1 $GtCO_2$-equivalent per year, equivalent to 21-37% of total anthropogenic emissions (Mbow et al., 2019). Tables 1 and 2 show annual GHG emissions from the agricultural sector for different countries. Recent studies estimate that emissions of 17 $GtCO_2$-equivalent per year are associated with producing, processing, distributing, consuming, and managing the residues of food systems (Crippa et al., 2021). Figure 3 illustrates the sources and amounts of GHG emissions from different food system components. According to the IPCC, the Agriculture, Forestry and Other Land Use (AFOLU) sector, including agricultural uses, can provide 20-30% of the global mitigation needed for a 1.5C or 2.0C pathway[4] to 2050 (Nabuurs et al., 2022). However, the IPCC also notes that the share of GHG emissions from food systems generated outside the AFOLU sectors has increased from 28% in 1990 to 39% in 2018 (Babiker et al., 2022). Ruminant animals, the vast majority raised for food, are the largest contributor to AFOLU CH_4 emissions, while manure application, nitrogen deposition, and nitrogen fertilizer use in agriculture is the leading source of AFOLU N_2O emissions (Nabuurs et al., 2022). The agricultural sector's CH_4 emissions are dominated by three major contributors: enteric fermentation in ruminants, rice cultivation, and a much smaller contribution from manure management (Nabuurs et al., 2022). Agricultural soil management and use dominates N_2O emissions, with the IPCC reporting robust agreement that agriculture accounted for approximately two-thirds of overall global anthropogenic N_2O emissions (Nabuurs et al., 2022).

[4] Limiting warming well below 2 °C and preferably below1.5°C compared to pre-industrial levels is the goal under the 2015 Paris Agreement to avoid significant and potentially catastrophic changes to the planet. 1.5 °C and 2 °C pathway refers to efforts tolimit global warming of 1.5 °C and 2 °C above pre-industrial levels.

Table 1. Top and bottom 10 emitting countries of agricultural methane and nitrous oxide in Gg

	Country	Total Annual Agricultural N2O and CH4 emissions (Gg)	
Non-Annex I countries	Niue**	0	**AFOLU reporting format
	Micronesia (Federated States of)*	0.77265	*LULUCF reporting format
	Nauru*	0.918404	
	San Marino*	3.934193548	
	Tuvalu*	4.6166	
	Singapore**	5.3	
	Andorra**	6.77	
	Cook Islands**	7.7227	
	Palau*	8.51	
	Bahamas*	9.303286	
Annex I countries	New Zealand*	41303.2	Not in top 10
	United Kingdom*	41879.8	11499.9
	Canada*	56622.5	Not in top 10
	Germany*	59601.9	33343.6
	Turkey*	68017.1	Not in top 10
	France*	72149.1	Not in top 10
	Australia*	72160.6	15845.5
	Russia*	111117.5	58233.1
	European Union*	423604.5	58897.5
	United States*	611246.3	31027.3
	Ukraine	Not in top 10	50028.7
	Kazakhstan	Not in top 10	22931.3
	Finland	Not in top 10	8639.0
	Iceland	Not in top 10	7195.5

**Data was collected from each Party's most recent National Communication (NC), Biennial Update Report (BUR), or Common Reporting Format (CRF) table submitted to UNFCCC. Annex I country data is from inventory year 2019, and Non-Annex I country data is for different inventory years. Source: Dittmer et al., 2021.*

Table 2: Net Cropland and Grassland CO2 Emissions and Removals in Gg by the top 10 net emitting countries

Annex I Party	2019 Net Cropland and Grassland CO2 Emissions and Removals (Gg)
European Union	58897.5
Russia	58233.1
Ukraine	50028.7
Germany	33343.6
United States	31027.3
Kazakhstan	22931.3

Annex I Party	2019 Net Cropland and Grassland CO2 Emissions and Removals (Gg)
Australia	15845.5
United Kingdom	11499.9
Finland	8639.0
Iceland	7195.5

** Data was collected from each Party's 2021 Common Reporting Format (CRF) table submitted to UNFCCC, representing inventory year 2019. Source: Dittmer et al., 2021.*

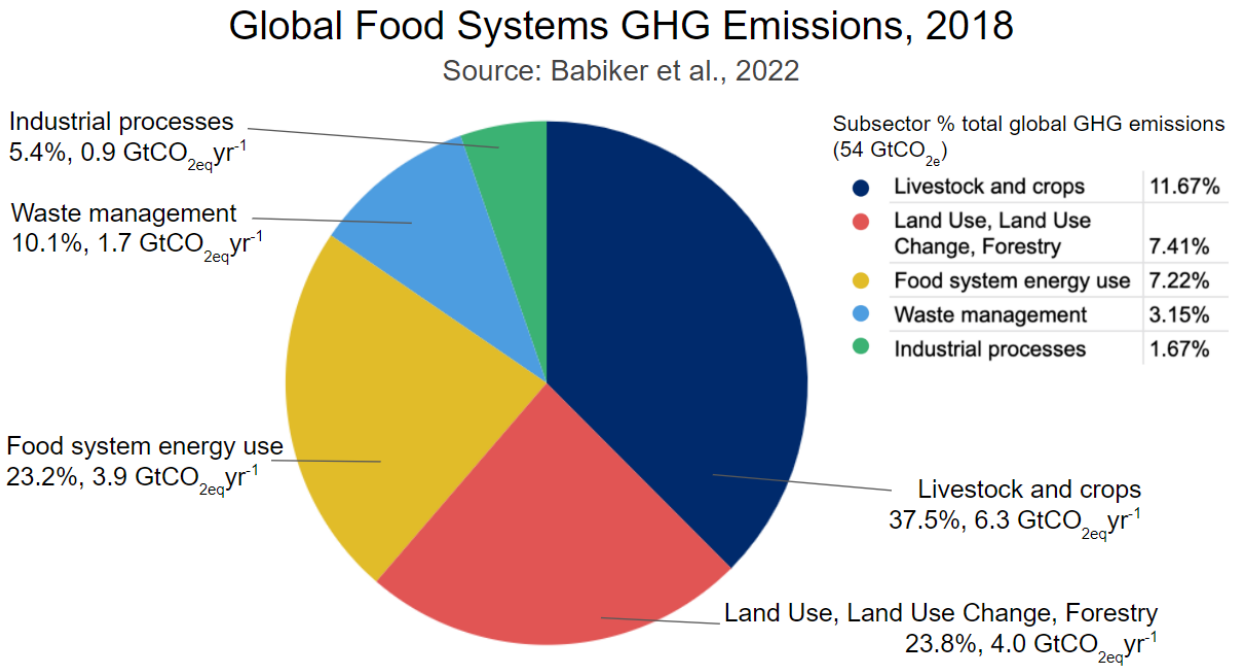


Figure 3. *Sources of emissions in food systems. Industrial processes include direct emissions associated with food systems such as refrigerants, fertilizer, and packaging. Waste management refers to waste generated in the food system. Food system energy use includes transport and electricity and heat attributed to the food sector, including refrigeration (Babiker et al., 2022).*

The IPCC, FAO, and other organizations report that climate actions in the agriculture sector often offer opportunities to generate positive effects outside of a narrow adaptation or mitigation focus. Such effects are often called co-benefits. Adopting a CRDP framing, as put forth by the IPCC, does not require implementing actions that result in both adaptation and mitigation benefits (Schipper et al., 2022); areas with significant adaptation needs may have minimal mitigation potential, while places with significant mitigation potential might not require the same level of adaptation intervention. Instead, CRD requires aligning them so that 1) adaptation actions in agriculture do not exacerbate emissions or compromise mitigation potential and vice versa, and 2) any adaptation or mitigation effort is aimed at the achievement of sustainable development.

3.2 Climate Change Adaptation and Mitigation in Agriculture

At the broadest level, climate change adaptation and mitigation in agriculture faces the challenge of transformational change. Agriculture represents one-third of global GDP, employing 65% of working adults globally. The IPCC's Sixth Assessment Report makes it clear that there are no longer pathways of incremental change that bring us to a just, sustainable future (IPCC, 2022). There is no pathway to a net -zero world without substantial changes to practice that reduce emissions from agriculture and food systems. Local, national, and global food systems will see increasing challenges from climate-related shocks and stressors. These challenges are most acutely felt by the most vulnerable in a population and therefore likely to be impediments to the achievement of SDGs such as no poverty, zero hunger, and gender equality. In this context, agriculture and food systems will have to meet a 55% increase in caloric demand from a growing, increasingly wealthy population (Searchinger et al., 2019). The IPCC notes that the projected potential for reducing yield losses in existing farm management practices averages 8% in mid-century and 11% by 2100, amounts too small to offset projected negative impacts on production from climate change (Bezner Kerr et al., 2022). Expanding the use of resistant seed varieties through genome-editing technologies can provide a pathway to adaptation to climate change at the farm level but these technologies require the appropriate policies and traits to ensure wide-scale use by smallholder farmers (IFPRI, 2022). Previous policies have emphasized yield increases through agricultural intensification of staple crops at the expense of creating a nutrient-rich food supply (Global Panel, 2022; Thornton et al., 2019). Dietary shifts towards plant-based diets could reduce GHG emissions by up to 80%, improve nutrition, and reduce mortality (Willett et al., 2019). Whether addressing adaptation needs or meeting mitigation targets, agriculture systems will need to implement actions that transform what is cultivated and raised and where and how it is cultivated and raised, while wider food systems will need to address issues of demand and waste on the consumption side. In some cases, adaptation could also mean exiting agriculture. Fostering such transformation will require both clear targets that define the desired outcomes of global agriculture production, adaptation, and mitigation and well-formed theories of change that link interventions big and small into pathways of transformation toward these goals.

UNEP estimates that keeping the world on a trajectory below 2.0 degrees of warming will require reducing global emissions from all sources by an additional 13 $GtCO_2$-equivalent per year above and beyond what we are likely to achieve under current policies, commitments, and practices (UNEP, 2021). According to the IPCC, the highest economically achievable emissions mitigation through agriculture is currently 5.9 $GtCO_2$-equivalent per year (with a carbon price of \$100/ton CO_2-equivalent) (Nabuurs et al., 2022). Including the mitigation potential of BioEnergy with Carbon Capture and Storage (BECCS) at the same emissions pricing level could mitigate an additional 1.6 $GtCO_2$-equivalent per year (Nabuurs et al., 2022). To further reduce food system-related emissions will require substantial transformations in every aspect of global food systems.

There are important opportunities that emerge if we transform not just food systems, but also the research, institutions, and governance associated with those systems (Carter et al., 2018). For example, the IPCC states that we need integrated and systems-oriented solutions to food systems under climate change to avoid competition and trade-offs between mitigation and adaptation while reinforcing equity and resilience (Pörtner et al., 2022). Such solutions can take many forms. For example, enabling crop diversification through policy, finance, and research has the potential to diversify income streams and food supply, building resilience through a portfolio of resources and assets. Legume diversification can be effective for both mitigation and adaptation. Such diversification can reduce the use of nitrogen derived from fossil fuels and increase soil biological activity and erosion control. Traditional and locally adapted mixed cropping and agroforestry practices that include leguminous trees can improve soil fertility and microclimate (Bezner Kerr et al., 2022).

3.3 Key Systems and Barriers to Inclusive Transformation

To prioritize systems of production, distribution, and consumption by the likely impact of their transformation, we are employing a rubric that considers 1) the scale of the potential impact on climate change adaptation, mitigation, or both; 2) the extent to which achieving adaptation/mitigation goals will entail substantial social, economic, and/or political transformation, inclusion, and equity; and 3) the alignment of projected outcomes of transformation with USAID policy goals.

In the course of preparing this document, the study team identified key gaps in knowledge and data that make it challenging to use this rubric to identify and prioritize systems that, if transformed, might overcome barriers to climate and food security goals:

1) Reports and assessments of opportunities and challenges for reducing emissions in food systems (Crippa et al., 2021; UNEP, 2021; Nabuurs et al., 2022) make little mention of adaptation co-benefits or tradeoffs, making it difficult to identify when co-benefits or tradeoffs are present and should be assessed.
2) Similarly, while some assessments of adaptation progress and effectiveness (Bezner Kerr et al., 2022) note mitigation as a co-benefit, there is less mention of mitigation tradeoffs.
3) There are few, if any, studies that examine the comparative value of adaptation actions versus mitigation actions. There is no easy equivalence between mitigation benefits and adaptation benefits. This produces two kinds of analysis challenges:
    a) First, there is the challenge of understanding the net benefit of a transformation that produces changes in both adaptation and mitigation outcomes. For example, how can we assess the net value of a project that helps 50,000 farmers in Sudanian West Africa secure agricultural livelihoods by shifting from precipitation-stressed maize to millet production, but in doing so releases more than a million tons of soil carbon

into the atmosphere? Has this release of GHG contributed to processes that will eventually make this adaptation effort ineffective? Or will the increased incomes provided by a more stable harvest improve the adaptive capacity of the farmers such that they can manage any enhanced impacts?

b) Second, there is the challenge of systems where the benefits of transformation principally accrue to mitigation or adaptation. Without a uniform means of measuring impact, it is difficult to weigh the potential impact of either mitigation or adaptation efforts to address the challenge of climate change such that we can prioritize them. For example, the IPCC notes that there could be adaptation tradeoffs to mitigation efforts, such as using land for bioenergy with carbon capture and storage if that work compromises food production or biodiversity protection but does not weigh the tradeoffs to come to an overall assessment of this approach to mitigation (Parmesan et al., 2022). The IPCC also notes that desalinization might supply needed water to some areas and thus reduce the impacts of changes in precipitation, but at a significant energy cost that might create mitigation tradeoffs (Caretta et al., 2022). Studies of tradeoffs also tend to be limited in scale and global coverage. In our assessment of systems—conducted through the review of reports, assessments, and key academic literature, along with KIIs and the public workshop —we have seen and heard of a wide range of systems that, if transformed in some manner or other, would result in substantial climate benefits. These include (in no order):

   Production Systems

   - Overall: production systems are approached as sites of both adaptation (by securing, stabilizing, or increasing agricultural yields and incomes) and mitigation (by reducing the GHG emissions associated with different activities), though rarely are both discussed in the same place.
   - Livestock/dairy systems: Overall, livestock system interventions are generally seen as having mitigation benefits. This is because ruminants are major emitters in the food system and because cattle raising in many geographies is well suited for transformation to silvopsastoral systems, which is a significant mitigation action.
   - Aquatic/inland fisheries: These systems are principally viewed as a source of livelihood assets that can provide adaptation benefits through local and regional economies by buffering vulnerable and variable agricultural production, but these systems are also sensitive to climate-related shocks and variability (Harrod et al., 2018). Many adaptation strategies for fisheries are concentrated in policy and governance, but there are few examples of practical and documented interventions (Brander et al., 2018; Holsman et al., 2019; Bell et al., 2020).

Transforming aquaculture will require institutional approaches that protect fisheries from overfishing yet also build resilience to climate shocks.

- Agro-ecological farming systems: These systems enhance resilience to extreme events through improving water storage capacity, biodiversity, food security and nutrition, and income, typically through increased biodiversity of crops, animals, and landscapes. If such systems avoid deforestation or contribute to reforestation, they can have significant mitigation benefits. A reduced need for synthetic inputs may also have mitigation co-benefits. However, there is a lack of scientific consensus on the impacts of a global transition to agroecological farming on food security. Some studies found that agroecological production resulted in lower yields than high-input systems (Muller et al., 2017; Barbieri et al., 2019), while others found that such approaches boosted productivity and profit (Smith et al., 2019; Smith 2020), varying with time frame and socioeconomic or political context. These contrasting results highlight the need for additional research.
- Smallholder systems: Most farmers in the world are smallholders. Many are deeply stressed by climate change. Transforming smallholder systems toward practices that enhance productivity and increase market access through mechanisms such as collective commercialization or cooperatives (Aflagah et al., 2022) can provide adaptation benefits, but transformations in what is grown and how have implications for soil carbon sequestration. Whether transformation produces a mitigation tradeoff or co-benefit depends on local geomorphology and ecology and the practices in question.
- Pastoral systems: Pastoral systems have a great deal of adaptive capacity and resilience, as those living in these systems are often mobile and can move cattle and other animals around the landscape to needed water and food. Preliminary evidence of the carbon sequestration potential of grasslands and rangelands suggests that these production systems have mitigation benefits, but evidence is not robust enough to inform our understanding of the magnitude of mitigation benefits or co-benefits that might emerge from transformations in these systems.
- Mixed systems: These systems are generally considered more resilient than crop-reliant systems, providing adaptive capacity in the form of diverse production activities and assets that are not sensitive to the same climate shocks and stressors, and therefore will not all be affected in the same way by a climate shock or stress.
- Irrigation/water systems: 70% of freshwater use is for agricultural irrigation that augments or smooths variability in local precipitation. As a result, irrigated systems are generally framed as having an adaptation benefit if transformed. Few

studies consider the mitigation implications of such transformation. Most consider the energy and emissions costs of desalinated water and wastewater treatment, though water security can enable farm practices that sequester more carbon in the soil. The studies that have considered mitigation tradeoffs have focused on the increase in energy use associated with scaling up wastewater treatment for agricultural reuse.

Demand/consumption systems

- Overall: Shifting consumption patterns, and thus the demand side of agricultural decision-making, is seen largely as providing a mitigation benefit, for example by reducing the number of livestock in farming and food systems. This would reduce emissions because ruminants are the single largest source of AFOLU CH_4. USAID's principal means of addressing these systems lie in efforts to shape dietary diversity and healthy diets. Such efforts present clear opportunities to connect adaptation efforts with low emissions development.

Processing and post-processing systems

- Processing and post-harvest food system: Discussions of this system tend to account for waste in terms of post-production losses in the developing world and post-consumer losses in the developed world. Managing waste can be framed as supporting adaptation, for example in the ways it can augment or stabilize food availability in more urban markets under a changing climate, or as a means of ensuring food security in a world of increasing demand. Securing the post-harvest supply chain is also expected to improve food safety under conditions of growing contamination expected under increasing temperatures. However, a growing body of work examines the GHG emissions implications of food waste, suggesting there could be mitigation benefits to transformation of this system. Improving post-harvest supply chains and increasing trade can also allow for optimal land use that incentivizes the cultivation of locally adapted species (Global Panel, 2020).

Land tenure and land-use systems

- Land tenure systems: Access to and control over land greatly shapes how individuals invest in land health and fertility, and thus both adaptive capacity and potentially mitigation benefits. Changing ranges for important ecosystems, biodiversity, and crops will make land tenure critical for managing both food security and conservation outcomes.

- Soil systems: While often seen as a production question, and therefore to some extent a question of building adaptive capacity, transforming the health of soils in places like sub-Saharan Africa also presents some opportunities for mitigation

co-benefits.

Transformations of these systems would yield adaptation or mitigation benefits, or in some cases both. However, as noted above, many transformations might produce tradeoffs between mitigation and adaptation outcomes. At this point in the prioritization process, having identified significant barriers to meaningfully comparing the mitigation and adaptation benefits that might result from the transformation of these systems, any claims about priorities would fall back on relative efficacy *within* adaptation and mitigation, rather than the contribution of a transformation to CRD.

A possible means of addressing this challenge is to conduct an expert elicitation on the relative importance of the key systems identified in this working paper. For example, from this paper, we can develop a shared foundation of information about the scale and character of expected benefits from each transformation for all members of the expert panel. From this shared foundation, experts will offer their assessment of the relative importance of each system to obtain a prioritization of these systems across mitigation and adaptation benefits and their contributions to sustainable development. This exercise would be used only to facilitate the ranking of systems, rather than to elicit further systems for consideration.

4. HIGH POTENTIAL LEVERAGE POINTS TO CATALYZE TRANSFORMATIONAL CHANGE

In discussions with the subcommittee, the public workshop, literature reviews, and KIIs we have identified ten leverage points with high potential, where a targeted intervention on the leverage point would transform more than one of the systems above and because the system(s) they might transform has the potential to yield very large benefits in terms of CRD. Because the relevance and efficacy of leverage points for transformational change depend on the specific system in question, a prioritized presentation of leverage points will be finalized after the systems prioritization is complete, and each leverage point will be associated with one or more priority systems and have the potential impacts of the transformation in question defined.

The high potential leverage points identified are (in no order):

- De-risking agriculture and food systems;
- Integrated soil management and health;
- Empowering women and other marginalized groups in social groups to make climate change adaptation and mitigation decisions;
- Carbon markets linked to regenerative agriculture, soil health, and forest conservation;
- Food waste and post-harvest loss (PHL);
- Research and development (R&D) for climate adaptation and low-emissions development;
- Multinational corporation Environmental, Social, and Corporate Governance (ESG) and Net Zero Commitments;
- Low-emissions livestock development;
- Synergies between agriculture and forest cover; and
- Climate services.

An in-depth overview of each leverage point is presented in the tables below.

<table>
<tr><th colspan="3">Leverage Point: De-risking Agriculture and Food Systems</th></tr>
<tr><td>Definitions</td><td colspan="2">Risk in agriculture and food systems includes production risk (including weather and climate risk), market and price risk, financial risk, institutional risk, and personal risk (Komarek et al., 2020). De-risking entails sufficiently mitigating and managing these risks for smooth production and consumption outcomes.</td></tr>
<tr><td>Rationale for Transformation</td><td colspan="2">● Climate-related risks result in the loss of crops and livestock, food insecurity, negative health and nutrition outcomes, and reduced incomes (IPCC, 2022).

● Uncertainty due to climate change drives hedging against risk and creates a disincentive to adopting improved technology and agricultural practices. Although hedging can protect against extreme situations, it comes at a significant cost to production during more optimal conditions (Sesmero et al., 208; Newman et al., 2020; Dercon et al., 2011; Ngoma et al., 2019; Barrett et al., 2012; Burke et al., 2010; Carter et al., 2022).

● The opportunity cost of transitioning to a climate-resilient production system is high. For instance, it takes years to reap the benefits of integrating trees into agriculture systems.</td></tr>
<tr><td>Impact Pathways</td><td>Adaptation:

● De-risking ensures food and livelihood security and builds resilience by minimizing the impact of extreme events (e.g., drought, and floods) on productive capacity.

● Sufficient de-risking unlocks productivity, improving yield and adaptive capacity through a higher rate of adoption of improved technologies and practices (Hill & Viceisza, 2012). De-risking also lowers household and community-level social pressures that constrain innovation and transformation</td><td>Mitigation:

● De-risking would accelerate the adoption of regenerative agriculture* and low-emission livestock production technologies and practices, leading to positive mitigation outcomes. One pathway for accelerated uptake is through the reduction of local and community-level barriers to innovation that are reinforced by a need to manage risk and uncertainty (Carr, 2020).

*Regenerative agriculture is defined as a farming system that rebuilds soil organic matter through soil biology, diversifies crop systems,</td></tr>
</table>

Leverage Point: De-risking Agriculture and Food Systems		
	in agrarian livelihoods (Carr, 2019).	and improves water retention and nutrient uptake. Regenerative agriculture is "crop neutral" that is, it is applicable to almost all crops and farming systems (Dahm & Listman, 2022)
Impact Estimates	**Adaptation:** From 2008–2018, USD $117B was lost as a result of declines in crop and livestock production in the aftermath of disasters (FAO, 2021). The nutrition loss is estimated at 6.9 trillion kilocalories per year (FAO, 2021). If production were fully de-risked, it would provide compensation for these losses.	**Mitigation:** De-risking would facilitate climate-resilient practices, including regenerative agriculture and nature-based solutions. For instance, agroforestry has a technical mitigation potential of 4.1 (0.3-9.4) GtCO2-eq yr-1 (Nabuurs et al., 2022), which is relevant if de-risking accelerates its adoption.
Sustainable Development Implications	Vulnerability to climate change is greater in parts of the world where there are high levels of climate-sensitive livelihoods (smallholder agriculture, pastoralism, etc.). In these settings, the impacts of climate variability and change often exacerbate structural inequalities related to poverty, access to services, conflict, and marginalization. As climate hazards become more intense and frequent, poor and vulnerable households have fewer options but to resort to negative coping mechanisms, such as selling productive assets or pulling children out of school. Such measures have impacts that are persistent over time. For example, studies show severe climate shocks experienced during early childhood by girls reduce educational attainment and wealth as adults (Hyland et al., 2019). De-risking is an important leverage point that could transform these systems toward CRDPs. Protection and fallback strategies against shocks help households maintain their consumption levels. But, more importantly, they provide households with the confidence to invest in more productive inputs and practices to take advantage of the good years while lowering constraints on innovation and transformation related to social roles. Lowering risk in agrarian systems is likely to improve food availability, contributing to SDG2, while also creating space for women and other marginal groups in agrarian systems to serve as agents of	

Leverage Point: De-risking Agriculture and Food Systems	
	change (Carr, 2019). This is foundational for a wide range of SDGs, including SDGs 1, 3, 4, 5, 8, and 10. Efforts that focus on a single risk are unlikely to be effective. As we have witnessed from the COVID-19 experience, compounding risk is an impediment to climate adaptation effectiveness. De-risking in agriculture should, thus, take a holistic approach to address all risks.
Gender, Youth, and Social Inclusion Implications	Women's climate risks are often more acute and severe than those of men because they face greater structural challenges in their everyday lives. For example, in many contexts, long-term investments in climate-resilient agriculture are risky for women due to their poor land tenure security, less access to collateral, and uncertain property rights, among others (Glemarec, 2017). Compared with men, women are more vulnerable to chronic food and nutrition insecurity as well as to shock-induced food insecurity (Puskur & Mishra, 2022).
Implications for USAID	USAID is already supporting research and knowledge creation through its Feed the Future Innovation Lab for Markets, Risk, & Resilience (the University of California at Davis). USAID should continue investing in research to identify new strategies and financial instruments for risk management. For effective programming, USAID could strengthen its tools for de-risking agriculture and food systems in its market systems and resilience programming, with a particular focus on climate mitigation and adaptation outcomes. This is of growing importance in the humanitarian sector. A growing body of evidence shows that a speedy response to disasters not only saves lives but also lowers the cost of response (Venton, 2018). A timely response to shocks and disasters prevents household reliance on negative coping strategies. Related to this, disaster risk finance instruments and shock-responsive social safety nets could be effective mechanisms when disasters hit. There is an important opportunity for USAID to incorporate disaster risk finance instruments, like forecast-based financing, into its humanitarian programming toolbox for managing the growing risk of climate extremes. In all cases, USAID should build its understanding of challenges, opportunities, and the appropriate means of addressing them through a lens that identifies the underlying structural drivers of vulnerability that are exacerbated by climate change and consider interventions that address these structural issues even if they do not appear to be directly related to climate change or agriculture.

Leverage Point: Integrated Soil Management and Health		
Definitions	Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans (USDA, 2022).	
Rationale for Transformation	• A third of global land is already degraded, requiring manure and fertilizer to replenish the nutrient loss (FAO & ITPS, 2015). • Over-application of nutrients in some regions of the world contributes to N_2O emissions and drives excess nutrient acidification and groundwater contamination, whereas yields are limited by nutrients in other areas. Global nutrient rebalancing of deficit and overapplication areas is urgently needed (Willett et al., 2019; West et al., 2014).	
Impact Pathways	**Adaptation:** • Increasing soil organic content improves nutrient storage, water holding capacity, aggregation, and sorption of organic and/or inorganic pollutants, leading to improved productivity, clean water supply, and biodiversity (Lal, 2004; Parmesan et al., 2022). Healthy soils produce nutritious foods. • Increasing nutrient recycling and use efficiencies could reduce nitrogen use by about 26% and phosphorus use by up to 40% (Willett et al., 2019).	**Mitigation:** • Increasing soil organic carbon through improved land use and management practices can help to sequester carbon.
Impact Estimates	**Adaptation:** Improving soil health can increase world food grain production by 24–40 million Mg per year, and root/tuber production by 6–11 million Mg per year. (Lal, 2006).	**Mitigation:** • SOC sequestration could effectively offset 20–35% of global anthropogenic GHG emissions (Minasny et al., 2017). Global meta-analyses demonstrate agro-forestry as storing 20–33% more soil carbon than conventional

Leverage Point: Integrated Soil Management and Health		
		agriculture (Parmesan et al., 2022). • Enhanced soil carbon management has a global technical mitigation potential of 1.9 GtCO2 yr-1 in croplands, and 1.0 GtCO2 yr-1 in grasslands (Nabuurs et al., 2022). • Between now and 2100, soil management practices and restorative land use have the potential to create a biosphere CO_2 drawdown of between 333 Pg C or about 157 ppm (Lal, 2020a)
Sustainable Development Implications	Improving soil health is at the nexus of the soil-human health-environment trinity (Lal, 2020b). Soil health is important to adaptation (improved productivity) and mitigation, with the potential to sequester significant percentages of GHG emissions. Transformations in soil health could enable potentially transformational shifts toward greater and more stable food availability in many parts of the world, thus moving us toward the achievement of SDG2 and, indirectly, SDG1. Challenges to soil health will increase with rising temperatures. Technical and non-technical barriers need to be addressed and considered. The key now is to help establish mechanisms to facilitate the adoption of integrated soil management and public programs that can roll out and effectively tailor soil needs to a given local context, utilizing locally based research and monitoring systems that can adapt under changing climate conditions.	
Gender, Youth, and Social Inclusion Implications	Through cross-population inclusion across the entire agriculture and food systems value chain, progress on soil health can also positively impact development goals around equality, women's empowerment, and youth engagement. There is also a need for gender transformative innovation and extension that integrate social approaches addressing underlying cultural and structural challenges for women and other marginalized groups with technical interventions so that they may adopt improved practices	

Leverage Point: Integrated Soil Management and Health	
	(Badstue et al., 2020). Gender-equitable land reform and gender-sensitive finance and technical support are necessary for female-led farms to invest in longer-term soil health practices and meet competitive market standards (Zhang et al., 2021; Ali et al., 2014; Quisumbing & Kumar, 2014). "Gender neutral" approaches, technologies, and policies often exacerbate existing gender inequalities and result in lower adoption among women-led or owned farmers. Further emphasis on understanding how traditional approaches to soil health can be enhanced rather than replaced where they have worked effectively, and how women and youth engagement at different points in farm activities can deepen inclusive engagement while valuing stable traditional structures, particularly in indigenous communities. Through dedicated training and finance for activities dominated by underserved groups (such as seed sourcing in some contexts), interventions can increase productivity and income on farms, leading to positive impacts on health and nutrition across all groups (Lal, 2016).
Implications for USAID	While continued support for research on integrated soil management methods is critical to addressing location and context-specific challenges, USAID should now prioritize bringing research to action (Lal, 2020), with governments to implement soil health restoration programs and with soil carbon sequestration central to these efforts. This includes restoring soil health (especially where it has been degraded) and facilitating better water management and irrigation, erosion control and environmental sustainability, and sound fertilizer application. Beyond extension and market mechanisms, USAID could also support governments to put into place carbon market mechanisms linked to soil carbon sequestration and/or regenerative agriculture practices (see Section 5). USAID could also consider facilitating discussion with the government and communities about reforesting land that had been used for agricultural purposes but with marginal soils. These could be linked with agro-forestry or other natural climate solutions, along with sustainable intensification of land on healthy soils. As a high-impact trust-building measure, USAID is also uniquely placed to study and capture indigenous soil health and broader food system practices that can be rapidly enhanced rather than replaced. On the other extreme, soil-less agriculture provides an opportunity to increase food availability and income with minimal environmental impact. While USAID is already investing in this type of agriculture (e.g., in water-scarce environments, in its value chain activity, and in its urban resilience

Leverage Point: Integrated Soil Management and Health	
	programming), there is an opportunity to strengthen and expand the practice in highly populated urban environments. For instance, by the end of the century, it is projected that 13 of the world's 20 megacities will be in Africa. Complementing more traditional agriculture with no soil agriculture in certain settings could contribute to achieving current and future food security, reducing PHLs in the transportation process, creating job opportunities, and generating economic output in the megacities of the future. One of the targets within USAID's climate strategy is to "support the conservation, restoration, or management of 100 million hectares with a climate change mitigation benefit" (USAID, 2022). Within this ambition, climate resilient agricultural targets should be set that specifically address soil health and regenerative practices with the greatest combined climate mitigation impacts and expected human health and nutrition impacts.

Leverage Point: Empowering women and other marginalized groups to make climate change adaptation and mitigation decisions.	
Definitions	Empowerment can be defined as the state at which individuals or groups are enabled to act freely in society, exercise their rights equally to those of other groups, and fulfill their potential as equal members of society. This includes the ability to determine their own life choices, fill leadership roles, and be involved in decision-making in households, communities, and societies. This leverage point focuses on women's agency and the capacity of women and girls to take purposeful action and pursue goals free from the threat of violence or retribution (Bill & Melinda Gates Foundation, 2022; Includovate, 2019). Huyer et al. (2020) discuss four dimensions of women's agency and resilience: (1) participation in decision-making at local, national, and global levels; (2) reduction of work burden; (3) access to and use of productive resources, livelihood incomes, credit, and climate finance; and (4) collective action. This leverage point focuses on agency most related to the first and fourth dimensions. These gender-focused definitions and framings can also be applied to other marginalized groups. USAID defines marginalized groups as "people who are typically denied access to legal protection or social and economic participation and, whether in practice or in principle, for historical, cultural, political, and/or other contextual reasons" (Cotton, et al., 2018). This may include, but is not limited to, persons with disabilities, LGBTI people, displaced persons, migrants, Indigenous individuals and communities, youth and the elderly, religious minorities, ethnic minorities, people in lower castes, and people of diverse economic classes and political opinions. Like women, members of such groups often find themselves facing challenges regarding

	their ability to act freely in society, exercise their rights, fulfill their potential in society, or determine their own life choices.	
Rationale for Transformation	• This paper proposes agency of marginalized groups to make decisions and implement changes for climate change adaptation and mitigation as a priority leverage point, an element of many systems where targeted actions can lead to transformational change. In many ways, empowerment of women and other marginalized groups is noted as a precondition to realizing the full impact of interventions responding to each of the other leverage points in this paper. • The increasing ability of a greater set of actors in global food systems to take climate change adaptation and mitigation actions is made more effective when women, youth, Indigenous communities, and other marginalized groups have equal access to and agency over resources (e.g., finance, land and natural resources, technology, and information) and participate equally in decision making and leadership (UN, 2022).	
Impact Pathways	**Adaptation:** • Empowering women in decision-making around adaptive practices in agriculture empowers women to make farm and business level decisions for more climate resilient agriculture (Huyer et al., 2020); examples show that farming households with greater women's empowerment are more likely to adopt climate resilient agricultural practices such as for soil health and water use (Pamuk et al., 2020) • Investing and engaging young people in adaptation and mitigation strategies will significantly increase their potential to be resilient (Bullock et al., 2020).	**Mitigation:** • One way to cope with extreme weather is to improve water management systems for water use efficiency. Solar-powered irrigation is an innovative way for women to participate in mitigation. In Nepal's Climate Smart Villages, women's groups used solar powered irrigation systems and saw an increase in crop intensity, productivity, and income (Khatri-Chhetri & Chanana, 2017). • More equitable intra-household decision making around fertilizer use has been found to lead to more balanced use of nitrogen fertilizers and, on a larger scale, could contribute to an overall reduction in greenhouse gas emissions (Farnworth et al., 2017). • Indigenous environmental management may also inform the achievement of mitigation goals. Intensifying collaboration and learning from marginalized populations to tap into their

		traditional knowledge regarding conservation practices that might further climate mitigation.
Impact Estimates	**Adaptation:** • A study based on data from 15 West African countries showed that an increased social inclusion could increase the level of food security by 41.5% (Khalid, 2021). • Further study is required	**Mitigation:** • Further study is required to estimate potential impacts and inform target setting. For example, an understanding of the number of individuals from marginalized populations making agricultural and livelihood decisions and the value of financing/grants provided to individuals from marginalized populations to invest in CSA and CSA related businesses.
Sustainable Development Implications	Women's agency and access to resources through agricultural production social networks, such as Village Savings and Loan Associations (VSLAs), can have a positive impact on agricultural productivity in the face of changing and challenging climates (Huyer et al., 2020). Increased women's empowerment is associated with improved food and nutritional security (Larson, 2019). Higher self-esteem and autonomy in decision-making of women is associated with decreased probability of stunting in children (Holland & Rammohan, 2019). There is growing recognition that supporting the empowerment and knowledge of women and other marginal groups in climate change policy and programming results in more successful, sustainable, and equitable climate change action. In this context, women and other marginalized groups are also potential agents of transformational change toward CRD, particularly when living in enabling environments that allow them to use their knowledge and capacity (Carr, 2020; Plan International Australia, 2018). As one early example to be explored as a potential priority intervention, CARE International's transformative potential of VSLAs coupled with its Community-Based Adaptation (CBA) approach has proved useful in building the resilience of vulnerable households in the face of climate change adaptation (Doka et al., 2015).	
Gender, Youth, and Social Inclusion Implications	Rarely does a single social category capture the roles and responsibilities of individuals in agriculture and livelihoods. For example, while there may be differences between men and women in agricultural practice, there are also likely differences among men and women, for example, depending on age/seniority or income. Therefore, marginalization emerges at the intersection of social categorizations relevant to agriculture and livelihoods (Carr & Thompson 2014). This means that efforts to	

	empower women and other marginal groups will need to take this intersectionality into account to fully identify barriers to and opportunities for transformation. Decision-making is complex, particularly at the household farming level, where it is important to understand the significant variations in co-management of assets and how these are connected to roles, responsibilities, and identities.
Implications for USAID	This leverage point speaks to several USAID policy and program priorities and will help to inform implementation of the anticipated USAID 2022 Gender Equality and Women's Empowerment Policy. For example, the USAID Climate Strategy says the Agency "will support our partners to achieve systemic changes that increase meaningful participation and active leadership in climate action among Indigenous peoples, local communities, women, youth, and other marginalized and/or underrepresented groups in at least 40 partner countries" (USAID, 2022). This leverage point also speaks to the three areas of focus in USAID's Youth in Development Policy: access, participation, and systems. This leverage point would deepen the connection between the Agency's climate, gender, and inclusion goals. Further study will assess priority interventions that align to these policies and with the greatest potential for transformative change for climate change adaptation and mitigation and will explore evidence of best practices to integrate gender impact measures into climate-resilient agricultural programs

Leverage Point: Carbon Markets Linked to Regenerative Agriculture, Soil Health, and Forest Conservation		
Definitions	Carbon markets are exchanges where carbon credits are traded. Carbon credits can be purchased and traded for the right to emit a certain amount (typically one ton per credit) of carbon dioxide or other GHG (World Bank, 2022).	
Rationale for Transformation	GHGs have largely been treated as a negative externality to production. Carbon markets are an avenue for businesses to incorporate the carbon they produce and achieve net zero emissions by purchasing offsets, usually in other locations.	
Impact Pathways	**Adaptation:** Payments can incentivize regenerative agricultural practices, and improve soil health, forest	**Mitigation:** Payments for environmental services may help transition land use in food production at the

Leverage Point: Carbon Markets Linked to Regenerative Agriculture, Soil Health, and Forest Conservation		
	conservation, and/or other nature-based solutions linked to agriculture.	systems level but require policy support for implementation.
Impact Estimates	**Adaptation:** Theoretically, carbon credits could finance the transition to sustainable agriculture for many agribusinesses and smallholders if they could be aggregated.	**Mitigation:** The total carbon market was $84 billion in 2021 across all sectors, up 60% from 2020 but covering only 4% of emissions (World Bank, 2022). Only 10 out of the 29 carbon credit markets globally include agricultural practices, with the largest being the Verified Carbon Standard. Renewable energy and forestry represent the vast majority of global credit issuance.
Sustainable Development Implications	The combination of the adoption of Article 6 of the Paris Agreement, multinational net zero commitments, and government national determined contributions (NDCs) should lead to a rapid increase in the demand for carbon credits and the demand for verified carbon projects generating them. Article 6 sets a standard for government regulation and international trade (Climate Council, 2021). While there are still challenges for carbon markets to work for smallholders and other small agribusiness, carbon markets are both a potential source of additional income as well as an incentive for the adoption of more sustainable agriculture, agroforestry, or regenerative agriculture. Carbon markets can reward farmers for management practices that store soil carbon. Additionally, proceeds from carbon credit sales can increase the economic viability of climate projects in challenging markets by allowing for another securitized source of up-front investment, further incentivizing private sector investors and agri-businesses to make the long-term investments often necessary in this space. However, even promising examples such as NKRCP face challenges as varied as technical barriers for monitoring and evaluation to key differences in carbon sequestration potential based on physical ecology. A holistic approach to government regulation is important for the success of carbon markets, including transparency and equity issues. Carbon markets can also	

Leverage Point: Carbon Markets Linked to Regenerative Agriculture, Soil Health, and Forest Conservation	
	incentivize natural climate solutions, such as adding trees to the agricultural landscape and avoiding deforestation and removal of existing trees. These actions have benefits for adaptation and mitigation actions, and depending on scale, can be part of a carbon market approach.
Gender, Youth, and Social Inclusion Implications	Carbon projects have not always resulted in benefits for some of the most vulnerable due to a lack of regulations and transparency, clarity around credit ownership, insecure land tenure, lack of stakeholder consultation, and bad faith behavior by project developers. As Article 6 implementation frameworks are established, it is important that considerations for women, youth, and other marginalized groups be integrated, including through tools like USAID's Policy on Promoting the Rights of Indigenous Peoples (PRO-IP). In addition, consideration must be made of the time and labor burden on women. Unintended negative externalities associated with carbon projects must also be considered, such as agroforestry projects driving long-term ecological (e.g., planting an invasive species of tree to mitigate emissions) or social (e.g., shifting deforestation to other agricultural landscapes, often in more socially marginalized locations) consequences. Learning lessons from the past attempts to implement carbon markets, any support for establishing carbon markets should include transparent design, and gender equality, and social inclusion-aware benefit distribution systems. In addition, marginalized communities should be actively included in landscape management and decision-making and the value of local and indigenous knowledge should be recognized and elevated throughout the process of establishing effective carbon markets.
Implications for USAID	USAID can continue to explore supporting carbon markets for agriculture and food security, facilitating the full spectrum of activities ranging from supporting governments to establishing carbon markets; building capacity and tools for monitoring and measuring frameworks; utilizing USAID's role as a convener to facilitate public-private dialogue around carbon markets and multi-stakeholder partnerships; and helping to ensure that the design is structured in a way that works better for the most vulnerable. Agricultural carbon credits are still an underdeveloped sector that is rapidly gaining traction, investment, and interest. This has important implications for equity and smallholder development and represents another income stream for agricultural land investors. USAID could support partner governments and build their capacity to design

Leverage Point: Carbon Markets Linked to Regenerative Agriculture, Soil Health, and Forest Conservation	
	governance frameworks, including for agricultural or land-based carbon credits, build monitoring and verification partnerships for the credits, and outline the various opportunities that could apply to their particular context and economies. Importantly, USAID can also help to ensure that the process of establishing these markets utilizes a clear and transparent process. Moving carbon markets ahead is essential. However, carbon markets on their own do not reduce carbon emissions. They create a mechanism that incentivizes reduction. While USAID markets typically are much smaller producers of GHG, facilitating more sustainable and lower emission practices now can help USAID focus countries leapfrog to better, greener technologies. USAID might consider a balanced approach, and also emphasize efforts to support countries' lower emissions within production and supply chains and use offsets for additional carbon reduction. This will also help to increase countries' overall competitive offering for potential investors when GHG emissions in supply chains become mandatory for publicly traded companies. Given that, generally, the countries where USAID focuses are low-carbon emitters, carbon markets may be a way to transfer monetary benefits. It is important to take a holistic and cross-sectoral view of potential carbon markets. For example, there are synergies between fragmented smallholder plots and the needed community and watershed approaches to soil and water conservation and community carbon credit projects. Facilitating transparent, locally designed, and led solutions can promote discussion around wider issues and support broader social cohesion. Finally, it is important to recognize the carbon market space as relatively crowded with existing donor and private-led support. While the importance of this leverage point means additional support is still worthwhile, it is crucial for USAID to consider the unique value-add it can bring to the sector as well as the key partnerships that can catalyze further transformational change. As an example, USAID has the potential to add value to the space by supporting the development of new types of carbon credits and methodologies that allow for monetization of climate benefits that are currently not eligible for climate credits (e.g., the protection of standing forests in HFLD countries, ecosystem service provisions, etc.).

Leverage Point: Food Waste and Post-Harvest Loss		
Definitions	Food waste includes plate waste, spoiled food, and peels and rinds, all of which are byproducts of food consumption norms and patterns (U.S. Environmental Protection Agency [EPA], 2015b). Post-harvest loss (PHL) reflects losses in the collection, transportation, and processing of food before it reaches the consumer.	
Rationale for Transformation	An estimated ⅓ of food intended to be eaten is wasted (Buzby, 2022). The UN estimates that food loss and waste account for 8% of all GHG (United Nations, 2020). Post-harvest handling loss and food waste may be able to redirect to better address food insecurity, in some contexts, along with addressing food safety issues (e.g., aflatoxin).	
Impact Pathways	**Adaptation:** Reducing food loss and PHL improves the value and efficiency of crops produced per input and hectare. This, in turn, stabilizes food availability in the face of climate-related and other shocks and stressors (Hansen, 2022; Vaughan et al., 2019).	**Mitigation:** Reducing food loss and PHL can prevent cropland expansion, leaving more land available for carbon sequestration (Global Panel, 2020).
Impact Estimates	**Adaptation:** ● Halving food waste and loss could reduce projected biodiversity loss by 33% (Willett et al., 2019). ● Reducing food waste and PHL could reduce land degradation pressure for 7Mkm2 and 1.98 Mkm2 of land (Smith et al., 2020) ● Stable food availability can reduce the vulnerability of farmers to climate variability	**Mitigation:** Agricultural emissions could be reduced by 0.7-2 Gt CO_{2eq} if food waste and loss are halved. Reducing food waste and PHL can reduce the need for cropland expansion (Broeze & Axmann, 2020). Bovine meat has the highest Food waste associated GHG emissions, suggesting that reducing food loss leads to lower GHG emissions, particularly methane (Guoet al., 2020).

Leverage Point: Food Waste and Post-Harvest Loss		
	and change. Reductions of vulnerability and risk empower efforts at transformational change (Carr, 2019). • Reducing PHLs improves food and nutritional security (Kumar D. and Kalita P., 2017; Kuiper M., and Cui H. D., 2021). Food availability gains from reduced food waste are equivalent to a 22% increase in crop production (Lipinski, 2013).	
Sustainable Development Implications	Food waste and losses from post-harvest handling are a significant contributor to GHG emissions and also represent a tremendous lost opportunity to support global food security. However, this appears to be an under-recognized connection in NDCs: a2020 World Business Council for Sustainable Development (WBCSD) research indicated that only 11 NDC strategies included food loss, and only 1 mentioned food waste (Sales, 2020). Efforts geared toward reducing food loss and waste could strengthen local food systems, leading to improved productivity, dietary diversity, and income, and ultimately achieving food sovereignty. Improving food sovereignty with shortened supply chains and strengthening local food systems can decrease food loss and increase productivity, dietary diversity, and income (Hansen et al., 2022). Reducing PHL and food waste is also a critical component of urban food security and food systems. The reasons for PHL and food waste are very context-specific and require analysis to develop interventions (for example, are they related to transportation delays or poor organization/planning in the production of food causing prices to drop at key times, or limited cold chain or processing infrastructure that might improve shelf life. In addition, value-added processing can increase producer incomes while prolonging shelf life. Processing linked to clean energy solutions and circular economy packaging designs could also be considered climate action.	
Gender, Youth, and Social Inclusion Implications	A 2021 GAIN study undertook a literature review on the connection between gender and food loss and waste. It revealed that women are a significant part of the post-harvest handling and processing/packaging stages, for example, serving as 83% and 72% of actors, respectively, in	

Leverage Point: Food Waste and Post-Harvest Loss	
	West Africa (Nordhagen, 2021). The GAIN study researchers found that some of the constraints that affect women's participation in production, such as access to extensions, new technologies, and transportation, also contribute to PHL and food waste, as well as the crops which women typically work in, which tend to be more perishable than certain commodities (Nordhagen, 2021). When technology is introduced to replace manual activities around postharvest losses, roles held by women may be replaced with negative or positive impacts (Kenney, 2015). The introduction of technology to post-harvest handling will mean a reduction in labor/energy and time use for women, a positive impact. However, it could also result in lost income or employment opportunities as women play a key role in the grading and sorting nodes of post-harvest handling.
Implications for USAID	USAID agricultural programs are already focused on reducing PHLs and food waste. There are Feed the Future Innovation Labs working on solutions, including the Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (Kansas State University) and Feed the Future Innovation Lab for Food Systems for Nutrition (Tufts University). However, it appears that more traditionally oriented market systems development activities that include activities to reduce PHLs are not typically seeing this work as climate action or measuring and reporting on the impact of these reductions on GHG reduction. USAID may benefit from more explicit recognition of these efforts in market systems development programming to support the achievement of climate change targets, including through monitoring and measuring potential reductions in GHG tied to food loss and PHL reduction, as well as food security. There may also be avenues to facilitate linkages between improvements/enhancements here with carbon markets, further building the business case for adoption of new technologies and practices. USAID could consider a suite of interventions, from improving transportation and access to markets (particularly important with the pressures of increased urbanization); facilitating actions that increase market information on consumer demand and improving organizations between producers and intermediaries to plan production schedules; and working with local governments and the private sector on transportation barriers. In terms of planning activities around food waste, USAID may consider explicitly using the EPA's Food Recovery Hierarchy (U.S. EPA, 2015a), which outlines six intervention areas to reduce food waste, ranging from source reduction (note: in these contexts, may be more about production

Leverage Point: Food Waste and Post-Harvest Loss	
	rationalization and planning), feeding people, feeding animals, industrial uses, composting for soil amendments, to landfill at the bottom in terms. Further, as noted above, the Agency should identify the key points in the food system where context-specific interventions at the country level produce reductions in food loss and waste with the greatest environmental and livelihood impact. From this work, USAID could develop new indicators to connect food loss and waste to specific climate related development goals. CCFAS also identified the lack of finance (for technologies, etc.) as one of the major contributors to PHL (Gromko, 2019), so finance for post-harvest handling could be incorporated into other forms of agricultural climate finance transition programming beyond agricultural production technologies.

Leverage Point: Research and Development for Climate Action	
Definitions	R&D constitutes the generation of new knowledge, technologies, processes, and practices following scientific methods as well as the integration of traditional and indigenous knowledge and collaborative innovation.
Rationale for Transformation	• Systemic, transformative change requires localized and holistic analysis of climate change that goes beyond climate impacts and employs second and third-tier climate risk assessment (Tonmoy et al., 2019) as well as options analysis to inform CRDPs across timescales. • Robust and agile research must be accelerated in order to develop diversified and nutrition-rich seeds, heat-tolerant seeds and livestock breeds, improved feed and feed additives, improved inputs, and other products that are linked to robust local market systems, as well as soil and water management technologies that are compatible with changing local ecosystems (Niles et al., 2020; Sala et al., 2019).There are innovative climate adaptation and mitigation technologies that require additional R&D to bring the cost to scale (Herrero et al., 2016). • Achieving systemic transformation requires expanded R&D to incorporate and facilitate adoption of improved technologies and processes across adaptation and mitigation planning, including maladaptation risks, disaster risk management, early warning, systems change, etc.

<table>
<tr><th colspan="3">Leverage Point: Research and Development for Climate Action</th></tr>
<tr><td></td><td colspan="2">Research is needed to design and implement cost-effective monitoring, reporting, and verification (MRV) in agriculture and grassland contexts to develop equitable and inclusive carbon market opportunities for smallholders and herders (Naeem et al., 2015).
R&D investments are needed to develop more sophisticated tools and frameworks that can lower transaction costs for investors and catalyze the flow of large amounts of capital toward smallholders and vulnerable rural communities.</td></tr>
<tr><td>Impact Pathways</td><td>Adaptation:
Understanding the climate enables stakeholders to better prepare, plan, and design transformative system shifts.
Improved seed varieties, livestock breeds, and water management technologies that are linked to robust local seed and production systems can support productivity under changing climates, particularly when linked to the Climate Resilient Development Pathways approach, adjusting for more significant changes over time.
R&D can better support the development of agro-ecological value chains that consider equity and fairness in the distribution of value and risk amongst the different actors.
Improved MRV could facilitate efficient carbon markets. Payments can incentivize regenerative agricultural practices, improved soil health, forest conservation, and/or</td><td>Mitigation:
Standardized MRV at the smallholder level could unlock market opportunities and help achieve mitigation outcomes at scale.
R&D could support the identification and design of new and innovative pathways to manage agricultural and soil carbon sequestration or emissions, ideally linked to the scale-up and commercialization of these models, such as valuation of ecosystem management services provided by farmers and payments.
R&D investment in improving livestock feed and breeding could produce cost-effective solutions that could minimize methane emissions from ruminants.</td></tr>
</table>

Leverage Point: Research and Development for Climate Action		
	other nature-based solutions linked to agriculture. • Refocusing donor R&D priorities from grains to nutrient-rich foods can increase agricultural biodiversity while addressing nutrition gaps (Global Panel, 2020).	
Impact Estimates	**Adaptation:** R&D investments by the Consultative Group for International Agricultural Research (CGIAR) and by national agricultural research systems in low- and middle-income countries (LMICs) have shown a 10 to 1 benefit-cost ratio (Alston, 2020) in benefits for the future in terms of agricultural productivity and poverty reduction, among other benefits. USAID investments in agricultural research through U.S. university programs, such as Feed the Future Innovation Labs, since 1978 have an economic impact of PPP$8.4B from a cumulative investment of US$1.24B, with 80% of these economic benefits realized by individuals with incomes under $5.50/day and about 29% of the benefits realized by those in extreme poverty (Dalton, 2022). Investments to increase agricultural productivity can offset the adverse impacts of climate change and help reduce the share of people at risk of hunger in 2030 to five percent or less in Northern, Western, and	**Mitigation:** Improvements in crop breeding and soil and water management that lead to a 20% yield increase would abate projected GHG emissions from land expansion by 7% (Ranganathan et al., 2018).

Leverage Point: Research and Development for Climate Action		
	Southern Africa, but the share is projected to remain at ten percent or more in Eastern and Central Africa (Mason D'Croz et al., 2019).	
Sustainable Development Implications	Given that many of the solutions, technologies, and frameworks for both adaptation and mitigation efforts are still in early stages, R&D is perhaps the most important leverage point for climate action across the full spectrum of interventions. Research toward innovation for intensification, producing more food on less land, should be developed considering the sustainability of such intensification, considering not only the potential to increase productivity (i.e., increased yields, reduced variability) and environmental sustainability (i.e., conserving biodiversity, protecting water supplies, and promoting soil health) but also assess innovations along the three other domains presented in the sustainable intensification framework: social, economic, and human (Musumba et al., 2017). Research is also important in terms of understanding and measuring the real risks of climate change at a very local level, which will feed into resilience and adaptation efforts, and even access to finance and investment decisions in the near future with the passage of regulatory frameworks like the SEC's on Climate Disclosures. One key consideration is the localization of research and knowledge. Over the last year, in a series of panels on the BIFAD Commissioned report "Agricultural Productivity Growth, Resilience, and Economic Transformation in Sub-Saharan Africa: Implications for USAID" (Jayne et al., 2021), expert discussions repeatedly highlighted the importance of strengthening coordination and collaboration between local and international research institutions to ensure that solutions are driven by local and indigenous knowledge and technologies, and are tailored to the local context and needs (UN Food Systems Summit, 2021). Adoption and scale-up of research, development of data systems, forming public-private partnerships around research themes, and collaboration across systems are critical. Research programming, ideally at the inception phase, must consider the question of how to scale up and implement new technologies or solutions (i.e., the last mile).	
Gender, Youth, and Social Inclusion	Gender-responsive research is "research that considers gender	

Leverage Point: Research and Development for Climate Action	
Implications	needs/interests, priorities, opportunities, constraints and ensures that both women and men participate in and benefit from the research processes on equal terms and are addressed as both the clients (or beneficiaries) and actors (or agents) in agricultural research" (Mangheni, 2021). It is essential to gender-responsive development in agriculture, nutrition, and food security. Women's labor-intensive agricultural practices such as weeding, collection of fodder for livestock, firewood, and collection of water for domestic and irrigation purposes can often be drastically reduced with the adoption of climate-smart agricultural practices and technologies. Other examples point to negative unintended consequences for women's drudgery and reduced empowerment, a form of maladaptation. Research that is informed by a gender analysis in the early stages and is responsive in the design, implementation, analysis, and decision-making, will be better suited for adoption, including by women who are often excluded from such research (Njuki 2016). As an example, research from the International Maize and Wheat Improvement Center (CIMMYT) in Afghanistan found that improved wheat varieties, developed through breeding programs with farmer preference trials that included women, increased yields while also reducing women's drudgery for small-scale farming families (Roett & Listman, 2017). In addition, deliberate action is needed to further document and integrate relevant elements of indigenous and traditional knowledge systems that have withstood centuries of environmental change and are in need of enhancement rather than replacement (e.g., the Adivasi's use of a Cycle of Agricultural, Horticultural, and Forest Products and Festivals to safeguard bountiful for festivals even during droughts or iTaukei's use of tamboo to replenish fish stock) (Laya, 2005). As with several other leverage points presented in this report, technology adoption among women, Indigenous communities, and others that are traditionally marginalized and participate less often in research is limited significantly by underlying barriers to access, power, and assets that prevent or increase adoption risks. As the Sustainable Intensification Framework suggests, this human domain should be integral to all R&D programs and explicit in the review of innovations in development.
Implications for USAID	The new U.S. Government Global Food Security Research Strategy Fiscal Year 2022-2026 incorporates a convergence research framework, which *"entails integrating knowledge, methods, and expertise from different disciplines and forming novel frameworks to catalyze scientific discovery and innovation,"* as defined by the National Science Foundation (Research Strategy, 2022).

Leverage Point: Research and Development for Climate Action	
	This approach is particularly well suited to support CRD that incorporates both adaptation and mitigation elements and relies on incorporating cross-sectoral solutions. The new Research Strategy also incorporates a new cross-cutting intermediate result focused on climate. Agricultural research is not gender neutral. Hence, gender-responsive research will need to be a minimum standard for investments in agricultural R&D. Future research efforts will also need to realign existing investments to address new challenges and opportunities (e.g., MRV for smallholder carbon), examining the trade-offs between adaptation and mitigation efforts (such as pollution from certain adaptation efforts), while doubling down on existing research efforts aimed at improving productivity and targeting PHLs and waste. There are also tremendous opportunities to further strengthen and expand collaboration between the private sector and universities and other research entities, particularly around helping to bring promising technologies to a wide audience. USAID investments in R&D should prioritize those programs that demonstrate a rigorous approach to stage-gate review of innovations under development that engages with end users and potential last-mile partners (private sector manufacturers and entrepreneurs, for example) to prioritize investments in those innovations most likely to reach scale. USAID's recent emphasis on applying the Product Lifecycle Framework to the Innovation Lab work is an important step. Investments in research will need to emphasize local research capacity development, equipping National Agriculture Research Systems (NARS) with the facilities, human resources, and enabling environment to lead adaptive research and drive research agendas that may be implemented in partnership with international programs such as the Feed the Future Innovations Labs and CGIAR centers.

Leverage Point: Multinational Corporation ESG and Net Zero Commitments	
Definitions	Refer to corporations' commitments to generally self-defined Environmental, Social, and Governance (ESG) issues. "Net Zero" is the state where GHG emitted that sequestered.
Rationale for Transformation	Multinationals represent powerful forces to influence actions in their supply chains, actions at a government level, and actions of their

Leverage Point: Multinational Corporation ESG and Net Zero Commitments		
	consumers (and vice versa). The increasing amount of ESG and net zero commitments are powerful levers of change.	
Impact Pathways	**Adaptation:** ESG covers broader social and economic issues, which could include supporting adaptation efforts in inclusive ways. Standardization, verification, and improved traceability may be link to market premiums for emissions reductions and social outcomes for certain products.	**Mitigation:** Consumer pressure to reduce emissions; pending government policy to reduce emissions; and MNC pressure on supply chain actors to reduce emissions.
Impact Estimates	**Adaptation:** MNCs can act as key catalysts for adaptation transformation in their supply chains, including at smallholder farmer and agri-small and medium enterprise (SME) levels. The nascent nature of ESG and Net Zero commitments presents an opportunity to track their short and long-term impacts on adaptation.	**Mitigation:** Seventy-six countries and over 1200 companies have pledged to zero out net emissions by 2050. If these commitments are realized, they will cut 76% of global emissions (UN estimate).
Sustainable Development Implications	Multinational companies are making net zero and ESG commitments at an unprecedented level. GreenBiz State of Green reports that 80% of companies in the S&P Global 1200 index disclose carbon, including most of the largest companies by sector (Makower, 2022). This appears to be driven by a combination of increasing consumer and investor awareness; existing or pending legislation (like the Securities and Exchange Commission [SEC] on climate disclosure and GHG emissions); and the realization of the real and escalating risks of climate change. According to the S&P GLOBAL SUSTAINABLE1, nearly 80% of the S&P Global 1200 will face moderate to high risks by 2050 (Mattison, 2022).	

Leverage Point: Multinational Corporation ESG and Net Zero Commitments	
	However, an estimated 84% of those emissions are estimated to come from the supply chain and the use of the product itself (Makower, 2022). The draft SEC regulations, if implemented as such, will require companies to disclose their Scope 3 emissions (supply chain emissions). The combination of the above means that multinationals are taking a fresh look at their entire operations and supply chains, as they consider what it means for both competitive purposes (both for the consumer as well as logistics lines), as well as to meet upcoming disclosure requirements. Multinational companies, especially those operating in tight supply chains such as coffee, cocoa, and palm oil, are uniquely positioned to act as a conduit for development impact aimed at fragmented producers that are already aggregated and made accessible by their existing sourcing and business models. The use of contract farming or working with cooperatives are mechanisms to aggregate outputs in fragmented markets. (Saenger et al., 2012; Aflagah, 2022)
Gender, Youth, and Social Inclusion Implications	The rising consumer awareness of ESG creates pathways for increased inclusivity. For example, Unilever requires suppliers to adhere to their Responsible Sourcing Framework, which includes specific guidance such as "Rights of communities, including indigenous peoples, will be protected and promoted" with specific requirements that must be in place. Multinational companies often have existing data reporting and monitoring infrastructure throughout supply chains as a natural result of their business models. These can be further leveraged to ensure efforts are focused on the positive impact on women, youth, and vulnerable communities.
Implications for USAID	USAID can capitalize on multinational commitments to various ESG and sustainability indicators and GHG emissions as a catalyst for partnerships that support both climate change and development outcomes. In particular, USAID can leverage its presence, relationships, and position as a trusted partner to help convene multi-stakeholder partnerships to address ESG or GHG reduction programs. USAID's involvement could help push these programs to be more inclusive of wider groups of people than might happen without USAID's involvement. USAID activities can play an important bridge in facilitating organizations and partnerships that may not come to fruition without USAID involvement. While promising on many fronts, these commitments and policy changes also present new challenges for agribusinesses to meet these standards and enter global supply chains without transition support and facilitation.

Leverage Point: Multinational Corporation ESG and Net Zero Commitments	
	Local food systems and farmers need support to meet the new standards and practices. In addition, USAID could help implement activities in partnership with corporations that reduce emissions through the supply chain. USAID may benefit from reviewing frameworks such as the Supply Chain Council for the Science Base Target Initiatives (SBTI, n.d.).

Leverage Point: Low emissions Livestock Development		
Definitions	Low-emissions livestock development refers to a production system that reduces GHG emissions while achieving greater production of outputs.	
Rationale for Transformation	• Livestock are responsible for 14.5% of GHG emissions, of which beef and milk production account for 41% and 20% of agricultural emissions globally (Gerber et al., 2013). • 500 million pastoralists depend on livestock for their livelihoods, which is increasingly threatened by climate change. • Significant productivity gaps exist in traditional livestock production systems that require transformation to contribute to adaptation and mitigation outcomes.	
Impact Pathways	**Adaptation:** • Improving animal feed, breeds, herd management, and health would increase productivity in traditional systems, improving food and nutrition security and meeting growing demand. • Shifts to small ruminants and poultry help maintain protein production and income while reducing emissions.	**Mitigation:** • Low-emissions livestock development interventions reduce emissions per unit of animal protein produced while addressing growing demand for animal protein (Ericksen & Crane, 2018) • Feed additives may reduce enteric methane by over 20%, (Hegarty et al., 2021). • Efficiency gains must be paired with reduced consumption of livestock products to help

Leverage Point: Low emissions Livestock Development		
		transition to low-emissions food systems (Costa et al., 2022)
Impact Estimates	**Adaptation:** ● Meat production stood at 340 million tons in 2018 and it is estimated to increase by 200 million tons to feed 9.1 billion people in 2050 (Conforti, 2011). ● One pilot project showed that optimized animal nutrition improved milk productivity by 57%, reducing emissions intensity by 33% (Balanka, 2021).	**Mitigation:** ● A 25% improvement in meat and milk productivity per ha of pasture would abate GHG emissions from land expansion by 11% between 2010 and 2050. While an 11% reduction is good, it is not sufficient. Low-emissions livestock production will allow lower emissions in appropriate ecosystems, but increasing demand for livestock products, and associated production increases, could increase net emissions. As such, mitigation efforts need to be complemented by dietary shifts in high-consuming regions. ● A 10% -25% diet shift away from consumption of livestock products will result in an estimated emission reduction of 0.5–2.5 GtCO2e/y by 2050 (Costa et al., 2022).
Sustainable Development Implications	Livestock are one of the highest emitters of non-CO2 GHGs, estimated at 6% of global emissions and 60% of agricultural emissions. At the same time, demand for animal protein is expected to grow as per capita income and the global population increase. The livestock sector is key to addressing climate change adaptation and mitigation outcomes, and there are substantial opportunities for transformation. One is by improving feeding, pasture, and herd management to achieve low-emission and higher productivity while also contributing to clean energy generation. This directly contributes to SDGs 1, 2, 7, and 13. There are also opportunities to decouple livestock production from land-based production systems through a circular economy approach, including	

Leverage Point: Low emissions Livestock Development	
	through alternative feed supply (e.g., microbial proteins), hydroponic fodder systems, and utilization of food waste (a study shows food waste compost/soil amendments can increase soil carbon in pastures) (Wright et al., 2022). Rising temperatures will expose animals to extreme stress, affecting their health and reducing meat and milk productivity. Adapting to these conditions requires a major transformation in infrastructure and market systems (e.g., effective early warning systems, cooling stations, shade, irrigated fodder production, etc.). As climate change continues to shift ecosystems, changes to promote long-term resilience in livestock systems may include relocating livestock production systems, introducing new livestock species, or transitioning into or out of livestock for other agricultural or nonagricultural livelihoods (Carter et al., 2021). On the other hand, significantly reducing the consumption of beef and dairy products and shifting toward plant-based proteins has a huge potential for transformation. (Willett et al., 2019, Costa et al., 2022). This could have substantial impact, especially in middle and high-income countries where there is disproportionate consumption of animal products. On the other hand, addressing food and nutrition gaps remains a priority in many low-income countries where cereal-based diets are dominant. Evidence from the Feed the Future Livestock Innovations Lab shows inclusion of even small amounts of animal source foods in cereal dominated diets provides essential calories, proteins, and micronutrients necessary for growth and development across the lifespan (McKune et al., 2022). Context-specific measures are thus needed to promote dietary shifts.
Gender, Youth, and Social Inclusion Implications	Agrosilvopastoral forage production improves resilience by increasing forage availability, maximizing and diversifying land use, and increasing animal output. Despite women's major involvement in and contribution to livestock management, they tend to have limited access to resources, and extension services and less participation in decision-making compared to men. The development of small-scale livestock enterprises must be seen as a key element of any effort to eradicate extreme poverty and hunger (Doss, 2011). In rural livestock-based economies, women comprise two-thirds (about 400 million people) of low-income livestock keepers (FAO, 2013). Africa has the largest youth population in the world. For Africa to prepare itself and its youth for a future economy in sustainable livestock development, there are several recommendations to consider. Engage youth in livestock as they are already members of resource-poor

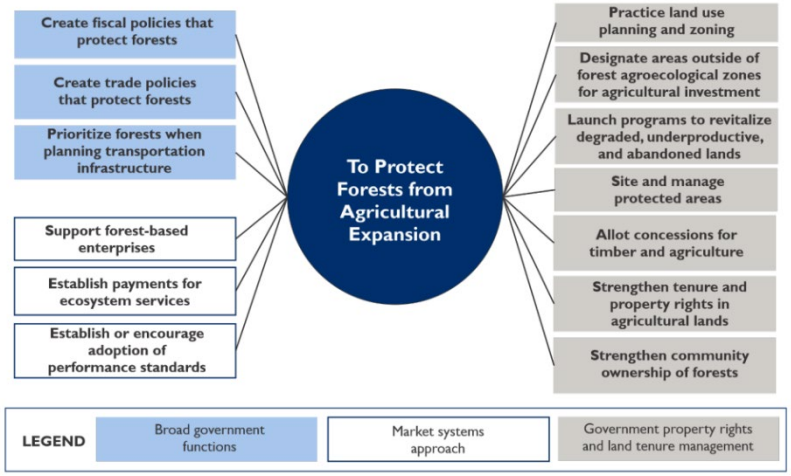
Leverage Point: Low emissions Livestock Development	
	households (Bullock and Crane 2020); facilitate entry level in curriculum design, research and policy, sustainability, (human) health, and production; design of easy-to-use toolkits focused on sustainable livestock projects; initiate local mentorship and capacity-building programs for youth; and training in disaster risk management (Zvavanyange & Hanyani-Mlambo, 2014).
Implications for USAID	USAID is already investing in livestock activities in many countries. The programs that have been reviewed for this study (the Feed the Future Bangladesh Livestock Production for Improved Nutrition Activity and USAID/Mali's Livestock for Growth [L4G] Project) focus on boosting productivity and market access for poorer households. While these programs have clearly achieved their intended objectives that contribute to climate adaptation outcomes (through improved resilience capacity), their positive or negative impact on mitigation is not well documented. There is an opportunity for USAID to measure and track mitigation outcomes in its livestock-related programming. Additionally, USAID could consider identifying the mitigation, adaptation, and inclusion trade-offs in its livestock programming more explicitly. Furthermore, there is growing interest in the promotion of insects as sustainable sources of proteins. Unlike cattle, insects provide sufficient protein with a lower carbon and water footprint. The consumption of insects is traditionally practiced in developing countries, with developed countries using insects for animal feed (Laureati et al., 2016). This is an area where USAID could support additional research and experimentation in terms of the nutritional value, impacts on existing livelihoods of dietary shifts, as well as conditions that facilitate behavioral change in consumption patterns.

Leverage Point: Synergies Between Agriculture and Forest Cover	
Definitions	Synergies between agriculture and forest cover refer to integrating trees into agricultural landscapes and the relationship between agriculture and forest conservation. There are clear links between food production and forest cover, whether the former is driving the reduction of the latter, or the latter is supporting, or inhibiting, the former.

Leverage Point: Synergies Between Agriculture and Forest Cover		
Rationale for Transformation	Agricultural expansion is inextricably linked to deforestation–it is one of the major drivers of deforestation worldwide. Agricultural intensification stimulates additional investment, which can result in additional agricultural expansion in the tropics, without governance mechanisms in place (See Figure 4 below). Increasing and/or maintaining trees in agricultural landscapes also brings multiple benefits, including enhanced soil quality, reduced erosion, cooling effects, and diversified revenue generation opportunities. Combining trees with agriculture is part of an integrated land-use approach that can be applied at multiple landscape levels (community level, watershed level). For agriculture production to be environmentally sustainable, production must be increased to meet growing demand while also protecting forests. Combining agricultural intensification practices with forest governance approaches that meet local contexts may be one of the few viable solutions.	
Impact Pathways	**Adaptation:** A virtuous cycle with the adoption of sustainable agriculture practices incorporated with tree planting and management of forested areas leads to improved productivity and conservation. Developing enabling policies at the landscape scale can help manage trade-offs in agroforestry and create incentives for implementation (Sinclair et al., 2019).	**Mitigation:** Sustainable agriculture, reforestation, and avoidance of deforestation maintain and increase forest cover and increase carbon sequestration. Explicit representation of agroforestry in Measurement, Reporting and Verification systems can help countries access finance and improve mitigation efforts (Rosenstock et al., 2018).
Impact Estimates	**Adaptation:** Benefits accrue from the prevention of soil erosion, improved productivity, incomes from tree crop cultivation, and shade (Celeridad & Gonsalves, 2019).	**Mitigation:** Carbon sequestration and reduced GHG emissions, Forest conservation and management. Approximately 45% of carbon sequestration potential (4.8 $GtCO_2$ y^{-1}) achieved through agroforestry, biochar application, and improved crop and pasture management

Leverage Point: Synergies Between Agriculture and Forest Cover		
		would cost up to 100 US$/$tCO_2$ (Costa et al., 2022). Action-oriented corporate commitments to achieve zero deforestation and/or reforest, with measurable targets, promote change in practices and strengthen ESG investment opportunities.
Sustainable Development Implications	There is a deep connection between agriculture, land use management, and forest conservation, which evolves depending on the features of a given country's context. The BIFAD-commissioned "Agricultural Productivity Growth, Resilience, and Economic Transformation in Sub-Saharan Africa" found that agricultural production gains in Sub-Saharan Africa over the last several decades were largely attributable to cropland expansion rather than productivity-led growth. However, agricultural intensification on existing land by itself is not sufficient. USAID's ProLand undertook a study to review farmer practices to intensify production and governance actions to influence agricultural expansion into forests. The study found that, at the local level, *"investment in agricultural intensification will increase pressure on unprotected tropical forests,"* pointing to evidence including conversion of forests in tropical South America between 1970 and 2006 (Ceddia et al., 2013). Intensification must be linked to governance efforts (see USAID implications below). Agro-forestry is one way to promote planting more trees in agricultural landscapes and conserve existing forest cover. Interventions work by facilitating the development of new markets and incentive mechanisms and shifting community perceptions of the forest from more extractive or short-term uses (such as charcoal production) to longer-term sources of income linked to reforestation and forest conservation.	
Gender, Youth, and Social Inclusion Implications	Diversifying income-generating activities through introducing tree crops in agriculture (particularly non-timber production, e.g., fruit trees) and associated activities (e.g., seedling nurseries) increases opportunities for women and youth, and contributes to dietary diversity, food security, and empowers women. Moving agricultural practices toward agroforestry requires consensus and planning and is an opportunity to introduce new roles and practices, which can bring new voices to the table. In a study of youth by the AgroForestry Network, 51% of youth cited access to land	

Leverage Point: Synergies Between Agriculture and Forest Cover	
	and finance as a constraint to agroforestry. However, 70% of youth respondents recognized benefits, including that it was "nature-based, eco-friendly, and sustainable" (Eng et al., 2022) reflecting positive youth attitudes.
Implications for USAID	In its natural climate solutions and forest land governance work, USAID has many examples of projects whose objectives are to conserve and/or reforest programs through forest-friendly agricultural practices or agroforestry. For example, USAID's Morodok Baitang in Cambodia and Modern Cooking for Healthy Forests in Malawi utilize market systems analysis linked to forest conservation to identify value chains that support both income and environmental objectives. For increased impact, USAID might consider more explicitly identifying opportunities to incorporate elements of forestry alongside more Feed the Future-oriented agricultural sector development/market systems development practices. The balance between the amount of land that can be dedicated to agriculture and to forests could also be addressed by taking an integrated approach and understanding the opportunities and trade-offs of each, including suitability of land. Not all situations will lend themselves to both objectives (increased food production and tree cover), but this concept is critical for transformation. Conserving and increasing forest cover is directly correlated to biodiversity conservation and aligns with the USAID Biodiversity Policy. The Forest Landscape Restoration approach may also be a way to promote agroforestry on land that is degraded or not suitable for other forms of agriculture (USAID Productive Landscapes, 2020). In addition, USAID may consider supporting more programs that include tree nurseries as enterprises embedded with other forms of agricultural sector development for adaptation benefits (shade, preventing soil erosion, etc.) as well as revenue-generating products from the sale of seedlings. Introducing trees can be done as part of an integrated natural resource management plan or a watershed-level plan. Importantly, efforts to improve yields on existing land must be facilitated with careful monitoring of intended as well as unintended impacts and with clear governance structures in place. The figure below from USAID ProLand presents key aspects of governance that were found to contribute to forest conservation to be considered with agricultural intensification efforts.

Leverage Point: Synergies Between Agriculture and Forest Cover	
	 ***Figure 4.*** *Governance approaches that can reduce agriculture-driven deforestation; Source: USAID's ProLand, "Designing Investment in Agricultural Landscapes to Mitigate Tropical Forest Impacts"*

Leverage Point: Climate Services	
Definitions	Climate services involve "the production, translation, transfer, and use of climate knowledge and information in climate-informed decision-making and climate-smart policy and planning." (Climate Services Partnership, 2022).
Rationale for Transformation	• Despite recent advances in climate modeling, prediction, and dissemination through ICT, some regions of the world are still lagging in producing quality and actionable climate information and advisories (Dinku, 2019). • Current efforts to improve climate services are focused on weather and seasonal forecasts and early warning systems to manage risk. Systemic transformation requires these efforts to go beyond short-term risk management. Climate services need to be strengthened to signal shifts in ecosystems and produce impact and options analysis to inform long-term adaptation investment and planning (Ashley et al., 2022). • A lack of robust baseline and projected climate data limits finance such as results-based performance instruments (Richmond et al., 2021).

Leverage Point: Climate Services		
	• While the field of climate services has embraced the importance of developing services alongside local partners and intended users to ensure the service is legitimate, credible, and relevant, there are still substantial knowledge gaps around climate service users and their needs, and the best ways to access both (Carr et al., 2020).	
Impact Pathways	**Adaptation:** • Climate services enable farmers and pastoralists to improve productivity, dietary diversity, and income (Hansen et al., 2022); (Vaughan et al., 2019). • Climate services, through early warning systems, help better prepare for disasters and prevent or minimize losses (Coughlan de Perez et al., 2022; Thalheimer et al., 2022; Tozier de la Poterie et al., 2022). • Climate services are essential for informing CRDPs across timescales.	**Mitigation:** While there is a knowledge gap around the connection between climate services and mitigation, one possible impact pathway lies in creating services that lower risk around the adoption of climate-smart agricultural practices, which could facilitate reductions in GHG emissions.
Impact Estimates	**Adaptation:** • Upgrading climate services and early warning systems to developed-country standards could save up to $2 billion in losses per year (Hallegatte, 2012). • One study, conducted in Kenya, Malawi, Mozambique, Tanzania, and Zambia, suggested that under ideal conditions, forecast information adopted by farmers could generate productivity	**Mitigation:** There is a knowledge gap regarding the potential impact of climate services on mitigation outcomes.

Leverage Point: Climate Services		
	gains averaging $3 USD per hectare (Vaughan et al., 2019).	
Sustainable Development Implications	Effective weather and climate services can contribute to increased food availability and stability of the food supply, thus advancing SDG2 (Hansen et al., 2022). In some cases, they can facilitate the cultivation of more diverse crops, improving nutritional diversity in food systems- another contribution to SDG2. Tailored climate services that account for the needs and pathways of use of diverse potential users in a context can empower marginalized groups to identify and address challenges in their agricultural production and livelihoods more broadly, advancing SDG1, 2, 5, 8, and 10. A failure to provide climate information that is actionable/usable, tailored to the specific context, delivered via effective channels, and using appropriate language, limits the reach, use, and impact of climate services. For a transformational change, climate services need to be inclusively expanded beyond larger producers to reach small-scale producers with suitable and accessible technology (e.g., radio and mobile telephone (text and voice services). Co-production of climate services is one mechanism to achieve impact and inclusivity. Co-production requires an iterative, inclusive process of collaboration and engagement with users of climate services to identify needs, generate solutions, and deliver them through appropriate channels. Furthermore, effective climate cervices require collaboration across local, national, regional, and global stakeholders, including data sharing policies to strengthen access to observational data and products. Arguably, climate services as a public good can have significant implications for reach and access. For example, strengthened National Metrological Services (NMS), which are often under-resourced and endowed with outdated technologies, are a key means of facilitating transformation (Ashley et al., 2020). Successful transformation of agriculture, food, and nutrition systems will require an overhaul of climate services to support medium and longer-term adaptation planning to make the CRDP approach work.	
Gender, Youth, and Social Inclusion Implications	Access to weather and climate information is not uniform across society. Modes of access can vary, whether by gendered access to spaces of dissemination and discussion or by the level of access different people have to radios or mobile phones (Archer, 2003). Further, men and women often farm different crops for different purposes and therefore may have differing needs for weather and climate information (Carr et al., 2016). More fundamentally, institutional biases and formal processes tend	

Leverage Point: Climate Services	
	to exclude women from accessing technical information, training, or advisories (Gumucio et al., 2020). Access also varies by the size and type of livelihood. For example, pastoralists' use of weather and climate services appears more limited than among sedentary farmers (Vaughan et al., 2019). Further research is needed to close the substantial knowledge gaps regarding the different users of and needs for climate services around the world (Carr et al., 2020).
Implications for USAID	USAID has funded over 40 climate services-related activities over the past decade. Most of the support went to African countries and focused on three main areas: 1) data provision, 2) decision support, and 3) learning. The evaluation of USAID's climate services activities has concluded that most of the investments have been "proof-of-concept" activities. USAID has an opportunity to take the lessons from the "proof of concept" and boost its investments to strengthen national climate services capacity to help governments achieve climate adaptation and mitigation objectives. NMSs are underfunded, inadequately equipped, and understaffed, limiting their ability to support local and national decision-making and national climate adaptation planning. More deliberate action to modernize NMS creates the foundation for the development of effective, legitimate climate services. Furthermore, USAID could build on this foundation by playing a key role in funding R&D of frontier climate data and products as well as leveraging its convening power for knowledge exchange across countries.

5. DEEP DIVE: PRIVATE CLIMATE FINANCE TO CATALYZE ADAPTATION AND MITIGATION ACTIONS IN AGRIBUSINESS

5.1 Introduction and Context for the Deep Dive on Climate Finance to Catalyze Inclusive Adaptation and Mitigation Actions

Mobilizing climate finance in food systems at a sufficient scale is a crucial tool to drive the transformational changes that can lead to climate resilience for the most vulnerable communities globally. Despite the environmental, social, and political importance of addressing climate in food systems, cumulative tracked financing for the AFOLU sector represents just around 3% of total global finance (Chiriac & Naran, 2020). Of that, only half (approximately $10B) of those funds are explicitly targeted at small-scale agriculture (defined as small-scale producers as well as cooperatives or farmer associations and value chain actors that support food production through provision of services, product aggregation and market linkages). These financing levels remain low in regions where the agriculture sector is the primary social and economic sector. In Africa, only 8% ($2.7B) of total climate finance was used in the agriculture sector (Meattle et al., 2022). Most of this capital (93%) came from international public financial sources.

There is a significant opportunity and need to catalyze further capital toward adaptation and mitigation actions in global food systems, in particular private capital. However, it is crucial that this mobilization results in inclusive climate finance benefits to smallholders and marginalized communities. Historically, global financial systems have been complicit in or fundamental drivers of the anthropogenic actions leading to the current climate crisis. This can be seen in food systems broadly, where financial markets have enabled and at times encouraged producers and value chain actors (primarily in developed markets) to profit from practices that are harmful to climate. Thus, any discussion around mobilizing climate finance for adaptation and mitigation actions must acknowledge the potential for capital to further inequity in the space and must stress the importance of inclusion to mitigate against this.

As with any sector, the fundamental and cross-cutting importance of adopting a climate lens in the food and agriculture finance space leads to a wide range of themes and opportunities for USAID to consider. This deep dive focuses on two key thematic opportunities:

- High potential mechanisms to intermediate large amounts of capital, targeted specifically to small-scale adaptation and mitigation actions
- Government and public sector tools and opportunities to catalyze and incentivize

(private) finance into food systems

In connecting these general themes to practical implications for USAID, three primary intervention categories that USAID can use as entry points have been identified:

Market enabling - interventions that target broad-based systemic and macro/meso results that serve to enable market actors - primarily in the private sector - to achieve success in the climate finance for agriculture space.

Pipeline development - interventions that focus on indirectly catalyzing sustainable finance into the sector by expanding the depth and breadth of investable opportunities focused on climate adaptation and mitigation in both the intermediary as well as end-user levels of the market

Direct Capital Participation - interventions that leverage USAID capital into key high-impact and sustainable areas of the market to serve as both a catalyzing force (e.g., de-risking investments) as well as a *targeting* force to ensure impact is focused on key inclusive goals (e.g., ensure inclusivity of youth, women, and other marginalized groups in adaptation and mitigation activities).

5.2 High -Potential Mechanism to Intermediate Large Amounts of Capital, Targeted to Small-Scale Adaptation and Mitigation Actions

Bilateral development partners have an opportunity to increase the financial impact in the space by increasing their focus on catalyzing private sector financing. While development organizations such as USAID have originated the largest share of climate finance in developing countries (e.g., responsible for 71% of all climate finance in Africa in 2020), for every dollar that multilateral development banks (MDBs) invested in climate finance, only USD 0.29 in co-financing came from private sources (Meattle et al., 2022). This deep dive identifies three key pathways to unlock the flow of large amounts of capital for inclusive adaptation and mitigation in agri-business. First is developing the standards, methodologies, and oversight bodies that allow financial markets to capture value from adaptation and mitigation practices (e.g., carbon markets). Second is supporting the processes that allow the financial markets to work. Third is providing direct support as an active player in participating and catalyzing activity in financial markets.

It is crucial that the mobilization and intermediation of large amounts of climate capital into food systems results in inclusive finance benefits for the most vulnerable end-users. Specifically, ensuring that smallholders, agri-SMEs, and marginalized communities (e.g., youth, women, and indigenous communities) realize the benefits of this increased capital flowing into food and

agriculture is of paramount importance. This deep dive highlights various opportunities for donor-led focus on inclusion within each of the broader themes explored.

○ Support Standards, Methodologies and Oversight Bodies that Allow Financial Markets to Define Investment Opportunities, Report Standardized Results, and Capture Value Within Climate Finance for Food Systems

Development Financial Institutions (DFIs) and international donors (like USAID) can work alongside governments and industry associations to support establishment and implementation of research-led standards. Ensuring high-level frameworks and standards are in place is crucial to enabling the broader market to effectively and accurately characterize the potential costs, risks, and returns available in this space. This work can be technically complex and costly, especially when applied to specific geographic and market contexts (as it should be) (CASA, 2022). USAID plays an important role in not just funding these initiatives but also ensuring collaboration and synergies across this landscape.

There are many examples already underway, for example, the EU taxonomy for sustainable activities, the Association of Southeast Asian Nations ASEAN taxonomy for sustainable finance, the Organization for Economic Cooperation and Development's (OECD's) ESG investing and climate transition, and the Taskforce on Nature-related Financial Disclosures. In a recent and potentially significant development, the Science-based Target Initiative (SBTI) launched The Forest, Land and Agriculture (FLAG) Science Based Target Setting Guidance in September 2022. These encourage businesses in land-intensive sectors such as food, agriculture, and forestry to set science-based targets that include land-related emissions and removals for the first time. More than 410 companies with land-intensive operations have already committed or set targets through the SBTI; however, few of these account for land-based emissions (i.e., emissions from forestry and agricultural production, land management, and on-farm vehicle and fertilizer production) in their targets or disclosures due to the lack of available guidance and methods. This science-based guidance gives these companies direct visibility into the actions needed to accelerate decarbonization.

These advancements are indicative of the broader positive trend seen over the last few years of consolidation and alignment of global public stakeholders and agendas around research-led standards and goals. Feedback from KIIs indicates that the next essential step is to support the implementation and enforcement of these standards and policies. A key barrier to this implementation is the lack of alignment with private sector stakeholders who express confusion or frustration with the various standards and frameworks. The initiatives above aim to address these issues, but often struggle to connect the global standards and frameworks with the more localized and domestic policies. This creates problems for private sector investors and businesses operating across various geographies with wholly separate reporting and standard

frameworks. USAID could work as a bridge between the global associations and standards already in place and the local governments working to establish their own. USAID should also strive for a unified approach and framework around which standards and policies should be applied in certain contexts. This will be driven by specific situational contexts (e.g., geography, commodity, target population, etc.), but USAID should ensure that it uses a systematic approach to establish which standard to use in any given context. Importantly, USAID should focus on the appropriate use of existing standards, as possible, in an effort to drive the actual use of these methods rather than potentially overlaying new standards in an effort to harmonize existing methods. This "top-down" use of leading standards will help shift the systemic focus from simply *convening* around these ideas to actually *implementing* them in practice.

Inconsistency, incomparability, or lack of alignment in standards are key challenges to effective mobilization of the private capital markets into the climate agriculture space. The efficient functioning of global private markets requires standard ways to measure and value assets consistently across various heterogeneous contexts. There must be a concerted effort to construct a broader ecosystem and infrastructure that enables markets to accurately understand the returns and risks associated with these opportunities. This is especially difficult for private investors and financial institutions (FIs) in the agriculture space, where climate impact plays an outsized role. A pressing example of this need can be seen in the innovative markets emerging within the Payment for Ecosystem Services (PES) and Results-Based Financing (RBF) space. Both markets essentially involve creating a category of financial securities that contribute capital to land use preservation and enhancement or climate-smart and carbon mitigation production activities (Pettinotti et al., 2022). This results in the need to reconcile, on the one hand, financial security that requires consistency and similar behavior under global economic drivers and, on the other hand, ecosystem and agricultural assets that are highly heterogeneous with complex interactions and potentially nonlinear behavior which may be difficult to bundle and are subject to drivers that are highly context dependent. Private markets have struggled to accurately do this and would benefit from the policy leadership, stakeholder convening, and market incentivizing activity that donors can support.

While this need for standardized measurement and evaluation presents a challenge across all sectors, KIIs indicate a particular need in food and agriculture to unpack and characterize (in terms of cost, risk, and return) the range of viable types of solutions that can impact adaptation, mitigation, and natural capital preservation. This mapping and development of different lines of attribution to headline goals is generally missing for investors to be able to understand the range of options related to smallholder-anchored production systems. In particular, feedback indicates a crucial need for monitoring and evaluation frameworks that specifically focus on the inclusivity impact of climate finance on smallholder farmers and other marginalized rural stakeholders. Mobilizing capital toward adaptation efforts will continue to grow in importance as rural communities suffer the increasingly negative impact of climate change (Lipper et al., 2022). However, there are very few established and scalable ways to measure the risk, return,

and impact of investment in adaptation efforts. Research indicates that high investment risk, driven by a lack of primary data/information asymmetries and unproven and early-stage business models with long development lead times, is a leading cause of core market failures to incentivize private sector investment in adaptation (Acosta et al., 2019). The holistic climate, social, and health benefits of adaptation-based finance in food systems are often not fully accounted for (especially relative to the mitigation use cases) and thus create a barrier to private capital properly valuing it as a sub-sector (Blocher et al., 2022). New approaches and initiatives, such as the Climate Justice Alliance, are attempting to provide solutions to these issues, but are yet to be adopted at scale.

Standardization of reporting and measurement methods is crucial, but KIIs also emphasize that the scale of the broader climate challenge means that incremental solutions leading to more 'bankable' projects and initiatives, while helpful, will not be enough. There is a need for incremental regulatory actions to catalyze and incentivize change. The vast scope of the issue requires fundamental regulatory pressure to structure and intermediate the needed flow of additional capital. For instance, requiring the incorporation of climate risks and emissions disclosures in standardized financial accounting reports can help investors and companies decarbonize agrifood systems. While still nascent, there are a number of regulatory initiatives already underway to directly exert pressure on private companies to incorporate a climate lens within their typical practices. A few key examples include the International Sustainability Standards Board's (ISSB's) Global baseline of sustainability disclosures for the capital markets and the SEC's proposed rules to standardize Climate-Related Disclosures for Investors. These regulatory changes will play an important role in catalyzing change within global agri-food value chains that are driven by multinational corporations. In particular, the focus should be on building a supportive regulatory environment that pushes multi-national agri-food companies that are directly linked with smallholders to ensure the impact of these measures is felt by the most vulnerable communities. USAID plays an important role in pushing the frontier on these policies; however, much of the local-level impact must be driven by national and sub-national policies and regulations. This is explored in more depth in the final subsection of this deep dive.

○ Support the Processes and Systems that Allow Climate-Focused Transactions Around Capital Markets to Work

The prior sub-section discusses the need for cohesive and aligned policies, standards, and oversight bodies in order to create the systemic infrastructure of climate finance for agriculture. However, there are crucial processes and systems operating within this infrastructure that currently face significant barriers which then prevents the efficient flow of transactions around capital markets. These barriers include limited technical capacity within FIs, high transaction costs, and a lack of proven innovative models in the space. Thus, there is a significant opportunity to support the processes and systems that make these markets function. USAID can help mitigate these barriers and enable the broader capital markets by:

- Providing technical assistance to FIs in order to build their capacity to offer climate finance products and assess climate risks in agriculture
- Supporting standardization and processes that bring down transaction costs and attract incremental investors.

Provide technical assistance to FIs in order to build their capacity to offer climate finance products and assess climate risks in agriculture

Research has shown the fundamental importance that FIs, and especially local FIs, have in the development of agricultural markets (ISF Advisors & Mastercard Foundation, 2019). FIs play a crucial role in both building a commercial market in specific localities as well as effectively intermediate capital from key sources (such as DFIs, governments, etc.) to otherwise difficult-to-reach rural recipients. This dynamic is no different in climate finance. Local FIs serve as perhaps the key actors to ensure the effective mobilization of private capital to close the climate finance gap for small-scale agriculture (Chiriac & Naran, 2020). These institutions can have easier access to local farmers, deeper local knowledge, existing financial infrastructure (e.g., branches, mobile solutions, cooperation with mobile network operators), and appropriate currency to provide appropriate lending programs (Apampa et al., 2021). In short, this is a key channel to scale in an effort to mobilize large amounts of capital to smallholder producers.

There are several barriers to scaling FIs as a channel for climate finance. Broadly speaking, local FIs require increased technical expertise and capacity to scale and de-risk capital mobilization. As discussed, evaluating the risks and returns of climate investments in food systems is difficult at all levels of the market. Local FIs domiciled in developing countries often do not have adequate policies and processes in place to incorporate environmental risk data into decision-making; and individual staff may lack the awareness and skills to mitigate, share and transfer those risks if they are flagged (Chiriac & Naran, 2020). Informality across agricultural value chains limits the availability of data that FIs need to use conventional risk assessment methodologies. Key project-level barriers include limited credit history of smallholders, lack of weather and soil data, limited knowledge of sustainability definitions, and limited expertise on climate-smart activities and technologies (Sova et al., 2018). It is worth noting that many of these concerns and barriers for FIs in climate finance reflect the key challenges associated with broader agricultural finance and that any TA aimed at mitigating these challenges do not repeat common mistakes typically used in that field. However, feedback indicates that FIs can see climate financing as being further incentivized than typical ag-lending due to an often more supportive policy support ecosystem (e.g., less stringent collateral requirements when climate outcomes are at play). This can possibly create a more compelling business case for local FIs. USAID could help mitigate these project-level challenges by supporting FIs, particularly local FIs, via technical assistance to build internal capacity (e.g., putting policies and processes in place to incorporate environmental risk data into decision-making). Increasing the expertise and risk-bearing capacity of FIs, as well as addressing the lack of data and information available across

the market, can serve as a key starting point to mobilizing large amounts of investment into inclusive and sustainable agriculture. KII feedback indicates that funding this type of technical assistance could serve as efficient use of scarce capital, as building the capacity of local FIs can serve to create a more sustainable local market over the long term. However, this TA must be carefully applied as it may not catalyze further capital flows in situations where the fundamental business case is never compelling for a local FI. Additionally, experience points to an opportunity for donor-led support to focus on enhancing and building established FIs with the intention of scaling up current agricultural portfolios and integrating proven climate smart approaches that can de-risk these portfolios rather than try to create new or incremental agriculture-focused banks and MFIs.

A recent example of this is the Africa Network and Advisory Board launched by the Glasgow Financial Alliance for Net Zero (GFANZ) in September 2022. The Network will work with African banks, asset owners and managers, insurers, and other FIs across the continent to support capacity-building on climate finance required to meet the unique needs of African institutions as the global economy transitions to net zero. It will also work with policymakers, regulators, and MDBs as it seeks to further its understanding of the country-specific conditions needed to enable and accelerate financial flows for climate investment opportunities across the continent.

There is also a need to educate and incentivize the long-term timeframe that is often required for climate finance in land use and agriculture (Chiriac & Naran, 2020). Effective changes in agricultural production and land use often occur over a long period of time (e.g., agro-forestry efforts require time to replant and grow trees on producing cropland). Local FIs often do not have internal policies that allow for such time frames. While this is often driven by the high cost of capital, there is also an element of lack of understanding that feeds into this. USAID can play a role in addressing the cost of capital barriers through grants, blended finance, and other financial incentives (this is explored in more detail in the next subsection). USAID can also play a role in creating awareness of the potential benefits of long-term investment horizons, especially when these may compete with short-term gains from investments from the same institution that degrade natural capital (Pettinotti et al., 2022). Advocacy can play an important role as well in establishing the business case for FIs that resilient farmers represent. Ultimately, resilient farmers and SMEs are better borrowers with less inherent risk - past experiences in other industries such as renewable energy reveals how advocacy and engagement with banks can be key to explaining the economic / business rationale of these approaches. A past USAID example that can be built on is the Climate Economic Analysis for Development, Investment, and Resilience Activity (CEADIR), which worked with second FIs in Central America to develop energy efficiency and green credit lines for small- and medium-sized businesses. This capacity support can also play an important role in ensuring inclusive impact targets such as gender inclusivity are being met. Research has shown that even when FIs and private investors focus on climate financing, there is often limited internal tracking and reporting on the gender

breakdown of portfolios (Phillips et al., 2022). Additionally, FIs often fail to combine gender portfolio targets within the broader climate targets, despite the often-outsized nature of climate impact on women and other vulnerable communities. Similar to virtually all other sectors, women working within food systems often work within different networks than men, which can result in a lack of access to finance from the typically male-dominated local FIs system. Thus, there is an opportunity to use technical assistance and capacity-building support to further channel gender-focused finance via local FIs.

Finally, there is an important opportunity for USAID to support emerging external solutions that could change how FIs are equipped to lend to small-scale agriculture recipients. The emerging ag-fin-tech third-party vendor market can provide FIs with various services that support increased market intelligence, data gathering, decision-making, and management processes (ISF Advisors & IFC, 2022). Frontier digital technologies, such as remote sensing and satellite imagery, can help FIs analyze the agro-climatic risk (particularly in terms of short-term weather risks and seasonal agricultural risks) at the individual, portfolio, and regional levels. Supporting these third-party vendors could represent a more efficient allocation of donor capital than supporting FI capacity building as it addresses specific technical barriers within these organizations. Key FIs are embracing this market as a solution to existing capability gaps. For example, RaboBank has begun developing its own in-house solutions provider while also working with SatSure (a digital climate intelligence provider) and CropIn (a supply chain management and decisioning provider) to develop more impactful systems.

Support processes and approaches that can bring down transaction costs and attracts incremental investors

A key barrier to efficient capital markets and the catalysis of large amounts of capital toward smallholders and vulnerable rural communities is the high transaction costs associated with the space. Scalability and/or replicability of climate finance projects for small-scale agriculture will be key to attracting large-scale capital. There are certain dynamics unique to the agriculture sector that pose a challenge to scaling climate finance, such as a broadly fragmented production base, informality throughout the supply chain, and technical limitations. In addition, agriculture faces a complicated set of dynamics and goals that must be considered alongside climate outcomes, such as nutritional needs, food security, biodiversity, and livelihoods of rural communities (Ahmed et al., 2020). All these factors lead to high transaction costs and barriers to scaling investment opportunities. Addressing these challenges will take a holistic approach at various macro, meso, and micro levels.

One way of addressing these issues is to develop more sophisticated tools and methods that can be applied efficiently and at scale across the fragmented market (e.g., remote agro-climatic risk assessment tools, insurtech platforms). While there is a tremendous amount of technology innovation that is being developed in this space (see next section for more details), there is an opportunity for the public sector to further support technical R&D. USAID could offer

resources and convening support to technical research facilities and programs (e.g., in academia) that work on the frontier of these technological solutions. These organizations play an important role in developing tools and frameworks that can lower transaction costs for investors and should shift toward a private sector demand-driven R&D model to deliver innovative solutions (Apampa et al., 2021).

Even accounting for the fundamental high transaction costs associated with the fragmented nature of food systems, existing financial mechanisms, and the way in which financial intermediaries approach the sector can evolve to mitigate these costs. Existing vehicles are often deployed at a purposefully small scale and are bespoke to certain geographic and commodity contexts (Apampa et al., 2021). This creates higher transaction costs at a more meso or macro level. To alleviate this, USAID could support financial intermediaries (primarily local FIs and private agri-food companies) to develop a set of structured archetypes that can be replicated and adapted across contexts easily, similar to historical experience in other sectors such as renewables. The consolidation of similar yet currently disparate facilities and products into a complementary structure (e.g., similar geographical approaches) could also eliminate some of the individual transaction costs by standardizing methods and metrics. USAID can also work closely with private agri-food companies, especially multinational corporations that have already addressed the economic problems with sourcing from a variety of smallholder producers, to share knowledge and expertise about how to best address this issue.

Despite the clear structural challenges that drive high transaction costs across the space, it is also worth noting that there is a relative lack of clarity around the drivers of some of these costs. Specifically, KIIs discussed how the opaque nature of costs and margins for various key actors raises the potential that these high transaction costs are not simply structural in nature but also a feature of market power being exercised by those actors in the form of unnaturally high margins. While this is a valid concern that should be explored in a more detailed and comprehensive manner (e.g., examining this effect across geographic and value chain contexts), it does not detract from the structural barriers that drive transaction costs across the smallholder agricultural climate space. These structural barriers also represent potentially easier leverage points to address for USAID rather than the opaque margins of key actors.

○ Support Experimentation with Innovative Financial Products and Markets, with a Focus on Inclusive Impact

Much of the discussion so far has focused on ways to enable existing flows of finance and capital markets to function more effectively and efficiently. Clearly, there are key processes, standards, and frameworks that can be adjusted to catalyze further mobilization of capital from all sources into climate adaptation and mitigation for smallholder farmers. Beyond catalyzing proven models and vehicles there is also a need to create and scale innovative frontier methods and

approaches to financial markets. There are several innovative financial mechanisms that have the potential to help drive capital into the market while ensuring financial impact is felt at the smallholder and rural community level. Donors can play a role in scaling these models and markets by supporting and de-risking experimentation that lead to proof of concept, investing in research that provides evidence for these changes, convening key stakeholders that need to be brought into these actions, and ensuring that any advancements maintain inclusive impact goals.

Innovative financial products and instruments in the climate agriculture space include carbon financing, results-based finance (e.g., Key Performance Indicator-linked funding, environmental impact bonds), risk mitigation instruments (e.g., guarantees, insurance), and structured finance mechanisms (standardization, aggregation, securitization) (Blocher et al., 2022). Different products can address different barriers within climate finance for agriculture. While market barriers remain relatively consistent across the sector, project-level barriers can differ drastically from project to project. Thus, various instruments and strategies should be deployed depending on the unique nature of the barriers encountered (Blocher et al., 2022) From a USAID perspective the goal should be to act as a catalyst across the broader space to de-risk these approaches in an effort to provide strong use cases and archetypes that provide evidence for further experimentation, uptake, and crowding in of capital (Phillips et al., 2022).

Barriers facing these have been discussed throughout this deep dive: high-risk perception, technical limitations, challenging unit economics (especially at scale), and lack of proven success cases. Donors like USAID cannot, and should not, attempt to solve all of these challenges. Rather, USAID could act as a convener, knowledge transfer facilitator, and de-risker to ultimately allow the private sector to develop these markets (Richmond et al., 2021). By combining the catalytic nature of blended finance with capacity and technical support, USAID could spur the flow of private capital into this space.

One key area that USAID could focus on is the creation of structured finance mechanisms that can aggregate and securitize fragmented agricultural producers to allow more efficient linkages with broader markets. This could solve the fundamental issues created by the fragmented and often informal nature of agricultural markets. Private investors ultimately will need to see the right scale and unit economics to make investments into agricultural production work. Mechanisms that can aggregate and securitize the disaggregated production base, essentially creating a more valuable single asset, are crucial to ensuring finance flows to that level. This would address a fundamental mismatch between private institutional capital and small-scale agriculture.

Feedback from numerous KIIs indicates that there is a significant opportunity for USAID to support this nascent and relatively untested area both directly and indirectly. Directly, USAID can use catalytic capital in the form of concessional funding to specific companies or funds that are working in the space. This capital could effectively de-risk the initial investment into

establishing this model and lead to successful use case examples for the private sector to pursue further (Phillips et al., 2022). By focusing attention on targeted investors and/or funds, which have an existing appetite for engaging in the time-intensive and often costly process of aggregation, donors can support the initial development of proven use cases that could then be scaled beyond those initial scenarios. Given the high degree of inherent variance in these types of innovative models, an existing challenge for USAID and other large international donors is to source and eventually partner with the funds or companies that are committed to achieving inclusion along with innovation. However, feedback indicates a growing desire from private investors to experiment and innovate in this space, reflected by a growing number of funds doing just that. This is further explored in the next section.

Beyond specific use -case situations, donors can support broader research and innovation into novel financial mechanisms that target inclusive impact. There is a significant amount of existing attention from academic and corporate sources on technical solutions to climate-ag issues (e.g., climate-smart production methods, land-use, and change management, etc.). However, there appears to be an opportunity for further research into innovative financial mechanisms and products that can help address key barriers currently limiting the flow of capital into the space (and especially to the most vulnerable communities). USAID could fund this type of research and can convene stakeholders across the private and public sectors (e.g., private multinational corporations, governments, impact investors, institutional investors, etc.) to implement innovative techniques.

Innovative financial products in focus: Link smallholder farmers to carbon markets to monetize and enhance thin margins

Perhaps the most talked -about emerging financial mechanisms across the broader climate finance space are carbon markets. Agriculture-related carbon markets have largely been confined to large-scale producers in developed economies due to the scale, information sources, and technology needed for implementation. However, the voluntary and compulsory carbon markets are relatively well developed in emerging markets across a few important sectors such as forestry and renewable energy (forestry made up 67% of the voluntary carbon market in 2021, while renewable energy made up 25%) (Forest Trends' Ecosystem Marketplace, 2022). Achieving successful implementation of carbon markets for smallholder farmers struggles from similar barriers to the broader climate finance for agriculture space: lack of standardization and adequate governance of the quantification and certification processes, difficulties in tracking credits, weak property rights on which to base credits, and the need to aggregate large numbers of disparate smallholders in order to have a reasonable volume of credits to be economically viable in light of low carbon prices relative to high transaction costs (World Bank, 2017).

Despite these barriers, carbon markets in certain geographic and commodity contexts are far more developed than others. In the broader agriculture and land use space, well-established

nature-based and land -use solutions include agro-forestry and conservation offsets or credits. For example, the voluntary carbon credits markets (VCM) in Southeast Asia are thriving, driven by agro-forestry and conservation offsets from plantation-based smallholder households in export-oriented commodities such as palm oil and coconut (the VCM market in Southeast Asia is expected to create US$10 billion in economic opportunities annually by 2030) (Bhattacharya, 2022). These markets do reach smallholders via intermediaries like private companies that integrate carbon credits into their supply chain, which is in turn sourced and aggregated from smallholders. However, smallholders struggle to engage with these existing carbon markets and often do not benefit from the monetary impact they promise. There are opportunities to further link existing markets to smallholders (e.g., educate, aggregate, etc.) and to focus on financial mechanisms that can do that at scale.

Addressing these barriers and creating a viable market for carbon credits will take several solutions, some of which are explored in other areas of this deep dive (discussion on policy and standardization frameworks can be found in the first section, while technology enables-d solutions can be found in section 1.2.5). However, there are clear examples of the market addressing the aggregation needs via financial mechanisms and business models that USAID could further support. Funds, investors, and businesses are emerging that aim to pool and aggregate carbon credits from smallholders to create an aggregated portfolio or asset class. An example of a fund doing this is the Carbon Value Exchange, which pools and aggregates emissions data from remotely monitored agtech equipment to centralize and lower the cost of verification for credit markets. Private companies are developing methods to help small-scale farmers monetize their carbon mitigation and adaptation efforts, such as Sistema.bio. Carbon Value Exchange (CaVEX) is a carbon trading platform that enables carbon reduction and sequestration activities to be monetized across a range of micro-projects, with the goal of addressing the transaction -cost problem associated with very small-scale carbon credits/offsets.

Rabobank's Acorn initiative is its flagship effort to incentivize agroforestry activities by smallholder farmers via monetizing carbon credits. Acorn measures and certifies biomass growth of planted trees on smallholder land and sells these carbon removal units on global voluntary carbon markets or within supply chains. They then compensate the farmer with 80% of the income. Acorn's model is made more economical by technological advancements, such as Light Detection and Ranging (LIDAR) and satellite imagery, which enable remote monitoring and evaluation. Boomitra takes a similar approach to enable farmers to boost income through certifying soil -sequestered carbon and linking those credits directly back to the producers.

While lessons can be learned from successful models such as Acorn and NKCRP, agroforestry and land use are just one solution to link smallholders to credit markets. Importantly, it is also the easiest climate-smart agricultural method to monitor and validate. A potential solution to mitigate the difficulties and costs of monitoring and validating farm-level activities such as climate-smart soil use and input use would be to rely on existing service providers, value chain enterprises, or FIs that are already working directly with these farmers.

These stakeholders, such as traders or input suppliers, already serve as de facto aggregators of smallholder farmers. By equipping them with the proper technical training and technology, the issue of aggregating MRV is mitigated. However, the need would then shift to creating a market that monetizes the carbon credits at a different level rather than directly linking farmers to the carbon markets themselves. This would require technical assistance and funding to establish and create a successful proof of concept.

Effectively linking smallholder farmers to carbon markets is certainly a promising and potentially transformational opportunity, but it should also be noted that establishing commercially viable carbon markets or business models that do so does not automatically ensure genuine inclusive benefits. There is some concern about the potential for the often-unregulated tracking and monetization of these models to allow foreign stakeholders to profit from the carbon credits generated at the local level without fairly compensating those local actors who actually "own" the original commodity. The priority action to mitigate this is developing further transparency and alignment across the markets and models that are pursuing these actions to allow regulators and governments to properly track, value, and ultimately benefit from them. USAID can support the process of broader market ecosystem reform by supporting open access platforms and mechanisms that allow for more visibility into the entire chain of processes to then allow the local populations making the climate impact on the ground to realize the full and proper benefits.

Innovative financial products in focus: Formal de-risking solutions for smallholder-related production (e.g., micro insurance for smallholders, macro insurance)

The impending potentially catastrophic impact of climate change on rural and agricultural livelihoods means risk -management tools targeted at smallholder- producers and rural agri-SMEs are more necessary than ever. Agricultural insurance is a powerful tool to reduce the vulnerability of these groups and can help drive the necessary adaptation. Research suggests that even a 1% increase in insurance penetration across sectors reduces the disaster -recovery burden on developing countries by 22% (Lloyd's, 2018). The development of a thorough risk -mitigation market in the form of smallholder-targeted insurance is crucial to counteracting the negative effects rural households will face from extreme weather events such as heat waves, agricultural droughts, and floods. Insurance for smallholders also plays a role beyond transferring risks associated with weather and climate fluctuations. It unlocks smallholders' productive potential by enabling prudent risk-taking in the adoption of improved technologies. Smallholders with access to insurance are often better positioned to access finance and business development services due to longer involvement with formal financial systems (e.g., positive impact on credit scores) and reduced risk perception (Meyer et al., 2019). Additionally, insurers are often better positioned and equipped to manage climate risks than local banks or investors. Insurance providers typically have access to innovative technology, historical climate data, advanced risk -modeling methodologies, and portfolio diversification (Blocher et al., 2022). Common agri-insurance solutions include several risk-pooling instruments such as index

insurance, parametric insurance, and other micro-pooling mechanisms. In short, enabling a functioning micro-insurance market for smallholders is a potentially highly effective leverage point for addressing some of the key barriers in the space.

Research shows that across developing countries there is a significant gap in agri-insurance coverage for smallholders, with 80% of smallholder households lacking access to formal insurance (ISF Advisors, 2022). In Subs-Saharan Africa, this portion is even higher, with 97% of smallholder farmers lacking insurance coverage. Barriers driving this low access rate include low interest and awareness from potential customers, low capacity of local insurers, under-resourced innovators trying to introduce index products, and limited interest from re-insurers in supporting small volumes associated with new products targeted at the smallholder market. Despite these consistent challenges, seen especially in Subs-Saharan Africa, there are still success cases that can be used as a model to build from. An example is the Agriculture and Climate Risk Enterprise (ACRE), a large input-linked, mobile-enabled micro- index insurance program in Africa targeted at smallholders. Nearly 2 million farmers in Kenya, Tanzania, and Rwanda have been insured for nearly $200M against a variety of climate-change- driven weather risks (World Bank, 2022). Pula, a Kenya-based agriculture insur-tech company, is another leading provider in the space. The company uses its digital products to help smallholder farmers endure yield risks and improve their farming practices. It has insured 6.8 million farmers and a total sum of $1.1B to date.

USAID has an opportunity to help catalyze the substantive shifts that are needed to scale the agri-insurance market. A recent convening of over 130 agri-insurance stakeholders in 2022 introduced a set of opportunities to catalyze this shift (ISF Advisors, 2022):

1. Building momentum for government-led approaches that include smart uses of subsidy, an involved private sector, and the resources to scale
2. Focusing innovation on how to cost-efficiently and effectively reach smallholder farmers at scale (e.g., establishing unconventional partnerships for distribution, leveraging new payment infrastructure and technologies, etc.)
3. Establishing the next set of critical public good "scale enablers" to help break through the required cost and quality thresholds for delivery and impact at scale (e.g., Establishing more open data hubs and data sharing standards, cracking the nut on collecting quality ground truthing data cheaply and at scale, etc.)
4. Establishing the right global, regional, and national platforms to drive coordination, collaboration, learning, and co-investment across silos and global agendas (e.g., more effective global knowledge hub, more donor collaboration)

USAID could play a role in supporting these actions, particularly in opportunity areas 1, 3, and 4. These opportunities largely will require global leadership, collaboration, and grant-based resources to create public goods that will enable scale.

Stakeholders agree that the frequency and severity of extreme climate events may mean that private insurance markets won't be able to absorb the ever-increasing climate risk at micro levels. There is thus an increased need for public-private cooperation around risk management, with governments essentially stepping in as reinsurers. The public sector could offer credit guarantees and/or step in to cover a catastrophic risk layer while using a range of tools such as multi-country risk pooling. This would result in the public sector essentially owning the broader macro insurance policy, while smallholders are the beneficiaries of any payouts triggered by climatic disasters. Examples of such schemes include FOGASA-SAC in Peru and CADENA in Mexico.

○ Participate as an Active Player in the Financial Markets to Generate a Pipeline to De-risk Investments and Mobilize Capital

Incorporate investment facilitation activities in project design and leverage global programs with that focus in order to develop a pipeline of investable opportunities for climate-focused funds

While supporting FIs with technical capability development is an important conduit to mobilizing capital toward smallholders and agri-SMEs, there are still barriers to overcome at the capital-receiver level (e.g., smallholders and agri-SMEs). Project-level economics present one of the most challenging barriers to investment in the sector due to high counterparty risk, small project sizes, and high vulnerability to environmental risk (Blocher et al., 2022). There is often a limited pipeline for these investments as smallholders and agri-SMEs often lack the technical training in advanced agricultural and forestry techniques needed to perform climate-smart production; training programs are cost-prohibitive for smallholders and small- and medium-sized enterprises (SMEs) (Apampa et al., 2021). Donor-supported capacity development could be a key catalyst for incremental capital entering the market, especially in areas where capital is already looking to be deployed. For example, investment in climate-smart capital is a key priority for many public and private investors but the lack of investable projects and recipients is a key barrier. Research by the World Bank showed that the single largest barrier to climate-smart adoption across the developing world was capacity needs in the form of training and information (Sova et al., 2018). There is a clear need for further investments in capacity-building via technical assistance to develop further a pipeline of investable opportunities for climate-focused capital.

USAID could play a key role in potentially solving this issue by directly supporting and developing the pipeline of investable opportunities. Pipeline development programs and R&D projects can support and accelerate the investment-readiness of early-stage investments, especially those that cater to smallholder farmers and vulnerable populations. These programs can take several different approaches, but evidence points to successful implementation

occurring when coordinated alongside corporates/banks and supported by research organizations and NGOs. Importantly, any action should acknowledge the potential for donor-led pipeline development to be less efficient and effective than alternative and often private-led options. With this in mind, USAID should work to augment those pipeline development programs by providing specific services (e.g., targeted grant funding, support for R&D, etc.) that may be a gap in existing FI and private sector pipeline development programs.

The experience of USAID's Green Invest Asia program serves as a good example of effective mobilization of TA to create a more robust pipeline for private sector investment. The program worked to identify SMEs across sectors that had the potential for positive impacts on sustainable landscapes and provided capacity support to drive the enterprises to be more investable. The program then built a network of investors that could be interested in these pipeline opportunities in an effort to match these two sides together. However, it became clear that the more efficient method was to provide the TA support to the SMEs that the investors had already identified as potential opportunities based on their own internal criteria. Green Invest Asia then supported these SMEs with key pre-investment and due diligence activities such as financial modeling, feasibility studies, impact assessments, and environmental studies. The program operated on a cost share basis with the investors, who were often hesitant to invest the necessary capital or resources up front to make high-risk opportunities investment ready, but who would then commit a significant amount of investment following this activity. The lessons learned from this Program around taking a demand-driven approach and working hand in hand with private investors are crucial for any further activities in this space.

Other existing USAID programs that leverage a pipeline development (or adjacent) approach include the West Africa Trade and Investment Hub, the Southern Africa Trade and Investment Hub, and the Kenya Investment Mechanism (KIM). While each of these programs are still relatively young, key achievements point to the potential USAID has to act as a catalyzing force in developing investable opportunities. For instance, KIM has engaged over 40 business advisory service providers who have signed engagements with over 300 agribusinesses for an estimated investment pipeline of over $1 billion and has mobilized over $310 million for enterprises in key sectors. The Southern Africa Trade and Investment Hub has Facilitated $177.2 million in private-sector investment ($114.2 million in agriculture and $63 million in non-agriculture sectors) since its creation in 2016. While the pipeline development activities of these programs are context-specific and thus can differ greatly, key best practices such as establishing virtual deal rooms can be taken forward into any future similar USAID work.

Another example of an existing donor-led pipeline development initiative is the UK-Nigeria Climate Finance Accelerator, which aims to accelerate the transformation of Nigeria's Climate Investments Plan by supporting a pipeline of bankable projects that can be invested in at scale. The project aimed to support a pipeline of investable projects in the climate-smart and renewable energy sectors through technical assistance, capacity building, and convening. In

addition, the project aimed to catalyze broader learnings across the climate finance space on how to improve understanding and processes of identifying and supporting bankable projects.

Feedback indicates that despite the existing focus on pipeline development efforts from other public sector actors (e.g., domestic governments) and even the private sector (e.g., the rise of incubators in the climate space) there is still a need for donors to support in this area. In particular, it is important that donors play a leading role in using an inclusivity lens in these pipeline development efforts. For example, despite the importance women play in food production processes (research shows they are involved with approximately 70% of food production in Africa), woman-owned enterprises are underrepresented both in total numbers as well as key metrics such as financial inclusion and access (Phillips et al., 2022). Private sector-led pipeline development appears to often leave women-owned enterprises behind. USAID could actively address these challenges by focusing on specific gender-based projects and outcomes. In addition to gender, other vulnerable and marginalized communities such as indigenous populations and youth are often underrepresented in the formal financing markets and should have access to increased opportunities and incentives within climate-proofed value chains. Climate finance flows into food systems and must address these inequities. USAID could target inclusive outcomes by partnering with and leveraging existing initiatives and alliances, such as the Climate Justice Alliance while working with agri-SMEs across emerging markets.

○ Participate as an Active Player in the Financial Markets to De-risk Investments and Mobilize Capital, with a Specific Focus on Inclusivity

The key themes and topics explored so far focus on ways in which USAID can support the mobilization of large amounts of capital into climate finance for food systems using primarily market enabling and pipeline development entry points. As referenced, these various topics would benefit at certain points from direct capital participation from USAID, for instance to de-risk innovative financial mechanisms via concessionary lending. However, these actions have primarily been framed in the context of broader macro and meso market system development outcomes. This particular subsection focuses on the opportunities for USAID to use direct capital participation in high-impact areas of the market to serve as both a catalyzing force as well as a *targeting* force to ensure the impact is focused on key inclusive goals. Broadly speaking, blended and concessionary finance mechanisms have proven crucial to improving the risk-return profile of small-scale agriculture investments and catalyzing further crowding in of additional capital. This can be particularly true for adaptation outcomes, where risks and returns can be even more opaque than mitigation approaches (Lipper et al., 2021). Research and past experience (e.g., International Fund for Agricultural Development's [IFAD's] Adaptation for Smallholder Agriculture Program [ASAP]) demonstrates the importance of grant and concessionary financing to provide effective use cases for as yet untested adaptation-focused projects and thus incentivize private capital to support these solutions (Millan et al.,

2019). There is a crucial opportunity for USAID, as well as the Development Finance Corporation (DFC), to provide this targeted catalyzing capital.

Co-invest in new or existing funds that have a climate adaptation focus

Despite the historical under penetration of private capital and investment into climate-based agricultural activities and the existing systemic challenges discussed at length already, there are a number of active or emerging investment funds that are focused on climate and smallholder outcomes. Globally, there are approximately 30 such funds either active or in fundraising that are $15M+ in size (or are aiming to be).[5] A handful of notable funds employing innovative and potentially impactful strategies are highlighted below:

- **Climate-smart Agriculture and Food Systems Fund *(responsAbility and CGIAR)* -** Supported by Deutsche Gesellschaft für Internationale Zusammenarbei (GIZ) and KfW, the fund focuses on providing long-term expansion debt to innovative businesses operating in food systems across Asia Pacific, Latin America, and Africa with the goal of mitigating climate change, reducing food loss, and promoting climate change resilience in smallholders. Its strategy is to finance agribusinesses that contribute to a more equitable and sustainable food system, but that lack access to long-term financing and strategic support to mainstream climate impact in their growth plans. CGIAR supports the climate risk and impact assessment of transactions, as well as post-investment capacity building of SMEs and smallholder farmers linked to climate-smart practices.
- ***The Smallholder Resilience Fund (SRF) (One Acre Fund)* -** Currently in development, this fund will aim to increase capacity at each link of a given value chain and create profitable opportunities for smallholders as they transition to climate-resilient crops. The approach will consist of: (1) Aggregating smallholder production via One Acre Fund's client base and rural infrastructure; (2) Deploying capital to established SMEs in the value chain, alongside technical assistance to de-risk investments; (3) Where investment-ready SMEs do not exist, design and launch new SMEs via a venture studio to fill market gaps. This approach is typically defined as an organization that works to build and launch different companies in rapid succession. Targeted SMEs include input suppliers, processing companies, supermarkets, and exporters. The SRF will target SMEs that require between USD 0.25-2 million, offering a combination of equity, working capital, mezzanine debt (subordinated debt that falls between equity and the more senior secured debt in the issuer's capital structure), and senior debt (debt that takes priority over other unsecured or otherwise more "junior" debt in the issuer's capital structure).
- ***Acumen Resilient Agriculture Fund (Acumen)* -** Supported by various DFIs and

[5] Authors estimates

philanthropies, this fund supports early and early-growth stage agribusinesses that enable SHFs to anticipate, weather, and bounce back from climate events, resulting in increased yields and incomes. The fund operates across Sub-Saharan Africa and primarily provides equity financing to these early-stage businesses.

- ***Land Degradation Neutrality Fund (Mirova) -*** The fund is designed to support large-scale rehabilitation of degraded land, for sustainable and productive use, with long-term private sector financing. LDN invests in other funds, banks, and MFIs to benefit their projects in conservation and land restoration. The goal is to reach land degradation neutrality, mitigate and adapt to climate change, improve livelihoods, and improve biodiversity.
- ***Terra Bella Colombia (Terra Global Capital) -*** Invests in smallholder agriculture and forest conservation to increase rural incomes and produce climate change mitigation benefits. The fund mobilizes private equity investments to finance smallholder agriculture projects that also contribute to climate change mitigation through forest conservation.

It is important that any USAID support focused within this area strives to be additive and transformational rather than supporting already established winners. Most of the funds above can fall into that category - they are largely donor-backed opportunities already demonstrating relative levels of success. Their inclusion here is meant to provide notable examples of past success rather than direct opportunities for USAID to pursue. Rather, USAID should focus on pursuing similar but novel opportunities that would benefit significantly from donor support.

Fund project preparation facilities and investment advisory assistance for early-stage projects/solutions

There is a particular need for additional risk and venture capital to be mobilized toward early-stage projects and solutions given the opportunity these projects offer. Many of the various technical obstacles and constraints faced by climate mitigation and adaptation pathways discussed throughout this deep dive have the potential to be addressed through technical solutions. These opportunities can leverage technology to create systematic transformation around entire value chains. There is a wide spectrum of tech-enabled solutions, from production level (e.g., drought-resistant seeds or low-emission farm infrastructure) to remote digital systems (e.g., Climate Information Systems and Early Warning Systems), and market enabling software (e.g., digital platforms to support more climate-friendly agriculture at scale). A wealth of evidence points to both the mitigation and adaptation impact that ag-tech enabled solutions deployed across food value chains can have on rural communities (Phillips et al., 2022). However, there is a lack of early-stage equity and short-term debt to support the scaling of ag-techs.

The agtech space has particular potential to mitigate the risks and barriers associated with climate financing of smallholder farmers and rural populations. In particular, emerging technology-enabled data collection and evaluation solutions can help FIs and investors analyze climate risks at an individual, portfolio, and regional levels. These solutions can be broken down into five major categories (ISF Advisors & IFC, 2022):

- *Climate intelligence Providers:* Companies primarily focused on collecting and analyzing environmental data. Relevant examples include Jupiter and SatSure.
- *Supply Chain Management & Decisioning*: Solutions designed to facilitate more efficient and effective interactions in the supply chain. Relevant examples include FarmERP and Agritask.
- *Insurtech:* Technologies and platforms that help optimize any of the principles for success or requirements of insurance. Relevant examples include Pula, Blue Marble and Acre Africa.
- *Financial Analytics Company:* Firms primarily focused on providing financial market data, analytics, or research to financial sector participants. A relevant example is FarmDrive.
- *Public Good Initiative:* Government, NGO, or non-profit sponsored initiatives aimed at increasing transparency around climate risk. Relevant examples include AgriMedia and InsuResilience Global Partnership.

There are also a range of SHF-market first Business-to-Business (B2B) solution providers emerging to serve the needs of major multinational corporations and large local agri-businesses (e.g., Cropin, Koltiva, Farmforce, etc.). These enterprises aim to serve larger agri-businesses by providing key services such as supply chain management and financial analytics that are often digitally enabled. Additionally, a range of SHF-market specific solutions are being designed by major agri-businesses (e.g., Olam AtSource; Yara AtFarm; Syngenta FarmAssist) often in partnership with technology companies (e.g Yara and IBM). Relative to developed market investments, these applications have lagged in development and have achieved less scale.

USAID has an opportunity to support technology solutions that can enable further linkages between smallholder and vulnerable communities and local FIs. As an example, climate-smart agriculture activities deployed by farmers can be adopted into credit scoring techniques of FIs that already provide credit. Donors could extend credit lines or other financial commitments to local FIs or micro-finance institutions. Technical advisory and support tools could also be provided to ensure that the climate-smart credit risk scoring and that monitoring tools are incorporated into their lending practices. Emerging agtech offers solutions to scale these tools efficiently and effectively. Ultimately, agtech could enable lenders to shift from a system where lending decisions are based on farmer collateral and income levels toward credit scoring that accounts for climate risks and the opportunities farmers are taking to mitigate and adapt to those risks.

USAID could employ capital in a targeted manner to support existing funds, incubators, and accelerators that focus on addressing this early-stage financial gap. Blending this public concessional capital with private money can help align risk. In particular, there is an opportunity to further capture the adaptation benefits and impacts that ag-tech solutions can have in an effort to monetize those benefits to the solutions providers. The African Development Bank's Adaptation Benefit Mechanism (ABM) is one such solution that aims to de-risk and incentivize investments by certifying the social, economic, and environmental benefits of adaptation activities and facilitating payments for the delivery of those benefits. Its pilot activities focus on agtech providers delivering low carbon solutions across value chains that can be scalable across rural African markets.

All of these various solutions face the similar obstacle of accessing early-stage risk capital needed to grow and scale. Public capital must be used to incentivize, de-risk, and catalyze further risk capital in this area. Additionally, there is a complementary need for technical support and advisory alongside this capital investment. Donors should seek out financial partners and intermediaries that can provide growth via both avenues. DFC Guarantees can be leveraged to catalyze local private capital to support these entrepreneur-led opportunities. In addition, several notable accelerators/incubators that focus on smallholders and climate include:

- ***ASAP***- a public initiative incubator/accelerator that seeks to build an ecosystem for early-stage companies in emerging markets that have technologies, products, and services that can be used to build resilience to the physical impacts of climate change.
- ***Global Innovation Lab for Climate Finance*** – a public-private partnership accelerator that identify, design, and pilot the next generation of climate finance instruments. Not only focuses on ag, but developed the Climate Smart Lending Platform, being tested in Kenya.
- ***African Centre for a Green Economy –*** a non-profit think tank that targets businesses in various sectors such as food, transport, energy, water, housing, and information technology. Preference is given to enterprises that have incorporated the following principles in their business models: Innovative forms of ownership, alternative forms of exchange and distribution of goods and services, focus on community upliftment, and environmental sustainability. The NEA has supported 28 enterprises in South and Eastern Africa.
- ***Africa Climate Ventures*** *(ACV)* – an Africa-focused venture developer aiming to catalyze the creation of a new carbon asset class in Africa through building innovative businesses to capture a large share of the global carbon market
- ***Carbon sequestration ventures Bootcamp*** – aiming to rapidly ideate, design, prototype, test and launch novel responses to carbon market opportunities through technology-driven ventures

- ***TECA*** – a fintech venture launcher for climate resilience. Opportunity to establish effective links to carbon markets
- ***Catalyst Fund*** – an accelerator pivoting to climate resilience thesis that aims to accelerate promising fin-techs in the climate space

This is an opportunity for USAID to act as a convener and macro-aggregator of these early-stage programs that are currently dispersed and often suffer from a lack of knowledge sharing around processes and best practices.

Partner and co-fund projects with food and agriculture companies aimed at net-zero and climate resilient supply chains (that include farmers)

Agrifood system players can benefit significantly from the broader momentum behind climate investing in food systems. Non-voluntary disclosure requirements and tax policies, driven primarily by regulators in the USA and Europe, will catalyze large multinational agrifood companies to disclose and thus manage emissions throughout their entire value chains. But there is an opportunity for these corporations to benefit in more voluntary manner by integrating a sustainable approach to food systems throughout their value chains, as discussed in Section 5. above (Draucker & Kobayashi, 2022). USAID can leverage the actions of global agrifood companies that have committed to net-zero emission targets and climate resilient supply chains and access a larger pool of investors and more attractive financing conditions.

Global climate-based financial products such as green bonds (fixed-income financial instruments used to fund projects that have positive environmental and/or climate benefits) represent a potential new source of capital that also serves to push companies to better understand and disclose their climate-related efforts (Dhaliwal et al., 2011). Ultimately, companies with better long-term sustainable strategies may have a competitive advantage over their peers in the same sector through access to more investors and lower capital costs (Matos, 2020). Existing research by the Food and Land Use Coalition shows that, by 2030, shifts in land use and agricultural practices could result in an incremental opportunity size of $4.5 trillion annually for the sector. In particular, significant market opportunities of S$2.5 trillion and S$0.5 trillion will be created as diets change and as regenerative agricultural practices scale. To capture this value, companies must act early to ensure sustainable and climate-friendly actions are integrated throughout supply chains and business models.

There is also the ever-growing opportunity to mitigate risk in supply chains by taking a proactive approach to strengthening climate resilience across suppliers and partners. In aggregate, there is considerable scope for companies to have a positive impact on climate activities for food and agriculture beyond their own positive internal benefits. Private companies have the opportunities to create impact through market opportunities (e.g., working with upstream suppliers to ensure climate-smart activities), operational opportunities (e.g., optimizing production processes to rescue emissions), and commercial opportunities (e.g.,

shifting lines of business away from environmentally harmful activities to growth areas driven by shifting consumer demand trends and a desire to safeguard reputation). Sustainable investments can help internalize externalities, support the adoption of greener technologies, or support the development of new markets with consumers.

USAID has an opportunity to work directly with multinational and large domestic agrifood companies to ensure the climate financing activities they deploy are focused on achieving inclusive benefits for smallholders, SMEs, and marginalized communities. Prior partnerships and engagements with private sector food systems companies can be leveraged to deploy climate-smart programming or deepen market linkages in climate-agriculture systems. These existing lines of collaboration and relationships can act as viable pipelines through which agricultural and climate financing can be explored. Past or ongoing engagements have been conducted between USAID and major agrifood companies such as Archer Daniels Midlands, Mars Corporation, Cadbury, Hershey's, KRAFT, Nestle, Olam International, San Miguel Breweries, Coca-Cola, Mondelez, PepsiCo, Starbucks, and Walmart (Koudelka et al., 2021). USAID's focus should be on situations where companies are working in tight agricultural value chains connected to smallholder farms and agri-SMEs which are particularly vulnerable to climate impact. Support can be offered via existing programs, such as the USAID Global Development Alliance, to create effective public-private partnerships targeted to these outcomes. Beyond simply incorporating climate adaptation and mitigation objectives in existing (or future engagements), USAID can also work with these companies to share knowledge and key skills/lessons learned via a convening role. KII feedback indicates that too often companies work to achieve these impacts in a relative silo rather than leveraging the successful approaches made by other actors in the space.

Key lessons can be learned from the ongoing USAID Green Invest Asia program, which aims to increase private funding for sustainable agriculture and forestry in Southeast Asia. The program works with investors, funds, commercial banks, SMEs within supply chains, and multinational companies. The program found that multinational companies which pledged sustainability commitments such as net zero emissions often lacked the knowledge and visibility needed to address those issues. In particular, companies found addressing Scope 3 emissions (all indirect emissions that occur in the value chain of a reporting company) challenging primarily due to the complexity of supply chains and lack of appropriate metrics. USAID worked with these companies to establish technical guidelines and goals (e.g., emissions baseline assessments), which in turn allowed the corporations to enact changes throughout their supply chain. In addition, USAID acted as a convener and facilitator for companies working in similar commodities to come together and share valuable knowledge and insights to enable success in this space. By acting as a neutral third party, USAID enabled the sharing of successful existing models that could then be replicated in other commodity or geographic contexts. Ultimately, USAID saw a significant impact by working with large private companies to enact 'top-down' changes throughout their supply chains thereby creating a ripple effect.

5.3 Government and Public Sector Tools and Opportunities to Catalyze and Incentivize (Private) Finance into Food Systems

Historically, long-term growth and development of agricultural markets depend on access to a range and volume of capital which, over time, naturally eclipses the government's ability to provide that capital directly. As private capital markets and financial service providers become involved in the agricultural finance market, the challenge for governments becomes how to appropriately create, incentivize, and regulate space for the private sector. This shift can take decades and often remains incomplete across different market segments. This economic progression from government directed to more private sector-oriented happens in different ways in different countries. Research conducted by ISF Advisors highlighted crucial themes and lessons learned about the role of government in the transition from public-led to more bank-led agricultural finance systems in developing countries (ISF Advisors, 2020). Key insights from that research include: i) while donors play a key role in promoting private sector involvement, local government input and integration with the macro policy environment is critical to sustainable private sector participation; ii) governments need more, and more reliable, evidence to guide integrated policy-making and implementation focused on private capital markets; and iii) Governments need new ways of managing the agricultural finance agenda across the macro, meso, and micro levels, as well as ministries to enable sustained private sector participation.

While that research focuses on agricultural finance more broadly, the key insights hold true (and are perhaps even more important) for climate finance in food systems. The long-term growth and development of climate-smart food systems depend on access to a range and volume of capital that necessitates private capital markets. However, there is a broad range of incentives and regulations that governments must provide to make this private market not just functional but also truly impactful. Government actions within the agricultural climate finance markets can be defined across three levels of engagement:

1. At the micro level, where government action focuses on directly influencing private sector financing
2. At the meso level, where government action focuses on indirectly enabling private sector financing activity
3. At the macro level, where government action focuses on setting a conducive overall policy and development agenda

This subsection focuses on a handful of key areas across these various levels where governments play a crucial role in facilitating the market transition as well as the actions USAID could take to support these areas. These issues include:

- Policy, regulatory, and incentive reform to focus on climate-smart outcomes in food systems and to create a more supportive ecosystem for private capital,
- Explicit alignment of broader development objectives in food and agriculture with NDCs, and
- Utilizing a "Whole of Government" approach, including developing more in-depth data and financial flow reporting and tracking.

○ Support Local Governments with Policy, Procedural, and Regulatory Reforms, Ideally Aligned with Bankable Projects

There are significant opportunities for governments at the national (and sub-national) level to reorient policy, regulatory, and incentive frameworks to support the shift of finance markets toward more sustainable practices. In particular, there are significant levers that domestic governments currently use in the form of agricultural subsidies and targeted tax policies that can be reoriented toward a climate-focused approach. Globally, the agriculture sector receives roughly $700B in public subsidy support annually. Not only do these agricultural subsidies often yield a lower economic return than investment in public goods, but they are also rarely deployed to drive sustainable and climate-smart outcomes (World Bank, 2018). In fact, research from the Food and Land Use Coalition shows that approximately $345B worth of subsidies per year can be categorized as harmful to the climate (Food and Land Use Coalition, 2019). These include subsidies that ultimately drive the overuse of harmful fertilizers, deforestation to expand agricultural frontiers (especially for the most harmful value chains such as cattle), inefficient use of underpriced water, over pumping of groundwater, and monocultural production systems of targeted outputs (World Bank, 2018; World Bank, 2021). In addition, these subsidies and incentives often benefit the larger and more resourced producers over smallholder and more informal farmers.

Importantly, the impact of subsidies on food systems broadly (and climate activities within food systems) ranges greatly depending on geographic and economic contexts. Subsidy support for the agriculture sector varies country by country, often defined by development stage and policy goals (FAO et al., 2021). Broadly speaking, support measures are most prevalent in high- and middle-income countries. Agriculture in low-income countries is often impacted by negative rates of support that often penalize farmers through low prices to protect consumers. Thus, while shifting away from food system subsidies that harm the climate is crucial, the transformation is primarily aimed at these high-income countries. However, there are several notable emerging economies that do pursue potentially harmful subsidy support, such as China, Colombia, Indonesia, Philippines, and Turkey (Ding et al., 2021). These serve as examples where subsidies often reward unsustainable land use and food production. For instance, research in Indonesia and Brazil revealed that agricultural subsidies contributed significantly to tropical forest loss, primarily through incentivizing large scale export crops (e.g., palm oil) and

livestock (McFarland et al., 2015). Clearly, while specific contexts matter, there is a broad opportunity to shift harmful agricultural subsidies towards more sustainable outcomes in both USAID partner countries as well as the broader global north. Governments should shift market-distorting subsidies and incentives away from the unsustainable and negative impacts and toward actions that are clearly aligned with climate goals such as net zero GHG emission targets and sustainable food production. Governments and fiscal regulators can reverse this trend by creating financial incentives and policies that support sustainable practices such as climate-smart production by smallholders, rural infrastructure, biodiversity goals during food production, and sustainable intensification of food production.

There are a variety of paths that domestic governments can pursue to catalyze this shift using fiscal and regulatory policies. Broadly speaking, governments should focus these efforts on environmental outcomes that private capital markets cannot easily address, such as conservation and restoration of natural landscapes, climate-smart innovation and research, and health-related climate agriculture impact. The public sector should focus on creating incentives and mechanisms that value social, health, and environmental outcomes and that integrate the hidden climate costs found in food systems. Tax incentives for food system actors to pursue sustainable and climate-smart production and land use are becoming increasingly popular. For example, South Africa offers tax incentives to private agricultural producers who will declare and manage protected areas for conservation within their property to help mitigate biodiversity loss to agricultural production (Laetitia et al., 2022). In Brazil, the policy has linked subsidized farm credit to forest protection (to avoid deforestation), while increasing the efficient use of land for cattle grazing. China is piloting a program to shift subsidy support away from overused nitrogen fertilizers and toward organic fertilizers. Clearly, the political economy plays a crucial role in determining the pace and extent of the subsidy-reform process. Bargained compromises and compensation are often necessary for those who may lose due to the removal of subsidies (World Bank, 2018). USAID could support domestic governments in this often-difficult process by providing direct training to key government stakeholders based on the lessons learned from similar processes in other countries. Leveraging relationships with key policymakers in places like South Africa and Brazil, which have already embarked on this journey, can be an effective entry point for USAID to support other partner governments.

It should be noted that while these positive subsidies can incentivize climate-smart agriculture and focus on sustainable outcomes, there are often risks associated with this type of approach. As with any public subsidy, these can run the risk of having a negative market-distorting effect. In addition, there are unattended natural distortions that could occur and must be mitigated against. An example from the land use sector shows the potential perils of well-intentioned subsidies: Chile's tree-planting subsidy led to a doubling in forest area between 1986 and 2011, but also led to a decline in biodiversity as native forests declined by 13% (la Puenta & Mitchell, 2021). USAID could work with domestic governments to ensure the proper processes and assessments, both on natural impact as well as market impact, are considered prior to launching

these types of subsidies. To do so, USAID can leverage existing processes and programs such as the Environmental Compliance Support Contract (ECOS). There are key activities within the broad scope of ECOS that could be further leveraged and mirrored throughout other USAID engagements, such as the environmental analyses it conducts (e.g., scoping, development, and review of climate vulnerability assessments) and host country environmental management capacity building (assessing and supporting capacity building of host-country environmental and CRM systems). Feedback indicates that capacity and technical support such as this are important to allow host countries to properly assess the policies and subsidies they pursue.

While many of these opportunities are explicitly linked with incentivizing and requiring these various shifts, there are adjacent, yet crucial policy actions needed to align the broader ecosystem with these goals. Some of the key micro and meso-level barriers to creating a functioning climate finance market in food systems across developing countries stem from local governance and policy issues and failures that may not be directly related to climate and agricultural finance (Blocher et al., 2022). These include:

- Land tenure issues and weak property rights, especially in rural and informal settings, which can limit the ability of farmers to use their land as collateral - often necessary to secure financing via various mechanisms,
- Poor contract enforcement exacerbates existing counterparty risks and acts as a barrier for the private sector to enter into riskier contractual obligations (Lipper et al., 2021), and
- Regulatory and administrative processes for projects on public and community-owned lands can be particularly costly, leading projects on private lands to be more attractive for investors.

The negative impacts of these issues are not unique to climate finance for agriculture; these create barriers for progress across all sectors in the developing world. Paradoxically, the ubiquity of these issues could represent an opportunity for USAID to reorient existing capacity-building and support programs and efforts to explicitly focus on climate outcomes. In alignment with its Local Capacity Strengthening Policy, USAID , could ensure that locally led policy reform is explicitly incorporated in climate-focused programming. By reforming and addressing these issues, domestic governments can create a more effective enabling environment for climate finance targeted at smallholders and vulnerable communities (Sadler, 2016).

○ Align donor Program Priorities with Government NDCs

Emerging economies and developing countries have developed NDCs under the UNFCCC system setting out their transition pathways and corresponding initiatives to achieve climate objectives. However, in this definition process, the degree to which corresponding finance needs have been identified is variable: a few have developed comprehensive pipelines of

projects, others disclose estimates of total funding needs, but most do not mention financing needs at all. This is indicative of the disparity in preparedness to execute robust investment plans to deliver their climate commitments. Some countries put forward emission reduction commitments contingent on receiving external financing, which makes the need to attract capital at scale critical to attain climate objectives.

Most developing countries, however, lack the institutional capacity to develop cohesive and comprehensive capital raising strategies linked to their climate objectives and other developmental targets. International institutions and governments have put capital aside to provide technical assistance to developing countries to operationalize and support the execution of their NDCs. Often, these pockets of money support initiatives that are narrow in scope (i.e., to develop projects in a specific sector) and efforts lack coordination between them. Moreover, some of this support is structured as funds or facilities providing countries with different types of capital (i.e., grants, technical assistance, or investment capital at different terms), which can be only optimized with a financial strategy laying out the country's capacity to access different instruments. USAID could work to align specific program and project priorities within the context of specific NDCs to allow for more functional and efficient utilization of this capital.

○ Utilizing a "Whole of Government" Approach, Including Developing more In-depth Data and Financial Flow Reporting and Tracking

Governments often face challenges driven by procedural or systemic failure when interacting with a sector as diverse and nuanced as climate finance in food systems. Successful climate finance markets in food systems cut across social, financial, health, and livelihood outcomes. Thus, governments often lack a coherent and unifying policy aimed at creating a supportive ecosystem for these outcomes. This is especially the case with adaptation-focused finance, which further blurs the line between economic and social outcomes. The result is a frequent lack of internal coordination within domestic governments (Lipper et al., 2021) Adaptation policies are often driven by environmental ministries, development policies and financing are managed by finance or development ministries, and agricultural and rural adaptation support is led by ministries of agriculture. These national level disconnects are often further compounded by a lack of coordination with sub-national and local public sector actors (World Bank, 2018).

These disconnects can go beyond inefficient and insufficient implementation; at times policies in one sector can be counteracted by those in another sector (e.g., training programs focused on food security can run counter to climate-smart and adaptive practices). Not accounting for inter-related risks can also mean potential 'win-win' solutions are left on the table. USAID could work with domestic government partners to build internal capacity and alignment for a 'Whole of Government" approach to climate finance in food systems. It can also act as a facilitator to

allow national governments with existing successful public-sector approaches to these issues to share knowledge with those countries developing their own approach.

Climate finance for agriculture requires accurate collection and tracking of both micro and macro data in national and sub-national contexts to ensure broader capital markets and international donors can make informed decisions about where to allocate capital. This is a particular need for climate finance for smallholder farmers and marginalized communities, such as indigenous populations (Chiriac & Naran, 2020). Governments should more accurately track and report on climate-related investments in agriculture, across all relevant ministries and agencies. USAID can strengthen its support and technical assistance, such as climate finance definitions, standards, and tools, to ensure this data is high quality (Guzman et al., 2022). USAID provides support to governments to develop NDC and NAP financing strategies. USAID could strengthen its support with particular attention to the unique requirements for adaptation and mitigation actions will help mobilize and more efficiently allocate large amounts of capital into the space. Potential modalities of support could include collaboration and knowledge sharing, funding for assessments, and stakeholder convening.

All of these actions require significant buy-in and coordination from local governments. KII feedback shows that a historically effective approach is to focus on explicitly clarifying and aligning on the economic benefits (and not just social) that can come from climate action. For example, successful interventions have focused on clearly laying out the economic benefits of how climate-smart interventions and effective data tracking can generate incremental revenue and jobs rather than a barrier to growth. This strategy can ease the burdens of coordinating and implementing a whole of government approach.

Finally, there is an opportunity for USAID to further strengthen and catalyze its own internal 'Whole of Government' approach. USAID can work to further coordinate and align the broader US government approach to supporting the climate adaptation and mitigation goals of partner countries. For example, there is an opportunity to further align support from USAID, USDA, and the Department of State to ensure that USG action is driving toward the same goal within this space and is also leveraging the unique strengths of each agency and department.

6. EMERGING OPPORTUNITIES AND ENTRY POINTS

The study team identified preliminary opportunities and entry points USAID could pursue to facilitate climate adaptation and mitigation actions. In the following months, as the study team solicits feedback and continues the analysis, we will refine these opportunities into concrete recommendations and intervention areas. However, to summarize at this point in the process:

1. ***The CRD approach provides a framework for USAID missions to integrate climate change more systematically into their strategy, plans, and activities*** and is already built into USAID's climate strategy. This CRD approach enables USAID to layer multiple climate-specific and non-climate-specific development investments into locally driven efforts to build climate resilience and achieve SDGs. CRD broadens the scope and considerations of a project's life cycle to more fully integrate mitigation and adaptation concerns, the relative tradeoffs between various choices, and considering the impacts of production over short and longer time horizons to accommodate the rapidly changing climate.
2. ***The budget and programming siloing of adaptation and mitigation into separate activities makes implementing a CRD approach more difficult.*** Adaptation programming that uses targets and indicators without including mitigation goals risk programming activities that compromise mitigation goals and vice versa. At a minimum, the relative budgeting for adaptation and mitigation should reflect an Agency's understanding of the leverage points it is most able to engage to bring about transformational change toward CRD. As mentioned in Section 2, such an understanding emerges from considering adaptation and mitigation efforts and their expected benefits side by side. However, the most effective work on CRD will take both adaptation and mitigation impacts of any intervention under consideration. This will allow for the identification and management of tradeoffs between adaptation, mitigation, and development goals.
3. ***USAID's research agenda can be utilized to develop the knowledge and tools needed to enable the effective prioritization of adaptation and mitigation activities while managing tradeoffs between them.*** There is a significant knowledge and tools gap related to weighing the relative value of adaptation and mitigation actions. It is possible to compare the relative value of different mitigation actions via the reductions in emissions they are expected to produce. Similarly, it is possible (but somewhat more difficult) to compare the relative values of different adaptation efforts, for example in terms of harvest or other economic losses averted. However, comparing the impact of a mitigation action to the impact of an adaptation action is both limited and very difficult at this time. For example, one could calculate the cost of GHG emissions and assign the mitigated emissions a dollar value, which could then be compared to the value of the losses averted by an effective adaptation project.

Calculating averted loss, though, is difficult and subject to large margins of error, and at this time there is little agreement on an appropriate price for emissions. An analysis comparing the economic value of an adaptation action to a mitigation action could arrive at completely different results if assumptions about carbon pricing and averted losses are changed. Finally, agriculture is a sector where actions in one climate domain will often have an impact on the other domain. Mitigation efforts might change land use and thus farm yields, reducing incomes and adaptive capacity. Adaptation efforts might suggest changes in crops, which can result in enhanced warming through net losses of soil carbon. Without means of comparing the costs and benefits of adaptation and mitigation actions, it is difficult to effectively identify and manage tradeoffs between adaptation and mitigation actions. Weighing these tradeoffs is further complicated by the need to consider the adaptation deficits of marginalized and highly vulnerable populations, whose baseline development needs and climate change adaptation needs may be higher to begin with and thus prioritized alongside other measurements of benefit or impact. The Agency, and the climate change community more broadly, needs a wider set of comparative measures and tools to facilitate work on tradeoffs.

4. ***Forming coalitions across government, donors, and private sector actors is a key success factor for climate action.*** USAID's Climate Strategy clearly articulates the importance of partnerships and collaboration**:** *"All of our efforts will be informed and guided by the plans, strategies, and priorities of our partners."* Our preliminary findings underscored the importance of coordination, not just at high-level policy, but across activities and interventions within a given country context. USAID and its implementing partners can utilize the Agency's reputation and act as partnership facilitators and conveners, bringing together key stakeholders in government, the private sector, communities, and the wider donor community to align adaptation and mitigation efforts in ways that facilitate advancement towards more inclusive and climate resilient development. Collaboration efforts should be built into activity design, as well as analysis, and work planning during the first six months, and clearly tracked and monitored over time. In these efforts, USAID can draw from the wealth of available resources and tools that it has, including USAID's Local Capacity Strengthening Policy, USAID Private Sector Engagement Policy, and USAID's Policy on Promoting the Rights of Indigenous Peoples (PRO-IP), and related toolkits and approaches.

5. ***Leverage points for systemic change are by definition linked to unique attributes of particular contexts, require up-front analysis as well as adaptive management, and, most importantly, must be co-identified and co-designed with local actors and communities.*** The study team is in the process of identifying likely starting points to achieve impact and potential interventions. Section 4 begins to outline high potential leverage points through which to catalyze wider systems change. However, the most effective leverage points for a given context will be identified through analysis of specific

country contexts and identified and designed by the country governments, country firms, and local communities that are going to own and implement them. This is in keeping with Principle 1 of USAID's Local Capacity Development Policy: Start with the Local System. We must acknowledge that high potential leverage points and interventions in the Pacific Islands may be quite different from those with potential for pastoralist communities in East Africa. While the effectiveness of leverage points may be contingent on local context, the tools for identifying them, the ability to engage communities and potential partners, and the incorporation of responsive adaptive management are generalizable. Therefore, the development of tools and approaches for identifying leverage points may be as valuable as the identification of current leverage points themselves. For example, the USAID Market Systems Development community has developed useful tools for facilitating and measuring systems change, considering people's unique experiences. These tools can be further adapted to more explicitly incorporate climate action (i.e., particularly on the mitigation side), building off the current work on resilience. This work has already started.

6. ***Women, youth, Indigenous Peoples, and other marginalized groups have a leading role to play in climate change adaptation and mitigation.*** There is wide recognition that transformative approaches to climate change adaptation and mitigation in agriculture are needed to address the vulnerabilities of these groups, particularly as climate impacts exacerbate existing inequalities. These transformative approaches need to factor in women's and girls' time poverty and lack of agency, as well as the youth bulge and the opportunities that this creates, particularly in Africa. People from marginalized groups can bring forward inclusive solutions to specific or widely experienced challenges. In an appropriate enabling environment, they can serve as agents of change, bringing innovation or their traditional knowledge to their roles and responsibilities in society, identifying barriers to needed transformations, and ways to overcome them. This suggests that some of the most critical development programming to facilitate CRD may not be about the climate as much as it is about including and empowering currently marginal groups to participate fully in markets, political processes, and CRD planning processes for the future.

7. ***USAID should be an active player in the financial markets to de-risk investments and mobilize capital, with a specific focus on inclusivity.*** USAID has an opportunity to use direct capital participation in high-impact areas of the market to serve as both a catalyzing force as well as a *targeting* force to ensure the impact is focused on key inclusive goals. Specific areas in which it can do this includes co-investing in new or existing funds that have a climate focus (and particularly an adaptation focus) and funding project preparation facilities and/or investment advisory assistance for early-stage projects/solutions (with a particular focus on the climate ag-tech space). Private sector partners interested in engaging in collaboration and partnerships with USAID will be

those that recognize the business case for USAID involvement, such as activities that can support aggregation of farmers and agribusiness, trusted relationships with Government and other key stakeholders, and transparency, in addition to co-investment. For USAID, engagement can help to ensure climate financing policy and activities are focused on achieving more inclusive benefits for smallholders, agribusiness, and marginalized communities, than might happen through purely market mechanisms.

8. ***Support the development of investable pipeline opportunities to de-risk investments and mobilize capital, while considering inclusive development objectives.*** Well-funded and highly capable financial intermediaries often still face key barriers at the capital-recipient level (e.g., smallholders and agri-SMEs). There is often a limited pipeline for investment, as smallholders and agri-SMEs frequently lack the technical training in advanced agricultural and forestry techniques needed to perform climate-smart production. Addressing these barriers on the ground via training programs or other development services is cost-prohibitive for smallholders and SMEs. Donor-supported capacity development to build investable pipeline opportunities could be a key catalyst for incremental capital entering the market, especially in areas where capital is already looking to be deployed. USAID can play a role in scaling these models and markets by supporting and de-risking experimentation that leads to proof of concept, investing in research that provides evidence for these changes, convening key stakeholders that need to be bought into these actions, and using USAID's leverage and advantages in the partnerships as described above to keep a focus on inclusive impact goals.

9. ***Support local governments with policy, procedural, and regulatory reforms, aligned with CRDPs.*** National and sub-national governments have a clear opportunity and need to reorient policy, regulatory, and incentive frameworks to support agriculture and food system transformation toward more sustainable practices. In particular, there are significant levers that domestic governments currently use in the form of agricultural subsidies and targeted tax policies that can be reoriented toward low-emission and negative agricultural productivity-enhancing technologies and practices. USAID could play a role by supporting robust long-term policy processes that lead to meaningful transformation. For instance, USAID could strengthen government capacity in scenario planning that accounts for climate change uncertainties and complex interactions that underpin agriculture and the food system.

7. NEXT STEPS FOR THE CLIMATE CHANGE STUDY

The study team sincerely thanks you for your time and consideration in reading this working document. We hope to receive your feedback, including at BIFAD's 187th Public Meeting on Transformative Pathways Toward a Climate-Resilient Agriculture, Food, and Nutrition System: A Pre-Meeting to COP27 on ***Wednesday, October 26, 2022, 10:00am-12:00pm Eastern Time***. We will consider feedback for incorporation in the full draft of the Climate Change Study, to be released early in 2023. The public meetings are elements of a broader communication strategy that is being developed to support the launch of the report at various stages.

In addition, the study team will be continuing to conduct background literature review and analysis and hold targeted KIIs. Our goal for the next phase of research is to outline targets for the food and agriculture systems, confirm priority leverage points, and provide more actionable recommendations around intervention areas. The following summarizes the next steps:

- Conduct targeted KIIs with the select private sector and financial sector institutions; USAID Mission and Regional staff, a sample of other Donors (e.g., FCDO, IFC, ADB), a sample of relevant USAID or other donor-funded projects to help outline specific intervention areas, and with relevant experts as needed.
- Connect with experts from the Feed the Future Innovation Labs (including the U.S.-based leads and the local research and scaling partners), particularly as the study team assesses priority leverage points and interventions.
- Undertake targeted background literature review to prioritize potential interventions and look for proof or confirmation of potential successful models.
- Undertake an in-depth look at the social aspects of transformation toward climate resilient development.
- The study team views dissemination of the study findings as a critical element to inform transformation process at both systemic and programmatic levels. Further to the engagement elements outlined, the team will develop and implement a communications strategy to 1) enable BIFAD's sharing of the study's key findings and recommendations, primarily with USAID leadership and among external stakeholders, 2) facilitate the process of moving from recommendations to effective implementation, and 3) support integration and coordination with and among other partners. This includes actions already underway, namely public consultations, and further efforts to distill key messages for various target audiences with diversified tools such as infographics, informational briefs, and support for direct stakeholder outreach.

This additional work will allow the study team to make informed recommendations on high-

priority leverage points and interventions. We will then go into more detail on select leverage points, including outlining the theory of change, the potential impact, the alignment with USAID policy or country government's NDCs, and potential intervention areas to unlock them. These impact pathways, from systems to leverage points to interventions, will bring forward a focus on the social dimensions of transformational change. Our final exercise will be building up targets from the leverage points and intervention areas that we recommend, and, at a high level, targets for the food, agriculture, and nutrition systems for adaptation and mitigation, and as it relates to USAID's Climate Strategy and the newly released Global Food Security Research Strategy.

ANNEX A. KEY INFORMANT AND BIFAD CLIMATE CHANGE SUBCOMMITTEE PRESENTATIONS

Table A-1. Key Informant Interviews

Name	Affiliation	Title
Rahma Adam	WorldFish	Scientist & GESI expert
Alex Apotsos	USAID	Climate Change Advisor
Mauricio Benitez	BIFAD Subcommittee; responsAbility Investments AG	Member; Nature-Based Solutions and Food Systems Lead
Rob Bertram	USAID, Bureau for Resilience and Food Security	Chief Scientist
Margie Brand	Vikāra Institute	Director
Daniela Chiriac	BIFAD Subcommittee; Climate Policy Initiative	Member; Senior Consultant
Alex Eaton	Sistema.bio	Co-founder and CEO
John Fay	SVA Services International	Director
Mike Field	Vikāra Institute	Senior Systems Thinking Specialist
Keith Fuglie	USDA, Economic Research Service	Senior Economist
Christina Garcia	Ya'axché Conservation Trust	Executive Director
Jerry Glover	USAID, Center for Agriculture	Deputy Director
Noel Gurwick	USAID, Center for Environment, Energy, and Infrastructure	Senior Climate and Land Advisor
Malick Haidara	USAID	Senior Energy and Climate Change Advisor
Tanja Havemann	Clarmondial AG	Director / Founder
Samir Ibrahim	SunCulture	Co-Founder and CEO
Linda Jones	International Consultant	Inclusive Growth / Market Systems Gender Equality and Social Inclusion
Rattan Lal	BIFAD; The Ohio State University	Member; Distinguished University Professor,

Name	Affiliation	Title
Songbae Lee	USAID, Bureau for Resilience and Food Security	Agricultural Finance Team Lead
Brian Midler	Aceli Africa	Founder and CEO
Mark Napier	FSD Africa	CEO
Carlijn Nouwen	BIFAD Subcommittee; Climate Action Platform for Africa	Member: Co-founder
Tom Ole-Sikar	Maasai Women Development Organisation MWEDO	Food Systems and Business Development Consultant
Christy Owen	USAID Green Invest Asia, Pact	Chief of Party
Rajiv Pradhan	Swisscontact (Cambodia)	Country Director
Ann Vaughan	USAID, Bureau for Resilience and Food Security	Senior Advisor for Climate Change
Simon Winter	Syngenta Foundation for Sustainable Agriculture	Executive Director
Peter Wright	BIFAD Subcommittee: CARE USA	Member; Senior Technical Advisor
Fernanda Zermoglio	USAID, Bureau for Resilience and Food Security	Senior Climate Change Adaptation and Resilience Advisor
Linda Zuze	IDinsight	Incoming Director

Table A-2. BIFAD Climate Change Subcommittee Presentations

Name	Affiliation	Title
Rob Bertram	USAID, Office of the Assistant to the Administrator, Bureau for Resilience and Food Security	Chief Scientist
Kevin Coffey	USAID, Office of Technical and Program Quality, Risk Analysis, Bureau for Humanitarian Assistance	Senior Humanitarian Assistance Officer and FEWSNET Program Manager

Name	Affiliation	Title
Clara Cohen	USAID, Office of the Assistant to the Administrator, Bureau for Resilience and Food Security	Executive Director, BIFAD
Noel Gurwick	USAID, Center for Environment, Energy, and Infrastructure, Bureau for Development, Democracy, and Innovation	Senior Climate and Land Advisor
Songbae Lee	USAID, Center for Agriculture-Led Growth, Bureau for Resilience and Food Security	Agricultural Finance Team Lead
Aurelia Micko	USAID, Environment Office, Kenya & East Africa Mission,	Director
Zach Stewart	USAID, Center for Agriculture-Led Growth, Bureau for Resilience and Food Security	Production Systems Specialist
Ann Vaughan	USAID, Office of the Assistant to the Administrator, Bureau for Resilience and Food Security	Senior Advisor for Climate Change

ANNEX B. BIFAD 185TH PUBLIC MEETING

On August 31, 2022, BIFAD hosted its 185th Public Meeting, A Consultative Workshop on Systemic Solutions for Climate Change Adaptation and Mitigation in Agriculture, Nutrition, and Food Systems, with 434 individuals from 59 countries attending via the ZOOM platform. The complete list of participants will be included in the final version of this report. There was a panel session with three speakers listed in Table B-1.

Table B-1. BIFAD 185th Public Meeting Panelists

Name	Affiliation	Title
Sara Boettiger	N/A	Independent Consultant
Ana Maria Loboguerrero Rodriguez	Alliance of Bioversity International and the International Center for Tropical Agriculture	Research Director of Climate Action
Olaf Westermann	Catholic Relief Services	Senior Technical Advisor in Climate Change

During the consultative workshop, hosted formally as a public meeting by BIFAD and planned in collaboration with the BIFAD Subcommittee on Systemic Solutions for Climate Change Adaptation and Mitigation in Agriculture, Nutrition, and Food Systems, BIFAD and invited speakers publicly announced the launch of the subcommittee and previewed the objectives and planned study approach for this study. A summary of participation by organization type and country representation is in Figures 5 and 6, below:

Figure 5. *Map of the workshop participation by country, with 59 countries represented in total*

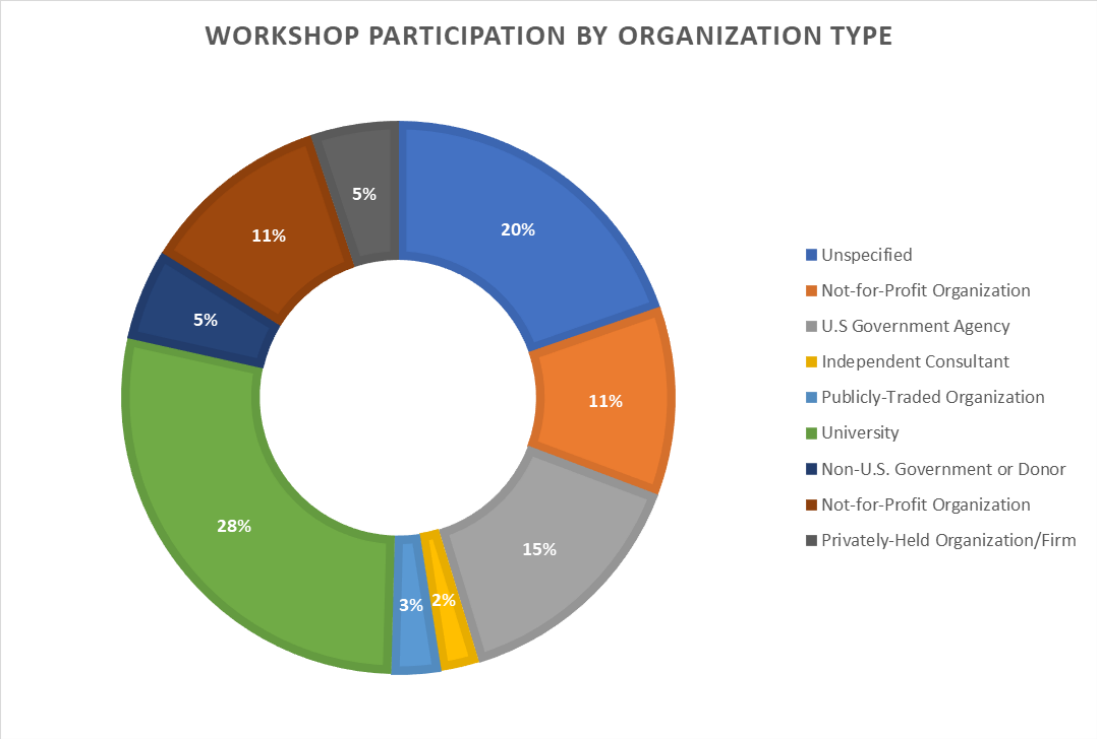


Figure 6. *Workshop participation by participant reported organization type*

To maximize public participation, the Subcommittee and Support Team organized breakout sessions and an interactive online whiteboard during the event for participants to interact with subcommittee members, the author team, and peers to: 1) identify leverage points across agricultural, food, and nutrition systems for transformative change and scaling climate finance; 2) identify enabling systems and conditions that support transformational economic, social, governance, essential services, or humanitarian capacities; and 3) prioritize USAID action areas to facilitate transformative systemic change that is inclusive of underrepresented populations and promotes gender equity and equality.

Expert presentations, discussion, and written content shared in the meeting were included in the sources of information to inform the study.

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