PATHWAYS to PROSPERITY

The Climate Challenge: A Smallholder Pathways Deep Dive

April 2021

I. THE CLIMATE CHALLENGE FOR SMALLHOLDER HOUSEHOLDS

The 500 million smallholder farmers operating on land under two hectares produce an estimated 30–34% of the world's food supply.[1] The impacts of climate change make these farmers—and the more than two billion people whose livelihoods depend on the agricultural sector—an important constituency in the climate response. **However, as global attention has focused on this crisis over the last decade, the response has often treated smallholder farmers as one homogenous group, if it considers them at all.** This research looks at how climate change impacts smallholder farmers and proposes a new way to think about different rural livelihood pathways in shaping the global climate response.

We hope this work will spark conversation among funders, practitioners, and researchers trying to balance complex and overlapping objectives around climate, livelihoods, gender, and youth—and subsequently lead to stronger rural development interventions.

CLIMATE CHANGE AND AGRICULTURE IN CONTEXT

The climate change crisis has the potential to undo decades of progress in global development. According to the latest Intergovernmental Panel on Climate Change (IPCC) findings, average global temperatures have already warmed by 0.5-0.6°C, relative to 1990 levels, and will likely reach a 2°C increase in the near future. Warming of just 1°C will lead to a worldwide decrease in food production yields, worsening as temperatures rise further[2]. A warming of 2°C by 2050 would likely result in the extinction of 15-40% of all species, while a 3°C or 4°C change in temperature would lead millions of people to be displaced due to sea level rise.

Agriculture is a critical part of this global picture, with food systems being responsible for approximately 26% of global greenhouse gas (GHG) emissions.[3] Agriculture-related GHG emissions are driven by land use (24%), crop production (27%), livestock and fisheries (31%), and the global food supply chain (18%), resulting from the evolution of our global food system over the past 50 years. Historically, while the Green Revolution increased farm productivity, it also accelerated the negative climate impacts of agriculture. Often-excessive use of chemical pesticides and fertilizers have resulted in soil and groundwater pollution, pest resistance to chemical control products, reduction of biodiversity, and human health risks. Similarly, the overuse of irrigation water in some areas has led to salinization and/or withdrawal of groundwater beyond its replenishment capacity.[4] A number of these impacts are summarized in Figure 1 below.

FIGURE 1

Agriculture and climate in four numbers

34%
of all land is used for agriculture

- Croplands cover 12–14% of the global ice-free surface while other lands are used for livestock and other agricultural production
- The global population is also projected to increase to approximately 10 billion by 2050, further expanding the land area used for agriculture
- One third of all food produced is never eaten, representing a huge waste in natural resources, human labor and financial capital

68%
of biodiversity losses are due to agriculture

- Agriculture is directly linked to 70% of biodiversity losses on land and 50% in freshwater
- Human use, at varying intensities, affects about 60–85% of forests and 70–90% of other natural ecosystems (e.g., savannahs, natural grasslands)

26%
of global GHG emissions are related to food systems

- The main drivers of GHG emissions are methane gas from cattle, nitrous oxide from fertilized soils and deforestation
- Since 1961, the use of inorganic nitrogen fertilizer increased by nearly 9-fold, dramatically increasing the amount of greenhouse gases
- Since 1961, the consumption of meat has more than doubled, driving an increase in the number of livestock

70%
of freshwater usage is due to agriculture

- Irrigation is used to produce approximately 40% of the world's food, including most of its' horticultural output
- Since 1961, the use of irrigation water roughly doubled and is expected to grow due to increased food demand and lower water resources
- Overuse of irrigation water has resulted in salinization and/or a withdrawal of groundwater beyond its replenishment capacity

Source: UNFSS, IPCC, and FAO; ISF analysis

THE SMALLHOLDER LINK: CONTRIBUTORS OR VICTIMS?

While the agricultural sector is a major contributor to climate change, agriculture and food production also stand to be principal victims of this crisis. Without measures to help farmers adapt to climate change, worst case scenario models estimate that global agricultural productivity may decrease by 17% by 2050[5] and by as much as 50% in Africa.[6] But where do smallholder farmers fit within this broader picture?

Climate change contribution of smallholder farmers

While the agricultural sector, as a whole, is a major source of greenhouse gas (GHG) emissions, **the contribution of smallholder farmers is concentrated in select commodities and is relatively small overall.** In several value chains—including cattle farming, rice, soy, and palm oil production—smallholder farmers produce significant GHG emissions, particularly methane. But those engaged in other value chains produce very limited GHGs, due to their limited use of chemical fertilizers and fossil fuels in production. By contrast, large-scale commercial farming contributes heavily to both GHG emissions and deforestation, including in low-income countries.

Relative to commercial agriculture and other sectors, smallholder production systems' GHG emissions barely register—a fact that should guide the allocation of climate mitigation resources. For example, the average two-acre smallholder farmer in Kenya produces 55 times less carbon than the average American.[7] With this context in mind, it is critical that mitigation efforts for smallholder farmers are focused on farming activities that contribute relatively more GHG emissions or drive land clearing, particularly conversion of wild shrubland, grassland, and virgin forest areas into farms.

Climate change impacts on smallholder farmers

Despite their low level of contribution to climate change, smallholder farmers are disproportionately impacted by climate variability and climate-related shocks. In the near future, many smallholder farmers will be forced to either leave their land, continue farming in difficult and risk-prone agro-ecological conditions, or adapt what and how they grow. Some climate-related migration will be more immediate—for example, due to sea level rise or natural disasters—but much more will happen gradually as environments degrade to unsustainable levels. **In fact, the World Bank estimates that for 143 million[8] people, climate change will result in land that is no longer arable by 2050, forcing them to migrate to other agricultural areas or to urban areas.** At the same time according to a recent International Fund for Agricultural Development study, only 1.7% of climate finance[9] from international financial institutions and other donors is going to climate adaptation activities for smallholder farmers in low-income countries.

Those farmers who choose to remain on their degraded land will contend with changing rainfall patterns, increased weeds and pests, and more extreme weather events, such as floods and droughts. As a result, without new technologies and approaches, yields will decrease and have a knock-on effect on rural livelihoods. These are the limited choices facing smallholder farmers in the near future, making adaptation of livelihoods strategies and reduced exposure to climate-driven hazards critical to survival.

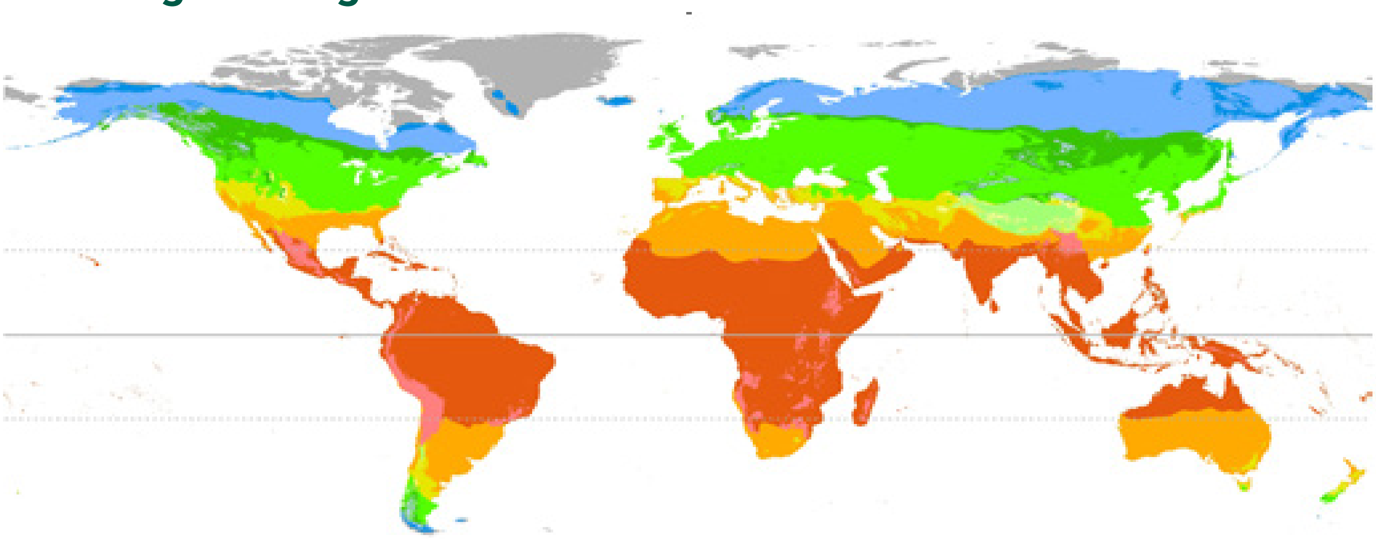
This dynamic is likely to reshape smallholder farming globally—but the impacts will not be felt uniformly. In this deep dive, we consider how different geographies, value chains, and smallholder segments are likely to be affected; and, relatedly, how global institutions need to be preparing, even now, for mass migration and significant adaptation of farming practices.

Environmental migrants are persons or groups of persons who—for compelling reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions—are obliged or choose to leave their homes, either temporarily or permanently, and who move either within their country or abroad.

II. CONSIDERING WHERE CLIMATE CHANGE WILL MOST IMPACT SMALLHOLDER HOUSEHOLDS

FIGURE 2

Global Agro-Ecological Zones



Source: FAO's Global Agro-Ecological Zones

In order to understand the projected impacts of climate change on smallholder farmers, we must examine the various agro-ecological zones (AEZs) in which they operate. AEZ is a land resource mapping unit, defined in terms of climate, landform and soils, and/or land cover; each AEZ has a specific range of potentials and constraints for land use. At a global level, there are 12 primary AEZs, with the warmest zones closest to the equator and each zone getting colder the farther one moves away.

At a basic level, climate change will lead to an expansion of the hottest areas; subsequently, the colder zones will be pushed farther out, decreasing their overall land coverage. While some agricultural systems in higher latitudes may gain net benefits from a temperature increase as more land becomes suitable for crop cultivation, lower latitudes will experience the brunt of the negative impacts. These areas typically encompass lower-income countries, where cultivated land per person is already less than half that in higher-income countries. Additionally, the land in these areas has lower suitability for agricultural production: in the dry tropics and sub-tropics, precipitation is erratic but farmers still rely on rain-fed agricultural practices. Unpredictable soil moisture availability over the course of a growing season reduces nutrient uptake and yields. This, together with low soil fertility and carbon content in the tropics, means that yields in rain-fed systems are about half the achievable potential in many low-income countries. Improved land and nutrient management can increase yields, but there is an upper limit as long as the threat of erratic rainfall remains. With limited access to improved seeds, fertilizer, and information, the rural poor in these areas remain vulnerable.[10]

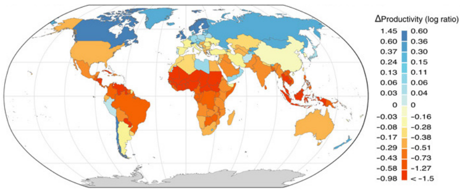
If GHG emissions continue at the current rate, approximately 90% of farmers will experience food production losses, while less than 3% will live in regions projected to gain agricultural productivity by 2100.[11]

The climate vulnerabilities of certain populations are not, however, based only on the impact of AEZs on agricultural productivity. Vulnerability levels are a combination of three factors that are depicted in Figure 3 below, including: 1) the likely change in productivity, 2) the dependence of said population on agriculture, and 3) the population's adaptive capacity.

FIGURE 3

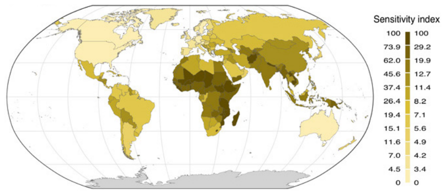
Likely geographic impacts of climate change on different regions

Regional change in agricultural productivity by 2100 (exposure; RCP 8.5)



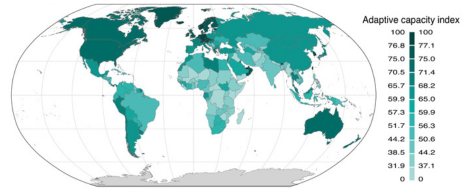
- ~90% of the world's population is projected to face food production losses, while < 3% would live in regions experiencing gains, by 2100
- Countries located around the equator will see the greatest decrease in agricultural productivity
- Countries at the top of the northern hemisphere are projected to see an increase in productivity due to climate change

Current regional dependence on agriculture (sensitivity index)



- Those countries with the highest dependency on agriculture also tend to be the least developed countries
- Countries located in Africa and South/ Southeast Asia have the highest dependency on agriculture
- Countries located in North America, Europe and Australia have the lowest dependency on agriculture

Regional adaptive capacity (adaptive capacity index)



- Dependency on agriculture is negatively correlated with adaptive capability, making these populations particularly vulnerable
- Countries located in Africa have the lowest adaptative capacity to climate change
- Countries located in North America, Europe and Australia have the highest adaptive capacity to climate change

Source: Science Advances; ISF analysis

Populations with the highest dependency on agriculture and the lowest adaptive capacity will be most severely impacted by climate change. Unfortunately, as seen in the regional maps above, these two characteristics are generally correlated. Countries that are most dependent on agriculture tend to be lower income, located in tropical areas most impacted by climate-related changes in agricultural productivity, and have limited economic ability to invest in adaptive capacities. Conversely, countries in higher latitudes—where food, jobs, and revenue dependency on agriculture is generally lower—will experience relatively fewer negative impacts and are less vulnerable across all categories.

The result of these cascading impacts in lower-income countries will be a large number of people unable to sustain their previous livelihoods from agriculture and therefore driven to migrate out of rural communities. By understanding this variation in vulnerability by region and country, we can develop national plans and the required dialogue among key stakeholders and policymakers to support the most vulnerable populations with adaptation and migration, as necessary.

III. UNDERSTANDING THE EFFECT ON SMALLHOLDER HOUSEHOLDS: A PATHWAYS APPROACH

In 2019, ISF Advisors and the RAF Learning Lab published Pathways to Prosperity, which introduced a new approach to smallholder segmentation based on rural transition pathways. This framework replaces a static understanding of rural households based on their characteristics at a particular moment with a more dynamic view of how households and their needs might evolve over time. The model lays out the different transition pathways rural households might take as they pursue increased resilience and agency through various livelihoods strategies. These pathways coalesce around four centers of gravity: 1) farming as a business; 2) rural services; 3) rural labor; and 4) urban migration.

Over the course of a lifetime, a single household may move forward or backward along a pathway, change pathways entirely, or simultaneously pursue multiple pathways. By mapping out the likely transition points for rural households, service providers can create a strategy for engagement that delivers the right services at the right time to help them increase their agency, resilience, and income.

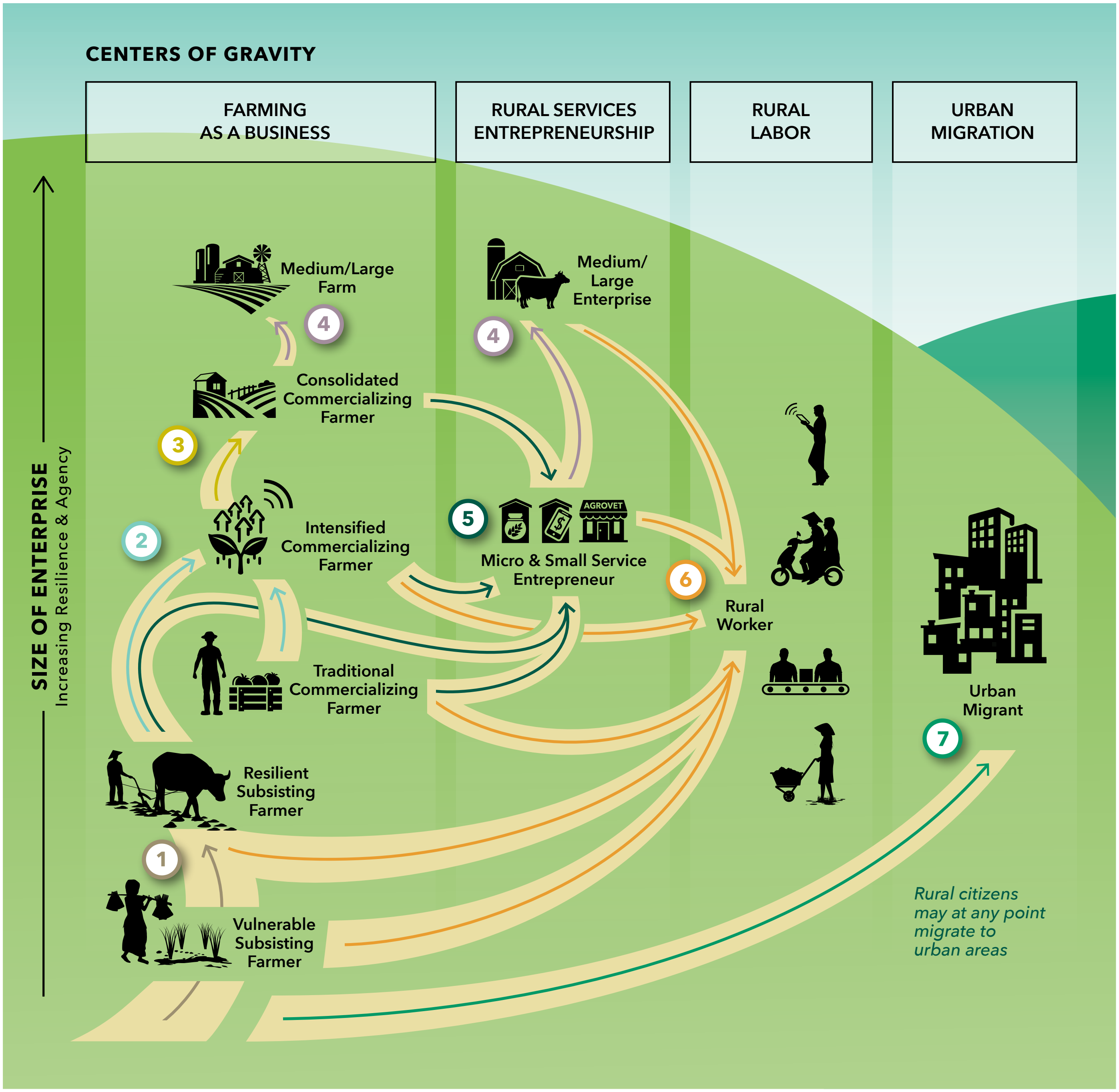
At a foundational level, farmers in all pathways will be impacted by climate change. But the extent and exact nature of these impacts will vary, as will the ability of households to contribute to climate change mitigation. In fact, transitioning between pathways may represent an adaptation strategy for farmers in reaction to climate impacts. With this in mind, in this deep dive, we explore how each pathway can uniquely mitigate or adapt to climate change.

GENDER AND YOUTH DYNAMICS

Different pathways have different inherent dynamics around gender and youth that are also very important to understand. Previous "Pathway Deep Dives" have explored these dynamics around gender and youth in some detail and can be accessed at https://pathways.raflearning.org/. For the purposes of clarity, in this Deep Dive we have limited our examination of pathway climate effects to major livelihood and employment impacts. However, we encourage readers to refer to our previous work on gender and youth as important additional lenses in considering the impacts of climate change on different pathways.

FIGURE 4

The Rural Pathways Model



PATHWAYS

1 Developing a Resilience Buffer
Smallholder farmer continues to farm primarily for subsistence–has little or no surplus–but is able to improve farming practices and build assets to strengthen its resilience to external shocks.

2 Farm Intensification
Smallholder farmer takes a business-oriented approach to farming, and is able to generate a surplus and increase production value through improved inputs, better farming practices, and regular sales to buyers and traders.

3 Land Consolidation
Farmer takes a business -oriented approach to farming and is able to consolidate multiple plots of land for more efficient, cost-effective, and competitive commercial production.

4 Transition to Formal Enterprise
Farmer or service entrepreneur consolidates its activities into a formal enterprise that is fully integrated into the value chain and relies primarily on hired labor and mechanization.

5 Transition to Service Provision
Smallholder farmer shifts away from agricultural production and instead pursues an entrepreneurship livelihood strategy in rural services, either related to agriculture (e.g., agro-vet) or not (e.g., mobile money agent).

6 Conversion to Rural Employment
Smallholder farmer remains in rural areas but shifts away from self-production or entrepreneurship to become labor for on-farm or off-farm activities.

7 Migration to Urban Areas
Smallholder farmer migrates to urban centers, transitioning to non-agricultural activities.

FIGURE 5

Pathways impact model

Pathway	**Mitigation** Definition: *An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2001a)*	**Adaptation** Definition: *Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001a)*
Pathway 1: Subsistence Farmer	Minimal contribution to GHG with low mitigation impact profile.	Most subsistence farmers depend on agriculture for their livelihoods and have limited means to migrate if the climate makes farming untenable. Adoption of regenerative agriculture practices that maintain soil health, diversification and/or adoption of AEZ specific seeds can help farmers adapt to changing climate increasing levels of resilience.
Pathway 2: Resilient farmer	Minimal contribution to GHG with low mitigation impact profile.	Resilient farmers have already adopted certain practices that help to create a climate buffer, but by fully adopting practices to maximize soil health and yields, their resilience further increases. Some of these farmers may have the means to migrate to urban areas, which they may choose to do in extreme conditions.
Pathway 3: Consolidated farm	These farmers have larger plots of land and are more likely to use fertilizers and commercial farming approaches that have higher GHG emissions. They are also more likely to have large scale soy, cattle or rice farms, which have a higher emissions profile. While still relatively small compared to large farms, these producers can start to adopt precision agriculture to reduce their use of farming inputs while increasing yields. Where possible, they can move to more organic farming.	Consolidated farms can start to adopt more integrated systems agriculture as well as agroforestry. This helps to diversify the agricultural system to make it more adaptable to climate change. These farmers may also look to diversify their revenue outside of agriculture and may even migrate to urban areas if changes in growing conditions become significant enough.
Pathway 4: Medium sized farms and Services Enterprises	Larger farms have the most significant GHG emissions profile due to their scale and usage of fertilizers and mechanization. They are also more likely to be involved in large scale livestock, the biggest agricultural contributor to GHG, as well as palm and soy. These farms should adopt integrated systems that restore degraded land through intelligent crop rotation and adopt new technologies such as precision agriculture to become more efficient. Larger farms in countries such as Brazil and Indonesia can also be linked to significant deforestation.	These farmers have larger and more complex farming operations. A stronger asset base affords these farmers more options in adapting their farming operations and agricultural activities to changing conditions, however, many will still be significantly affected by changing growing conditions and major flooding and drought events.
Pathway 5: Micro-small entrepreneur (MSME) **Pathway 6: Rural worker** **Pathway 7: Urban migrant**	Minimal contribution to GHG with low mitigation impact profile.	Moving into this pathway may be a livelihood adaptation strategy for pathways 1-4, to diversify income away from agriculture. However, rural workers and MSMEs are also affected by market shocks related to extreme weather events and natural disasters as well as the risk of climate displacement in geographic areas where rural agriculture becomes untenable and can not support other rural industry.

Source: ISF analysis

Legend (level of relevance)	LOW	MEDIUM	HIGH

A pathways view on mitigation

The majority of climate change mitigation activities should focus on farmers that are consolidating land or expanding farm enterprises (Pathways 3 and 4), as they contribute the most to GHG emissions. The four farming activities contributing the most to GHG emissions (cattle, rice, soy, and palm) tend to be produced at a larger scale and using more resource intensive farming practices and also contribute the most to land clearance. Small vulnerable farmers building a resilience buffer or intensifying production (Pathways 1 and 2), on the other hand, contribute relatively little to GHG emissions; thus, mitigation should only be a focus for these pathways if they are involved in rice or cattle, or if they're farming in particularly vulnerable ecosystems.

Based on biodiversity loss and deforestation, countries such as Brazil, the Democratic Republic of Congo (DRC), and Indonesia have large virgin forests that are being rapidly depleted through agricultural land clearing. In Brazil and Indonesia, the primary drivers of agricultural GHG emissions are larger commercial farmers, while in DRC a large number of subsistence farmers also play a role. By analyzing these value chains, and regional differences in GHG impacts, we can target climate change mitigation efforts in a way that prioritizes the largest and most important GHG emissions drivers.

A pathways view on adaptation

For the majority of smallholder farmers, the focus should be on adaptation rather than mitigation. The capacity to deal with climate change vulnerability can be thought of in terms of resilience, a rapidly increasing goal of many donors and host-country governments. Resilience can be easily understood in terms of the "three A's framework," developed through the Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) program, one of the largest resilience programs globally. In this framework, the concept of resilience is broken down into three readily recognizable capacities or abilities: **adaptive capacity, anticipatory capacity, and absorptive capacity.**

Small vulnerable farmers building a resilience buffer or intensifying production (Pathway 1 and 2) are most vulnerable to climate change, given their high dependency on agriculture for their livelihoods and limited absorptive and adaptive capacity. These farmers are also most likely to be forced off of their land as the economics of farming worsen due to lower climate-associated productivity. Recent research from the RAF Learning Lab reinforces this view: in it, small subsistence farmers in Kenya ranked climate-related dynamics (e.g., weather, pests, and soil degradation) as their number one challenge in achieving their livelihood goals.[12] This makes them particularly likely to migrate to an urban area (Pathway 7) or to move into rural laboring (Pathway 5) or starting a micro-services enterprise (Pathway 6) as a livelihood adaptation strategy. Farmers in these pathways are in dire need of resilience-building support to help them build more capacity to weather shocks and respond to new climatic conditions. In particular, subsistence farmers may not have the financial means to move or to pursue alternative livelihoods strategies.

Farmers that are consolidating land (Pathway 3), while still vulnerable, have an existing resilience buffer and greater levels of absorptive and adaptive capacity. They still need to adapt to new environmental conditions, but have more resources at their disposal; this reduces the likelihood that they will be driven to migrate. Farmers associated with larger farm enterprises (Pathway 4) are even more capable of adapting to climate impacts given their larger land size, which enables them to diversify or adapt strategies such as agroforestry. They also typically have more financial means to invest in their farms.

Those rural households that are not directly involved in farming are also affected by climate change in the form of market shocks. Extreme weather events and natural disasters can significantly affect demand for rural labor (Pathway 6) and services provided by rural micro-enterprises (Pathway 5), making them an equally important set of constituents when considering the effects of climate change.

Of course, the relevant adaptation interventions also depend heavily on geography, as farmers in the same pathway but a different location will be impacted in diverse ways.

CLIMATE-FORCED MIGRATION, A PENDING GLOBAL CRISIS

As temperatures rise and farming production becomes untenable, tens of millions will become climate refugees—particularly smallholder farmers who are forced to abandon unproductive land. In his recent book, *How to Avoid A Climate Disaster*, Bill Gates stated that:

"The poorest in the world live near the equator. And they are subsistence farmers. And when they don't see that they are able to feed their family, that creates incredible instability and incredible migration. And so, this will be the world's biggest migration ever, as those areas become unlivable, where they have crop failures and they aren't able to work outdoors."[13]

He estimates that, in the coming decades, we can expect to see 10 times as much migration from equatorial areas than we saw from the Syrian war.[14] The world has already witnessed the destabilizing effect that this type of migration can have. In the worst drought ever recorded in Syria—which lasted from 2007 to 2010—1.5 million people left farming areas for cities, helping to set the stage for the armed conflict that started in 2011. That drought was made three times more likely by climate change[15].

Migration is a livelihood adaptation strategy for smallholder farmers whose situation becomes untenable. Households that migrate seek to diversify their livelihoods and reduce reliance on farming. According to FAO, over 1.3 billion people in developing countries have migrated within their own nation.[16] Many of these have moved from rural to urban areas. However, the need and options to migrate are not the same for all rural livelihood pathways; additionally, the gender dynamics in household migration are significant.

Three key dynamics and trends are worth noting in considering climate-forced migration of smallholder households:

- For many migrating households, the economic opportunities outside of farming simply do not exist at the level required to compensate for their loss of rural livelihoods; this puts strains on urban areas, creates populations that are "stuck" in urban slums, and reduces livelihoods overall.
- In migrating households, men and boys typically migrate first to seek employment in urban areas and generate remittances to send home; this leaves women to manage the farm and leads to a "feminization of agriculture," particularly in South Asia. In Nepal, for example, approximately 9 out of every 10 people who left the country in 2011 were men, and women's workload in agriculture increased to over six times that of men.[17]
- Farmers in different rural livelihood pathways have different resilience profiles that affect their migration decisions. Small, vulnerable farmers building a resilience buffer or intensifying production (Pathway 1 and 2) have limited assets and are more likely to have a family member migrate to find work based on a single shock or bad season. In contrast, farmers that are consolidating land or expanding farm enterprises have more assets and capacity to diversify; this can create a resilience buffer to climate-related shocks, allowing them to remain on their family farms for longer before having to move.

In responding to climate-forced migration, governments and donors need to understand these types of dynamics so they can design economic-, gender-, and pathway-responsive approaches to supporting livelihoods.

IV. RESPONDING TO THE CHALLENGE

Over the last decade, the global imperative around reaching net zero emissions and managing the climate transition has gathered momentum. But we still need a quantum leap in financing, research, innovation, and solutions that can scale in relation to smallholder agriculture, with a clearer focus on adaptation and resilience. While the more traditional agricultural development sector is largely behind the curve on this issue, a number of response frameworks have emerged from different stakeholder groups.

Some of the key response frameworks include:

1. Landscape approaches;
2. Climate-smart agriculture programming;
3. Climate financing;
4. Rethinking food systems;
5. Technology-led solutions; and,
6. Sustainability standards and certification.

As depicted in the figure below, each of these response frameworks involves different actors and underlying solutions. It is important to note that none of these are mutually exclusive in scope. In fact, there are significant crossovers between many of the activities and solutions and a common integration point around the client/beneficiary (i.e., smallholder households). To create a basis for exploring the global response and the relationship between the different response frameworks, each is briefly explained below.

FIGURE 6

Climate response frameworks

LANDSCAPE APPROACH

Primary actors: Local and regional governments, private sector, local communities, support organisations

Solution focus: Coordinated action

CLIMATE SMART AGRICULTURE PROGRAMMING

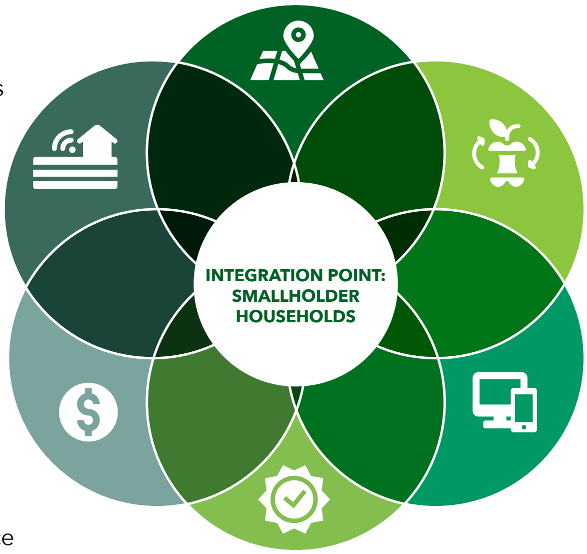
Primary actors: Donors, agri-services providers, support organisations

Solution focus: Enabling services and technologies

CLIMATE FINANCING

Primary actors: Donors, DFIs, commercial funders, financial service providers, support organisations

Solution focus: Finance



RETHINKING FOOD SYSTEMS

Primary actors: : Donors, UN, Multi-lateral development agencies, MNCs

Solution focus: Systems redesign, trade, incentives

TECHNOLOGY-LED SOLUTIONS

Primary actors: Donors, technology companies, FSPs, technical support programs

Solution focus: Innovation and technology

SUSTAINABILITY STANDARDS AND CERTIFICATION

Primary actors: MNCs, certification companies, Industry bodies and coalitions

Solution focus: Certification and standards

A **landscape approach** has three interlinked goals: 1) Production – creating areas where commercial and food crops are grown sustainably; 2) Protection – sustainably using and protecting forests and other natural resources; and 3) Inclusion – enhancing farmers' and communities' livelihoods. This overall approach works with all actors across a certain ecosystem and finds ways each actor can contribute.

For example, IDH has been working in the Mau Forest Complex in western Kenya. More than 10 million people depend on the rivers in this ecosystem, yet the activity of tea plantations and other industries has resulted in more than 25% of the forest being cut down. IDH built a strong coalition of the Nakuru, Kericho, and Bomet county governments; national government agencies; tea, energy, telecommunications, and timber companies; and civil society to work together to protect the South West Mau Forest. With the coalition, IDH helped develop an integrated action plan based on forest conservation, improvement of water flow and access to water, sustainable energy, and alternative livelihoods for local communities. It also created a trust—which included actors from across the coalition—to catalyze investments in forest conservation and smallholder livelihoods. The landscapes approach allowed IDH to mobilize different actors around a shared ecosystem, providing different interventions based on each actor's role, but ensuring cohesion between them to create lasting change.[18]

Climate-smart agriculture (CSA) refers to interventions that contribute to productivity, adaptation, and/or mitigation, focused on changing specific farming practices. This approach typically involves working directly with farmers to promote new techniques and technology.

For example, SNV is implementing a CSA project in Khammouane Province, Laos, to test and pilot innovative adaptation approaches in rice cropping systems. SNV recently partnered with Australia's national science agency, The Commonwealth Scientific and Industrial Research Organization (CSIRO), and the National Agriculture and Forestry Research Institute of Lao PDR (NAFRI) to build community-level adaptive capacity of rice farmers. The partnership piloted a rainwater visualization tool, cropping advisory, and dynamic cropping calendar tool in 10 villages during the wet season. In each of the villages, a rain gauge will be installed, and village heads will organize to collect data on daily rainfall. The rainfall patterns are then analyzed and visualized, with the subsequent analysis shared with farmers throughout the growing season. Local partners in the communities will also be trained in weather observation and use of the rainfall visualizer tool. Using these tools, farmers will be able to adapt better to the pressures and changes on their cropping systems due to increasing climate variability.[19]

Climate financing aims to reduce emissions and enhance GHG sinks through innovative financing, such as carbon credits, micro-insurance, and clean energy incentives. It often includes investment in infrastructure, as well as technical assistance to adopt new technologies and practices that increase resilience. Despite this broad definition, 93% of total climate finance targets mitigation activities—which we have seen are not applicable to most subsistence farmers. Of the 7% that goes toward adaptation, only a small proportion is allocated to programs reaching smallholder farmers.

An example of climate financing is the Forest Carbon Partnership Facility (FCPF), a global partnership of governments, businesses, civil society, and indigenous peoples' organizations focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, sustainable management of forests, and enhancement of carbon stocks in developing countries. The FCPF supports these efforts through two separate but complementary funds. The FCPF Readiness Fund helps countries set up building blocks to implement these activities, including designing national strategies, developing reference emissions levels, designing measurement and reporting systems, and setting up national management arrangements. The FCPF Carbon Fund pilots results-based payments to countries that have achieved verifiable emission reductions in their forest and broader land-use sectors.[20]

Rethinking food systems refers to all activities involved in producing, processing, transporting, and consuming food, touching every aspect of human existence. The health of our food systems profoundly affects the health of our bodies, environment, economies, and cultures. By looking holistically at the different outcomes that food systems support—health, livelihoods, climate, gender, and employment—a more integrated and sustainable approach to market development can be pursued.

For example, in 2021, the UN will convene a Food Systems Summit as part of its Decade of Action to achieve the Sustainable Development Goals (SDGs) by 2030. The Summit is guided by five Action Tracks, including Action Track 3 to optimize environmental resource use in our food systems, thereby reducing biodiversity loss, pollution, water use, soil degradation, and GHG emissions. This Action Track aims to deepen understanding of the constraints and opportunities facing smallholder farmers and small-scale agricultural enterprises. It will also support food system governance that realigns incentives to reduce food losses and other negative environmental impacts.[21]

Technology-led solutions leverage the power of technology to more systematically transform agriculture across entire value chains. While technology can include new low-emission infrastructure and biologically modified, drought-resistant seeds, it increasingly refers to the potential for digitally enabled technologies. This includes agriculture sector-specific data, such as Climate Information Systems (CIS) and Early Warning Systems (EWS); hardware, such as irrigation solutions; and software infrastructure, such as digital platforms to support more climate-friendly agriculture at scale.

The dynamics around technology-led solutions are complex as many technologies are high tech, high cost hardware solutions that support more carbon-intensive farming methods. The UNFCCC Technology Executive Committee's "Technologies for Adaptation in Agriculture" paper[22] covers the different types of technology-based solutions ("hard-, soft-, and org- ware") and an important way to think about their relevance to climate adaptation. While there is a need to be sensitive to the technologies used, there is no doubt that technologies will be a large part of the climate adaptation solution for many smallholder farmers.

For example, using the Internet of Things to enable remote monitoring, technology solutions can enable low-cost pumps and/or drip irrigation to support supplemental or deficit irrigation. By integrating this technology into water management, farmers can increase water use efficiency. Reducing water use can also increase crop productivity and enhance soil quality by preventing mineral loss from overwatering.

Sustainability standards and certification are typically used in tight, export-oriented value chains that are anchored by large multinational companies, including traders, manufacturers, and consumer brands. These sustainability standards and certification systems are used to create more traceability and transparency in the production practices of consumer foods; they often involve passing on premiums to producers for meeting specific quality and sustainability standards that are certified.

For example, the Better Cotton Initiative (BCI) was founded in 2005 by adidas, Gap Inc., H&M, ICCO, IFAP, IFC, IKEA, Organic Exchange, Oxfam, PAN UK, and WWF. In 2009, BCI published its first global standards, and the first harvest of Better Cotton was in the 2010/2011 season. With cotton having a significant environmental footprint—as well as supporting over 250 million people's livelihoods—the Better Cotton Initiative exists to transform cotton production worldwide by developing Better Cotton as a sustainable mainstream commodity. Building on a set of principles and standards, farmers are trained in sustainable production practices and produce is certified in the aggregation system, working with ginners and traders. This approach is replicated in a number of other commodities—including cocoa, palm oil, tea, coffee, and cashew nuts—that all have large, highly dispersed smallholder producer bases.

Each of these approaches encompasses different responses to climate change mitigation and adaptation, as well as different supporting actors—as we can see in the figure below.

FIGURE 7

Stakeholder landscape associated with different climate response frameworks

Approach	Key Actors
Landscape approach	idh the sustainable trade initiative; UN environment programme; World Agroforestry; World Resources Institute; CIFOR; Rainforest Alliance; WWF
Climate Smart Agriculture Programming	UNDP; SNV; Feed the Future; The World Bank IBRD · IDA; FAO
Climate Financing	European Bank for Reconstruction and Development; Adaptation Fund; Banque Africaine de Développement / African Development Bank; ADB; gef; Green Climate Fund; IDB; UN-REDD Programme
Rethinking food systems	AGRA Growing Africa's Agriculture; Ministerio de Agricultura y Ganadería de Costa Rica; iPES FOOD; Alliance Bioversity International CIAT; One planet handle with care
Technology-led solutions	The Rockefeller Foundation; mastercard foundation; GSMA; Bill & Melinda Gates foundation; Mercy Corps AgriFin Accelerate; Feed the Future
Sustainability standards and certification	MARS; Cargill; P&G; Certified Sustainable Seafood MSC; FSC; Rainforest Alliance Certified; Fairtrade; BCI Better Cotton Initiative

ADAPTATION SOLUTIONS

This research has highlighted just how significant and complex the adaptation challenge will be for smallholder farmers in different rural livelihood pathways. As we consider building the resilience profile within different pathways and preparing for more climate-forced migration, new technologies and approaches will be more critical than ever before. Adaptation solutions can be considered in terms of **i) climate adaptation intelligence solutions that help identify and assess physical climate risks, and ii) climate adaptation products and services that help to address physical climate risks.**

- Examples of types of climate adaptation intelligence solutions include: Climate monitoring and forecasting systems, temperature regulation technologies for livestock, remote sensing-based drought monitoring tools, crop data and analytics platforms with mapping interfaces and early warning systems
- Examples of types of climate adaptation products and services include: Drought tolerant crops, crop diversification, high precision laser land leveling systems to reduce runoff, pressurized irrigation technologies, parametric insurance and water storage and harvesting solutions

Different response frameworks prioritize different types of solutions. While this research does not set out to systematically assess the relative merits of different types of solutions it is clear that many (such as drip irrigation, parametric insurance and water storage) have been refined for smallholder use through over a decade of innovation. As solutions continue to evolve it will be important that they are linked to the Pathway and context specific challenges of different smallholder households.

V. CONCLUSIONS AND RECOMMENDATIONS

There's little doubt that climate change will disrupt smallholder farming globally and that the time to act is now. Solutions that have delivered productivity gains in the past through carbon-intensive technologies and practices need to be rethought. At the same time, entirely new solutions need to be developed—particularly those that are financially viable for these segments. The response frameworks that have emerged provide a good starting point for ramping up the required action.

However, with so many strategies available, there is a real danger of new and unnecessary silos building up around ideological approaches, funding flows, and practical program associations (i.e., CSA vs. landscapes vs. food systems approaches, all of which are trying to solve similar issues).

In reflecting on a pathways view of climate change we propose four specific recommendations to continue to guide the global action agenda.

RECOMMENDATION 1: Strengthen the science and research foundations with more localized, data-led climate science and modeling.

More modeling should be done to project where smallholder farming is most likely to become untenable—and what types of farmer segments will be most affected over time—to support stronger global planning around managing climate effects. Organizations such as IPCC are mapping climate impact scenarios based on a huge number of inputs. To effectively act on this mapping, it needs to be brought down to the local level with more local impact data, where we can see how specific countries and landscapes will be impacted by temperature change, variations in rainfall, or desertification. Once we understand how a particular landscape is likely to change, we can look at specific crops that are grown in that landscape and which smallholder pathways will be most affected.

A more localized view should be brought together with resilience mapping using assessment frameworks (such as the "three A's" referenced in section III) to provide governments, donors, civil society, and the private sector with clear modeling to inform policy and interventions. With predictive mapping on food shortages and changing growing conditions, governments can plan food stocks to avoid potential famine and prepare for potential rural migration. Without this accurate modeling at the local level, linked to the pathways model, any response is likely to be less effective and future-proofed than it needs to be.

RECOMMENDATION 2: Anchor action in shared agendas that are government-led but built around a systems view of landscapes and markets.

The effects of climate change will be different in each country and reflect the unique nature of the local food system, agro-ecological growing conditions, farming population, market actors, and policy environment. Host country governments are ultimately responsible for the long-term strategy, planning, and policy that safeguard the livelihoods of citizens and shape food markets to support a balanced set of outcomes. However, food systems and climate change are also global in nature and built around markets that are driven by the private sector. As such, all responses to climate change action need to be built around a systems view of markets, leveraging the very best global science and research and long-term in their outlook. Global food systems initiatives, landscape approaches, and other market-shaping responses need to be continually aligned with national climate strategy and planning to ensure that different rural and smallholder needs are considered both holistically and long term. This creates a critical need for more effective forums for the public and private sector to come together, aided by regional and international institutions where relevant, to co-design solutions.

RECOMMENDATION 3: Integrate a rural pathways view into all response frameworks to more effectively target, prioritize, and coordinate action.

By breaking down responses based on different pathways, we can develop and prioritize specific interventions that are most suitable to each populations' specific contribution and vulnerability to climate change. For example, applying a pathways lens to CSA programming shows us that small, vulnerable farmers building a resilience buffer or intensifying production (Pathway 1 and 2) would benefit more from productivity and adaptation interventions, while farmers that are consolidating land or expanding farm enterprises (Pathways 3 and 4) are more appropriate for mitigation and adaptation measures. Similarly, we can see that climate finance is currently serving the expanding farm enterprises and providing minimal support to smaller subsistence farmers. This could push climate finance providers to adjust their financing mechanisms to support the most vulnerable populations, even if that is to ultimately transition away from untenable farming in the future. A pathways analysis of food systems approaches allows for more targeted interventions around households engaged in rural labor markets, services micro-enterprises, or urban migration (Pathways 5-7), who no longer work directly in agriculture but are still vital parts of our food system. This type of approach to targeting can lead to much more efficient and effective responses, while also uncovering opportunities for critical coordination between different actors focused on the natural point of integration: the smallholder farmer.

RECOMMENDATION 4: Increase funding for innovative adaptation solutions.

This research has highlighted just how significant and complex the adaptation challenge will be for smallholder farmers in different rural livelihood pathways and the types of response frameworks that have emerged to support a response. With the scale of the current adaptation challenge for smallholder farmers rapidly increasing and only 1.7% of climate finance from international financial institutions and other donors is going to climate adaptation activities, a quantum increase in investment will be needed in innovative and scalable solutions. In the past ten years over 700 new digital agriculture service providers have emerged globally that are driving new types of products and services for smallholder farmers. Many of these innovations are directly related to the adaptation challenge. Companies such as Acre Africa and Pula have pioneered the development of insurance products for smallholder farmers while companies such as Proximity Designs, Precision Agriculture for Development and iDE have done the same for drip irrigation. As these, and other, companies continue to refine and scale their solutions more grant-based innovation funding and sub-commercial impact investment will be needed.

RECOMMENDATION 5: Develop smarter ways of structuring finance to scale promising solutions.

The concurrent challenges of continuing to feed a growing global population while using less resources, supporting adaptation needs and simultaneously moving to net-zero carbon is an immensely difficult problem to solve. Within this context, public funding is not going to be large enough to fund the scale up of the required solutions. Innovation will be needed within capital markets to create new investable asset classes (such as climate credits), developing new pay for result incentives and "blending" public and private capital to fund solutions at scale. This type of innovation will be critical to unlocking the right types of finance for solution providers supporting different smallholder Pathways.

ABOUT ISF ADVISORS

ISF is an advisory group committed to transforming rural economies by delivering investment structures and partnerships that promote financial inclusion for rural enterprises and smallholder farmers. Combining industry-leading research with hands-on technical expertise, ISF develops practical, profitable, and sustainable financial solutions. ISF's primary role is to act as a "design catalyst." Emphasis is on mobilizing additional financing for rural enterprises and seeding replication of innovative models.

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