

# Private Markets for Climate Resilience

## Global Report



# Private Markets for Climate Resilience

Private Markets for Climate Resilience (PMCR) is the first initiative by a development institution to better understand climate resilience solutions provided by the private sector. The Inter-American Development Bank (IDB) and the Nordic Development Fund (NDF) have funded this assessment that focuses on transport and agriculture, and examines current best practices and opportunities related to climate resilience, by identifying leaders that are shaping the national markets, highlighting products, services, tools and processes.

The private sector across the world is already supplying hundreds of products and services that could be classified to increase climate resilience, but in general, recognition of the climate benefits of these solutions is limited; they are responding to other drivers of demand within their market. This report brings together common, practical and affordable solutions already in place across the agriculture and transport sectors in Colombia, South Africa, the Philippines, Nicaragua, Kenya and Vietnam. Some of the solutions presented are not yet fully established and are reported here as resilience innovations. This report does not represent a full market assessment of the selected solutions, rather highlights products and services already in the market together with barriers and opportunities for demand and supply, and current financing options.

## Proadapt

The current and future impacts of climate change pose substantial threats and costs to business and communities across Latin America and the Caribbean (LAC) through systemic, incremental changes or abrupt extreme weather events. Yet, in the face of growing climate variability, there are many business and investment opportunities arising from the demand for climate resilience solutions in the form of emerging technologies, analytics, market intelligence, as well as new financial and investment models that better frame and manage climate risks.

Against this backdrop, Inter-American Development Bank (IDB), in partnership with the Nordic Development Fund (NDF), created a project facility, Proadapt. The Facility pilots and supports the development of new and innovative methodologies, tools, and business models and knowledge to help micro-, small- and medium-sized enterprises (MSMEs) and their supporting ecosystems reduce their vulnerability to climate change while seizing related business opportunities in the LAC region.

The Facility includes four components: (i) development and promotion of a climate adaptation action plan, and stakeholder outreach; (ii) development of business models and tools to help enterprises develop new business opportunities; (iii) individual sub-projects for building MSME climate resilience and related business opportunities; and (iv) knowledge management and dissemination.

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# Foreword

## From Climate Change to a Climate of Opportunity

At this writing, a pandemic is slamming into countries with the speed and lethal impact of a natural disaster. Unlike most disasters, this crisis strikes the entire world at once. Global climate change, though less immediate, shares some similarities with the COVID-19 contagion. Climate change is also a global humanitarian and economic crisis that contributes to the death, illness and poverty of those most vulnerable to drought, floods, invasive pests, vector-borne disease, extreme heat, cyclonic winds and other climate-related risks. The climate challenge and a pandemic both underscore our common vulnerability and the unequal distribution of capacities and resources available to build resilience against these threats. Pandemics and climate change share one more commonality: neither are Black Swan events. Scientists have warned us for years about both. Once again, we are reminded of our habit of discounting both the lessons of the past and the science-based scenarios of the future.

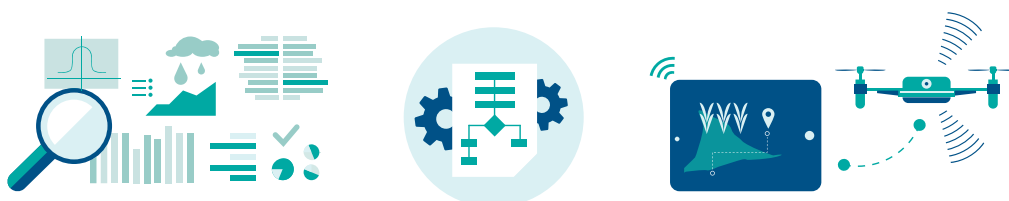


This study, Private Markets for Climate Resilience (PMCR), examines an overlooked component of the response to climate change: private-sector contributions to climate adaptation and resilience. Climate adaptation is the process by which humans attempt to adjust to the many challenges that result from climate risks. One successful outcome is greater climate resilience, or the capacity to identify, manage, mitigate and withstand risks related to climate change. The majority of work on climate adaptation and resilience has until recently been done in the climate science and policy communities, with little attention paid to the role of private actors in producing technologies, products, and services that help people and organisations to become more resilient in the face of a changing climate.

The PMCR study was commissioned by the Proadapt Facility of the Inter-American Development Bank (IDB), a program that fostered private climate resilience and related opportunities in Latin America and the Caribbean. Both Proadapt and the PMCR were generously co-financed by the Nordic Development Fund (NDF). Proadapt was based on a few basic propositions. First, that climate related risks are becoming more extreme. Second, the poorest countries are among the most vulnerable to climate hazards, and the least responsible for this threat. They will pay the highest price without enjoying the economic benefits that created this atmospheric waste in the first place.

The third idea was that innovative and safe carbon neutral or negative technologies may come online. If so, they could be game changers, but we cannot plan on this. Our current emissions trajectory continues to far exceed the pathway needed to avoid destabilising increases in temperature. Even with rapid and dramatic reductions in emissions, we are likely locked into many decades of escalating climate risk. Fourth, climate resilience must become a major priority in developing countries because of threats to their food and water security, livelihoods, settlements and public health.

Fifth, the demand for resilience drives business opportunities for many businesses, large and small. As climate risks worsen, public and private customers need to protect people, property, operations, supply chains and natural ecosystems from heat, drought, flooding, sea-level rise, cyclonic winds and other threats. This need is a business opportunity for many firms. Private resilience solutions are growing in demand. To name only a few, these include water-efficient products and services, micro-technologies in 'precision agriculture,' drought-resilient seeds, storage and logistics, consulting and digital solutions, climate analytics, new building materials, monitoring systems and construction

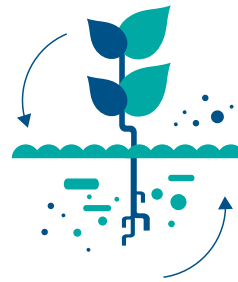


methods, including more efficient ways to cool buildings, resilient infrastructure, including transport, adequate back-up power generation, distribution, micro-grids, storage and disaster recovery. Other resilience solutions in healthcare include new vaccines, pharmaceuticals, measures and products to protect against vector-borne diseases delivered by mosquitoes and other pests, more resilient healthcare facilities and other solutions. To date, no systematic research or data is collected anywhere on private-sector resilience solutions.

A sixth idea is that companies rarely use climate terminology when describing their resilience solutions. Weather is often used in the description of resilient products and services, but enterprises mostly use the language of business: finance, risk management and marketing etc. to describe their activities, not climate jargon. It is possible that companies disappear from “adaptation policy radar,” reinforcing the perception that private actors are inactive in this area. This may deprive public authorities of useful market intelligence that could inform national adaptation planning and other policies.

## The Private Market for Climate Resilience

These ideas led to a market assessment of private resilience in one country in each of three regions: Latin America, Africa and Asia. This would provide an overview of the private market and innovation in climate resilience, identify opportunities, highlight weaknesses inhibiting a market response, and examine the role of policy and enabling frameworks among other variables. The team chose the agriculture and transport sectors in Colombia, South Africa, and the Philippines, with desk studies in Nicaragua, Kenya, and Vietnam.



Agriculture was obvious given its vulnerability and importance for food and water security, employment and livelihoods. Transport is a major sector, but in most countries investment decisions in transportation are made by the public sector. However, most of the work performed — from design to maintenance — is by the private sector.

This study is a pioneering effort. It is a first-of-its-kind inquiry into private climate resilience in three emerging and developing markets. First, the study has found an active market for private climate resilience solutions, albeit very specific to sectors, tasks, climate hazards and geography. The study notes that the hundreds of solutions identified by the team are a tiny fraction of the innovations in just these two sectors, suggesting that the scope of private action in resilience is vast and remains terra incognita. This assessment has generated a significant amount of insight and data, through interviews, primary and secondary sources, and market intelligence culled from private and public actors.

The team found that while many businesses are producing and selling resilience solutions, the “tyranny of the short term” still hinders the strategic thinking in many firms with respect to resilience in one’s own operations and the recognition of opportunities driven by climate risks.

Further, the business case for resilience has not been well articulated, various attempts among consulting firms to calculate the “cost-benefit” of resilience activities have not led to any one approach going mainstream. While most businesses acknowledge that greater climate resilience is an important goal, the lack of a recognized financial metric, such as a “return on resilience” measure, impedes private action in this area.

This assessment further highlights the divergent framings of climate change by public and private actors, noting that this “demands a serious examination of the status quo.” This is important given that neither public nor private action alone can address the climate threat. The public and private sector need each other when it comes to climate resilience. Private actors need the enabling frameworks and policies that foster transparency, trust and that facilitate investment and commerce. Smaller companies need access to finance. The public sector needs private innovation, creative problem solving and capital. Going forward, any effective climate response will at times blur the boundaries between public and private, between planning and the market. This will not come about because of impassioned pleas for cooperation, but because of the practical necessity for collaboration among governments, businesses, experts and communities leaders on the profound challenge of climate change.

This study found that smaller firms, including some microenterprises, are among the most innovative enterprises in climate resilience. Specialised consultancies offering knowledge and technical services are all very small, including analytics or digital solutions in agriculture or on sediment monitoring in ports. The advisory and consultancy space is developing rapidly in agriculture in surveillance intelligence. These and other specialised knowledge companies speak often and emphatically about climate risks and resilience, and represent a growth market in the countries studied.

The PMCR notes that no set of resilience solutions, technologies, products, or risk protocols can solve the challenges ahead. Research and development and continual improvements to processes and products will help companies adapt to risks and generate opportunities. Moreover, resilience building is not a “one-off” intervention, but part of a continual effort to feed emerging data and market intelligence into an organisation’s production system and to inform its actions. Resilience is not static, but one outcome of the continual improvement of a production system. As Anton Cartwright in Cape Town commented, “The intuitive appeal of resilience thinking lies in the ability to look beyond a single goal such as profit maximisation, and to address entire systems.”

Greater climate resilience is a necessity as we move into an uncertain future. While the cost and benefits of resilience building are debated, climate risks are accelerating. Yet relatively little attention has been paid to the business and ultimately investment opportunities presented by the need for buyers to better manage climate risks that threaten public and private property and assets, value chains, people, settlements and natural ecosystems. This study has revealed the emergence of market opportunities in climate resilience in emerging and developing markets. As noted, many micro-, small- and medium-sized enterprises, the largest employers in these countries, are among the most innovative in resilience in their respective markets.

Since this study was commissioned, the Task Force for Climate Related Disclosures, the Global Commission on Adaptation, the Network for Greening the Financial System and other high-level initiatives have placed greater focus on the private sector and resilience. However, PMCR has been among the very first inquiries into private contributions to climate resilience, and points the way toward a new research agenda on private innovation in climate resilient technologies, products and services in developing and emerging markets.

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May 2020

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# Executive Summary

*Climate change is increasing risks and impacts in all parts of the world economy, particularly in developing countries where there is less capacity to adapt. By 2030, the cost of making climate-vulnerable business sectors resilient is expected to be in the billions per year. Given that public action alone will not be sufficient to address the scale of this threat, the cost will largely be borne by the private sector, which will also be tasked with developing the innovative products and services needed to drive resilience. However, in private markets, where there is a very large challenge there is also a very large opportunity and businesses stepping up to increase their resilience or to create new climate-resilient products, services and business models, will be well-positioned to safeguard their own future as well as take the lead on transforming entire economic systems.*

The **Private Markets for Climate Resilience (PMCR) study** took a frontlines look at how the private sector in six developing countries is addressing climate risk in agriculture and transportation. Along with identifying a vast range of promising climate resilient business examples and solutions, the study also came up with findings and recommendations on how private stakeholders could become more active, as well as gain a better understanding of the business case for doing so.

The working assumptions underlying the PMCR study were that most people recognise that the climate is changing, but lack an understanding of the associated risks and uncertainties for implementing practical measures to protect their businesses and communities from these risks. Moreover, the private sector is already supplying products and services to meet a growing demand for solutions to help buyers better manage their exposure to climate risks, and this demand represents a business opportunity for firms of all sizes.

The **PMCR Global Report**, together with the **Resilience Solutions Factsheets**, aims to reach several stakeholder groups, including international development organisations and donors, private sector associations, policymakers, academic institutions, and private sector actors in agriculture and the transport sectors, among others.

The Report builds on the findings of national reports produced by the country teams as well as resilience dialogues held in each country. **Colombia, South Africa** and the **Philippines** were designated as Tier 1 countries, in which extensive field data was gathered through workshops and resilience dialogues. Tier 2 countries were **Nicaragua, Kenya** and **Vietnam**, where the same approach was implemented mostly through desk studies made inside the countries.



*Jayson C Berto, the Philippines*



## ***Framing the context for climate resilience***

In all the areas under study, climate change is no longer an abstract concern, but is affecting societies now, and in major and complex ways. Notably, extreme weather events are affecting local and regional economies and community livelihoods. A firmer understanding of the specific impacts associated with, or attributed to, climate change, as well as the interrelation among them, is the subject of ongoing research.

In the macro-context, the climate mitigation narrative is now largely understood, with global-level proposals like the Paris Agreement aiming to limit the magnitude and rate of long-term global climate change. However, a substantive commitment to dealing with adapting to climate change and new longer-term and innovative approaches integrated into the way we live, work and govern are needed.

The great advantage of climate adaptation and strengthening resilience to a changing climate as concepts, is the implication of a systemic approach, with the private sector as a necessary and integral part of the system. While the public sector must create an enabling environment for resilience and lay out a framework that protects public goods and addresses market failures, it is the private sector that will be tasked with developing the innovative products and services needed to drive resilience. In this context, there is a growing understanding and awareness that public action alone will not be enough to meet the scale of the climate threat and that private sector innovation and resources will be critical.

To date, the impacts of global climate change have been primarily framed by private sector actors as risk, most often expressed in terms of weather risk. Although extreme events get the most public attention, longer-term climatic changes and associated impacts may prove costlier to society, particularly in the context of food and water security and the viability of communities and their productive assets. Moreover, dealing with near-term impacts, remains the primary driver of action in private companies, which typically prioritise current risk and short-term profitability over longer-term business sustainability.

## ***The role of the private sector in climate resilience***

The PMCR study was tasked with identifying how the private sector in agriculture and transportation in the selected countries is addressing climate resilience. This included looking at growth opportunities for solutions already enhancing climate resilience as well as barriers to the wider availability of such solutions across value chains.



A central finding of the PMCR study is that engaged private-sector stakeholders are well aware of how weather and extremes impact operations. In fact, private-sector actors need support in understanding other unknown risks, addressing the impacts as well as the uncertainty around climate change, and how to turn them into business opportunities that benefit their companies, their customers and the communities where they operate.

The PMCR study also found that the private sector is already providing many solutions, but just not referring to them as ‘climate change adaptation’. Practical and, in many cases, cost-effective **climate resilience solutions** are already in place. Notably, these are to protect against extreme events, by providing weather forecasting, agro-climatic simulations, flood control, soil management, resistant construction materials, and infrastructure design and refitting services, among many other products and services aimed at managing climate risks.

Resilience is place, time and actor specific. This is because resilience actions are highly dependent on the type of risk and vulnerabilities linked to the local climatic conditions that are being addressed. Political context, existing market structures, geographical settings, institutional capacity, socio-economic conditions and regulation requirements are also key.

Across the PMCR sectors, there were no single solutions applicable to all risks and vulnerabilities, but instead hundreds of sector-specific climate resilience options that work in complementary ways. This array of solutions is beneficial in that it allows decision-makers to tailor and access only those solutions appropriate for their context, based on their own assessment of risk. Adaptation benefits depend on good practices, but, without a clear understanding of vulnerability drivers, geographical settings, including climate risks and local context, even known good practices can lead to maladaptation.

A general lack of awareness of the business case for resilience, combined with the relatively high cost of doing business for smaller companies, was apparent. Unsurprisingly, many of the barriers to market expansion were not specific to climate but rather a general reflection of local market operating conditions. Typical examples are a lack of government incentive for business innovation, burdensome regulations and taxes, and the inability for smaller players and start-ups to get access to capital or credit.

### **Private action on climate resilience**

Much of the current resilience activity among private-sector actors is not classified as such, but is often considered business as usual. Looking through the lens of the countries and sectors under study, climate resilience actions are being led by enterprises of all sizes and can be classified loosely into three main types: *defensive*, *innovative* and *transformative* – with many that can be considered crosscutting.



*Defensive solutions* protect existing operations or infrastructure in the face of a changing climate. *Innovative solutions* involve new methods, practices and technologies that can spawn new social or value-chain relationships. Many companies identified as providing innovative resilience services were often micro-, small- and medium-sized enterprises (MSMEs). *Transformative solutions* change the nature of a company or sectors, disrupting business as usual, or finding new applications for existing tools or practices.

As climate conditions worsen, stakeholders in the agriculture sector are increasingly finding value-add in more precise and contextualised farming approaches and implementing good practices. These include adapting planting and harvesting schedules, actively managing soil health, diversifying products or using technology to optimise resources. Linked to precision, is the power of information, where access to knowledge services is also becoming more and more valued. Climate projections, weather monitoring and forecasting, combined with early-warning systems, agro-climatic models designed to drive quality yield, water efficiency and crop management techniques, are all among the many promising resilience solutions studied.

In all PMCR countries, the study found agreement with the basic premise that resilient transport infrastructure development is key for the long-term sustainability of the agricultural sector. New informed design parameters and climate resistant materials are now being seen as the way forward for increasing disaster preparedness and strengthening resilience. Climate-resilient design and construction is also associated with lower repair and maintenance costs as well as lower insurance claims and costs.

### **Building private markets for climate resilience**

To flourish, sustainable markets need more than just willing buyers and sellers, they also depend on relevant public services, including access to reliable information to promote behavioural change, as well as favourable policies and enabling market conditions. Strong policies are needed to incentivise the private sector to embrace and invest in long-term business continuity, instead of focusing on short-sighted climate-proofing of operations and treating resilience as an 'added cost'.



There are common challenges hindering the development of a mature market for these products and limiting the ability of the private sector to more actively engage in climate resilience. As access to finance is one of the main challenges faced by both buyers and providers of climate resilience solutions, these markets need access to capital flows to scale up promising technologies and services. Consequently, the financial sector also has a key role to play in providing investment capital, affordable insurance, credit and other financing products. In this context, a strong need was identified to engage local multi-stakeholder groups, including public, private and civil society, to build stronger cooperation and transparent dialogues around resilience building.

Suppliers of resilience products and services face constraints specific to both climate resilience and in-country business environments. Formal incentives are limited and there is a large untapped opportunity for suppliers to widen their customer base to include those at the 'base of the pyramid', to whom these services are unavailable but where demand exists. New business models will be required

to take advantage of this potentially large opportunity. Customer profiles vary by geography, financial status, purchasing power as well as access to information, among others. Currently, international assistance and government subsidies are used to bridge the affordability gap. To date, however, this support only reaches a relatively small portion of potential stakeholders.

### ***Finding the way forward***

Climate risk is driving a large and growing demand for private climate resilience solutions. Resilience dialogues showed that agricultural producers want affordable products and services that will solve their short-term challenges while helping them build longer-term climate resilience. They also want climate resilient supply chains, access to sustainable markets and financial mechanisms that will lead to sector transformation. Similarly, in the transport sector, stakeholders have significant expectations for more resilient infrastructure.

The PMCR study alone identified manifold target market segments, which are active and ready for scaling. Companies taking proactive measures to increase their resilience or to create new products or services, even in the face of uncertainty, can maintain their viability and gain competitive advantage. The ability to calculate the benefits and costs of resilience will be vital for companies in making comprehensive risk assessments. However, there are methodology challenges, as it is not a straightforward process to reflect resilience costs and benefits, which can be spread across multiple actors, or over time, or manifest as non-monetary benefits. Moreover, most of the challenges faced by companies are not directly linked to climate change, but rather to prevailing operational and regulatory environments.

While relevant action is taking place, it is unclear how much, or whether it will be enough to avoid significant economic loss. Clearly, private solutions can protect many types of assets and businesses from climate risks, and in turn strengthen the global response to climate change, while also generating economic opportunity and social benefits. Although the solutions selected for detailed presentation in this study were those with the most potential for each specific context, they are only a fraction of the hundreds of other solutions identified and therefore just the ‘tip of the iceberg’.

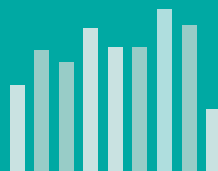
The PMCR study sits early in the market-innovation cycle at the stage of identifying potentially viable business models, and even though its methodology was designed to inform decision-making rather than produce investment-ready business cases, the contextual message is clear. Investors need no longer wait for a comprehensive global strategy to start addressing the effects of climate change – technologies and solutions exist and are ready for investment and scale up.

Climate resilience requires markets to take a more system-wide and forward-looking perspective. Effective long-term adaptation to climate change will require extensive stakeholder engagement, higher levels of expertise and prioritisation of proven resilience products and solutions to facilitate investment and move beyond project-based adaptation towards a more integrated systemic approach. Clearly, radical strategies will be needed to transform key economic systems to be more resilient and productive in the face of a changing climate.



*Coastal road, South Africa, Claudia Munera*

# 1. Putting PMCR into Context



# Framing the **macro-context** for the private markets for climate resilience

## ***Climate variability and extreme weather are impacting people now***

In all the geographical areas under study, climate change is no longer an abstract concern, but is affecting local people now, and in major and complex ways. Notably, extreme weather events are affecting local and regional economies and community livelihoods. And this is in addition to the normal environmental conditions experienced by companies and their local economies.

## ***It is not a matter of climate change alone***

Local climate impacts can also become tangled up with historic land-planning decisions, natural capital degradation, water and air pollution, extreme natural events, among many other drivers (local, national and global) that influence how certain sectors, systems or communities respond to a changing climate.

## ***Mitigation helps but adaptation-focused efforts are required***

In the macro-context, the climate mitigation narrative is now largely understood, with global-level actions like the Paris Agreement helping limit the magnitude and rate of long-term global climate change. But a substantive commitment from global decision makers to dealing with adapting to climate change is still missing. Adaptation recognises that even the most aggressive mitigation efforts will not be enough. New longer-term and innovative approaches integrated into the way we live, work and govern are needed.

## ***Adaptation is holistic although often perceived as a less evident study field***

However, even among climate adaptation specialists, a firmer understanding of the specific impacts associated with, or attributed to, climate change, as well as the interrelation among them, is also needed. These include a better understanding of episodic events such as cyclonic winds, flooding, severe drought, as well as the slow onset of chronic events like shifting precipitation patterns, saline intrusion, and sea-level rise.

Also, when it comes to evaluating and developing climate adaptation solutions, unlike climate mitigation, which lends itself to easy comparisons (i.e. reduced greenhouse gas emissions), resilience solutions typically involve multiple outputs and outcomes, and assessing their feasibility requires awareness of multiple, interacting areas, including behaviour, governance, infrastructure and technology.



### **Something to consider:**

Climate change is a change in known environmental conditions that is being experienced by business and communities as an economic challenge.



*Storm surge at Santa Marta Bay, Colombia, Carmen Lacambra*

**“Climate change mitigation is to avoid the unmanageable. Climate adaptation is to manage the unavoidable.”**  
**Nicholas Stern, UK economist and author of *The Stern Report, The Economics of Climate Change, 2006.***



## Climate change resilience versus climate change mitigation

*Climate change resilience* can be described as adapting and preparing communities and their economies to respond to, and recover from, the impacts of climate change and continue on a sustainable economic development pathway. While extreme events such as hurricanes, major flooding and wildfire receive the most attention, slower and longer-term changes in sea level, temperature and rainfall patterns can be at least as costly, threatening food supplies, water and energy security, health, businesses, livelihoods and housing.

*Climate change mitigation* activities aim to reduce global greenhouse gas emissions contributing to a human-altered climate, and incentives for this can be externalised across borders. Climate resilience, or adaptation, however, is more likely to begin in local markets, and with solutions that protect and allow people and assets to adapt, for example, through efficient irrigation technologies, back-up generators, storm-resistant building materials, water harvesting services, flood control, insulation against heat, early-warning systems and climate information, and flood-and heat-resistant housing, among many other products and services.



*Fedearroz, Colombia*

### What is the private sector's role in climate adaptation?

The great advantage of climate adaptation and strengthening resilience to a changing climate as concepts, is the implication of a systemic approach, with the private sector, as a necessary and integral part of the system that must respond.

To date, the impacts of global climate change have been primarily framed by private-sector actors as risk, most often expressed in terms of weather. Although extreme events get the most public attention, longer-term climatic changes and associated impacts may prove costlier, particularly in the context of food and water security and the viability of communities and their productive assets.

While the public sector must create an enabling environment for resilience and lay out a framework that protects public goods and addresses market failures, it is the private sector that has and will be tasked with developing the innovative products and services needed to drive resilience. In this context, there is a growing understanding and awareness that public action alone will not be enough to meet the scale of the climate threat and that private sector innovation and resources will be crucial.

#### ***Private sector already doing a surprising amount***

It was found that the private sector is already providing many solutions, but just not referring to them as 'climate change adaptation'. Notably, these are to protect against extreme events, providing construction and building repair, weather forecasting, agro-climatic simulations, agricultural inputs, including seeds and pest control strategies, flood control, irrigation strategies, soil management, and back-up power generation systems, among many other products and services aimed at managing climate risks.

However, dealing with these kinds of near-term impacts, including those that have little to do with climate change, remains the primary driver of action in private companies, which typically prioritise current risk and short-term profitability over longer-term business sustainability.

### ***Public and private sector speak different languages***

Public and private actors use different languages to frame climate risks based on variously dissimilar definitions of markets, customers, and even perceptions of risk. Terminology like ‘climate adaptation’ and ‘climate resilience’ are not part of the language of business. For the most part, companies describe the material consequences of climate change using words like risk management, market research, product development, and logistics, or as simply ‘doing business’, while areas within the public sector working on climate adaptation use climate science and policy terminology to describe their activities – what business might refer to as climate jargon.

### ***That does not mean business is not aware of climate change***

While this lack of shared language and framing lead some public sector players to believe that business is unaware, or uninterested in addressing the climate threat, the PMCR findings in no way support this. In fact, businesses are very well aware of climate change, and specifically need support in addressing its impacts and turning their actions into business opportunities that benefit their companies, their customers and communities where they operate.

### ***Resilience depends on types of risks and vulnerabilities***

Resilience is place, time and actor specific. This is because resilience actions are so dependent on the type of risk and vulnerabilities linked to the local climatic conditions that are being addressed. Political context, existing market structures, geographical settings, institutional capacity, socio-economic conditions and regulation requirements are also key.

Across the agriculture and transport sectors there were no single solutions applicable to all risks and vulnerabilities, but instead hundreds of sector-specific climate resilience options that work in complementary ways. This array of solutions is beneficial in that it allows decision-makers to tailor and access only those solutions appropriate for their context, based on their own assessment of risk.



### **Something to consider:**

If policy speaks one language, business and financial markets speak another, and science and research yet another, in discussing one of the greatest global challenges of our time, we will need people fluent in all three. Plus, more spaces for collaboration, co-learning and mutual understanding need to be promoted.



*Coffee Landscape, Antioquia, Colombia, Claudia Munera*

**“Climate resilience activities are generally time, place, sector, and actor specific because they are so dependent on the specific risks and vulnerabilities being addressed.”**

**Carmen Lacambra, PMCR project coordinator.**



## Close-up on PMCR study context

The PMCR study was tasked with identifying how the private sector in agriculture and transport in six developing countries is addressing climate resilience. This included looking at growth opportunities for solutions already enhancing climate resilience as well as barriers to the wider availability of such solutions across value chains.

The PMCR study was the first of its kind within each country to directly address and recognise the private sector as key in building resilient communities and to provide recommendations for the more integral involvement of private stakeholders in building climate resilience. The study has also set a baseline for deeper research into potential solutions, challenges, benefits and opportunities.

### ***Considering agriculture in context***

When it comes to addressing resilience, wine producers in South Africa face similar challenges to specialty coffee producers in Colombia and top-quality cocoa producers in Nicaragua, in that while minimising costs and environmental impacts they must also prioritise product quality. Similarly, rice producers in the Philippines and Vietnam are in many ways contextually closer to the average Colombian coffee and Nicaraguan cocoa producer, than they are to Colombian rice producers, which in turn have more in common with maize producers in South Africa.

Agricultural products such as cocoa, wine or coffee take years to reach profitability. And reaching a desired level of quality requires longer-term investments into good practices like soil protection, long-term access to water, conservation agriculture and adequate post-harvest practices. For shorter-term crops like potato, maize and rice, returns on investments can be realised more quickly and crop decision-making can be adjusted based on annual projections. For these short-term crops, investing in appropriate seeds and in agro-climatic projections, represent good business opportunities.



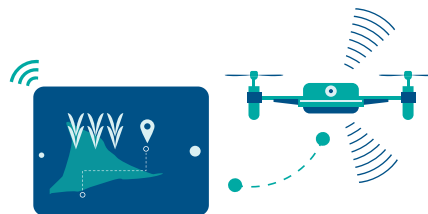
*Mogambo Sendero Ambiental, Colombia*

### ***New technologies drive efficiency and productivity***

Water management, regardless of the sector, is imperative particularly in areas prone to drought. While technologies to store, distribute, maximise and filter water resources have been historically available, more recent technologies such as sensors, satellite image analysis, drones, drop irrigation, among many others, now allow for much more efficient use of water resources.

Similar technologies are being used to identify plagues and diseases in crops, reducing the need for pesticides. Precision agriculture is mainstreaming these efficiencies in agriculture, including wineries and maize in South Africa, and rice in Colombia.

For all agriculture producers, market price marks the profitability of their investments. That means being able to own the decision of when to take products to market – taking into account convenience, optimum product quality, and prevailing weather conditions. Most producers interviewed highlighted access to affordable storage facilities, either on-farm or at the community level, as key in achieving sustainable profitability.



### ***Considering context in transportation***

A port on the Colombian Pacific coast with a daily tidal range as high as five metres might not view relative sea-level rise as such an imminent climate threat as a port on the Caribbean Sea, where the daily variation is less than 50 centimeters. The Pacific coast port might instead see increased precipitation as a more challenging risk, in an area ranked among the most humid in the world.

To calculate the insurance of each shipping container, marine transport companies factor weather conditions into their cargo value chain. For ports, reliability and safety are essential for business continuity. And a port that can stay operational regardless of weather conditions is a competitive port.

Roads are also built under variable environments, according to geographical and environmental conditions, including climate variability. In the Andes, over the course of 40 kilometres, a road can go from 2 degrees Celsius in the highlands to 38 degrees Celsius in the valleys. While path, design and material selection must take these kinds of variations into account, the uncertainty related to climate change and related extreme conditions still remains a challenge.

### ***Materials enhancing climate resilience offer new market opportunities***

Recycled plastic-based asphalt materials are becoming more popular in South Africa and Colombia, with the climate adaptation and mitigation benefits slowly becoming more evident in the road sector. However, these materials are still more expensive than 100% asphalt or concrete choices, and despite proven lower maintenance costs and less weathering, a sustainable market is still a long way off.

In ports, as with roads, understanding the regional infrastructure vulnerabilities and main climate change related risks remains crucial. But given that the highly dynamic conditions surrounding ports demand frequent maintenance works, it makes good business sense to refit infrastructure and upgrade materials during scheduled maintenance instead of renovating an entire port to still unknown future standards.

## **Without context and coordination, adaptation can become maladaptation**

Not every initiative, public or private, addressing climate risks will lead to a good adaptation pathway. Many well-intended attempts at adaptation can have the reverse effect and lead to maladaptation. For example, attempts to protect property or operations from climate risks, such as certain types of flood control or shoreline stabilisation, can in many cases reduce the vulnerability in one place while bringing greater vulnerability to another. And risk can be transferred to more vulnerable communities.

Adaptation benefits come down to good practices, but, without a clear understanding of vulnerability drivers, geographical settings, including climate risks and local context, even known good practices can lead to maladaptation. For example, take an area in South Africa, where ground water for farming is scarce. If one farm decides to adapt to ever-increasing water shortages by sinking a bore on their land, this could dry up the well completely and leave the neighbours without water. This is fine for the farm adapting but it becomes a maladaptation for the rest of the community. A farm increasing its water efficiency to consume even more water, could be depleting the resource for other users in the watershed.

In the Philippines, PMCR coordinators are working to facilitate a new public-private partnership that could bring irrigation to the nearly 50% of rice farmland. Although this is a potentially transformative initiative, if not handled in a correct and coordinated way it could lead to wastewater along the way or even the depletion of future water supplies, making it a maladaptation.

### ***Short-term fixes can also become maladaptive***

In the agriculture sector, short-term adaptive measures can become maladaptive over time. For example, if farmers decide to counter a drop in crop yield by adding quick-fix nutrients to their soil, they may see success in the form of a one-year bounce in yield but ultimately will have reduced their soil capacity in the long term. Instead, they could take a longer-term approach to soil health for example through alley cropping or precision farming.



#### **Something to consider:**

If a farmer in a flood plain arbitrarily builds a dike on their land to reduce the risk of flooding, this could be maladaptation, because it is merely transferring risk to another neighbour, in many cases to a more vulnerable community.

## Common barriers for growth and scale

It is worth noting that the many companies identified as providing resilience services in PMCR were often micro-, small- and medium-sized enterprises (MSMEs). In the countries and sectors under study, a general lack of awareness of the business case for resilience, combined with the relatively high cost of doing business for smaller companies, was apparent.

### ***Barriers are often typical for any smaller market player***

Unsurprisingly, many of the barriers to market expansion identified during the resilience dialogues were not specific to climate but rather a general reflection of local market operating conditions. Typical examples are a lack of government incentive for business innovation, burdensome regulations and taxes, and the inability for smaller players and start-ups to get access to capital or to good credit. In turn, climate change can exacerbate these barriers even more for small producers and MSMEs.

### ***National and local policies can also challenge implementation***

Access, flow and understanding of climate data has been a common barrier for even understanding normal environmental processes, independent of climate change. Policies around environmental data ownership, use and management can also lead to lengthy bottlenecks and lack of action.

Similarly, farmers heavily dependent on certification to meet market quality requirements often face stringent economic barriers for entry into farm certification programs. On the other hand, some governments are also constructively engaged with local producers including in supporting conservation farming, promoting public-private partnership development around irrigation and in infrastructure construction and operation.

### ***Climate change is often an excuse for inaction***

However, national and local governments too often show a willingness to unquestioningly continue 'known practices' that may no longer be suitable to a changing climate. Examples include using hard infrastructure for flood control, channeling rivers, occupying high-risk areas, and using outdated building codes and building materials. Many government officials also use climate change as an excuse for action, or inaction, making it harder for people including private sector stakeholders to truly assess the urgency of need for local, national and global change.

### ***Resilience finance difficult to track***

Also, even though most existing resilience solutions are being financed via well-known financial services, it is not easy to separate out normal business inputs, costs and expenses from those exclusively providing climate resilience. So, although credit cards, loans, wires, cheques, etc. are being used every day to purchase products like sensors, irrigation, drones, precision agriculture, seeds

**“P**eople want climate adaptation systems we can plug and play but the world doesn't work that way. Context matters.” **Anton Cartwright, PMCR South Africa.**



*Maize harvest in the Garden Route, South Africa, Claudia Munera*

and agricultural inputs, these transactions are not being booked by business as climate resilience funding, even though in many cases they are.

Furthermore, companies supplying climate resilience solutions, and companies that have incorporated resilience into their core business are using exactly the same financial services to sell their products, and often struggling with cash flow as the return on investment is so long.

## Where is the investor community?

The effects of climate change from the point of view of the financial sector can be seen in terms of two key considerations:

1. Climate change is already a risk for investors everywhere. Climate change is already causing increased risk and impact on the real economy. The United Nations estimates up to USD 300 billion per year will be needed to deal with the negative and costly impacts of climate change in developing countries alone by 2030.
2. Yet very little is being noticed or acknowledged. Surprisingly little third-party investment is being made, with fewer than 5-6% of all investment tracked globally having any links to adapting to or building resilience to climate change.

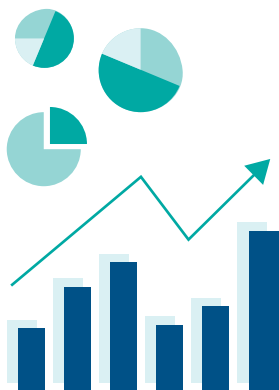
### ***Contextual message to investors is clear***

The PMCR project sits early in the market-innovation cycle at the stage of identifying potentially viable business models, and even though its methodology is designed to inform decision making rather than produce investment-ready business cases, the contextual message is clear. Investors need no longer wait for a comprehensive global strategy to start addressing the effects of climate change – technologies and solutions exist now and are ready for investment and scale up.

### ***Markets need system-wide perspective***

Climate resilience requires markets to take a more system-wide and forward-looking perspective. This is something that markets when left alone do not always do well. Instead evidence suggests that information gaps and asymmetries, vested interests and other barriers sometimes inhibit the functioning of newer or better markets.

Effective long-term adaptation to climate change will require extensive stakeholder engagement, higher levels of expertise and prioritisation of proven resilience products and solutions to facilitate investment and move beyond project-based adaptation towards a more integrated systemic approach.



**“**Investing in climate resilience companies can generate two outcomes – extranormal growth for those companies and returns for investors, as well as measurable impact on the climate change problem itself. These outcomes are complementary – the faster these technologies and solutions grow, the more capacity we will have to deal with climate change.”

**Jay Koh, Managing Director, The Lightsmith Group – World’s first dedicated private equity strategy focused on climate resilience.**

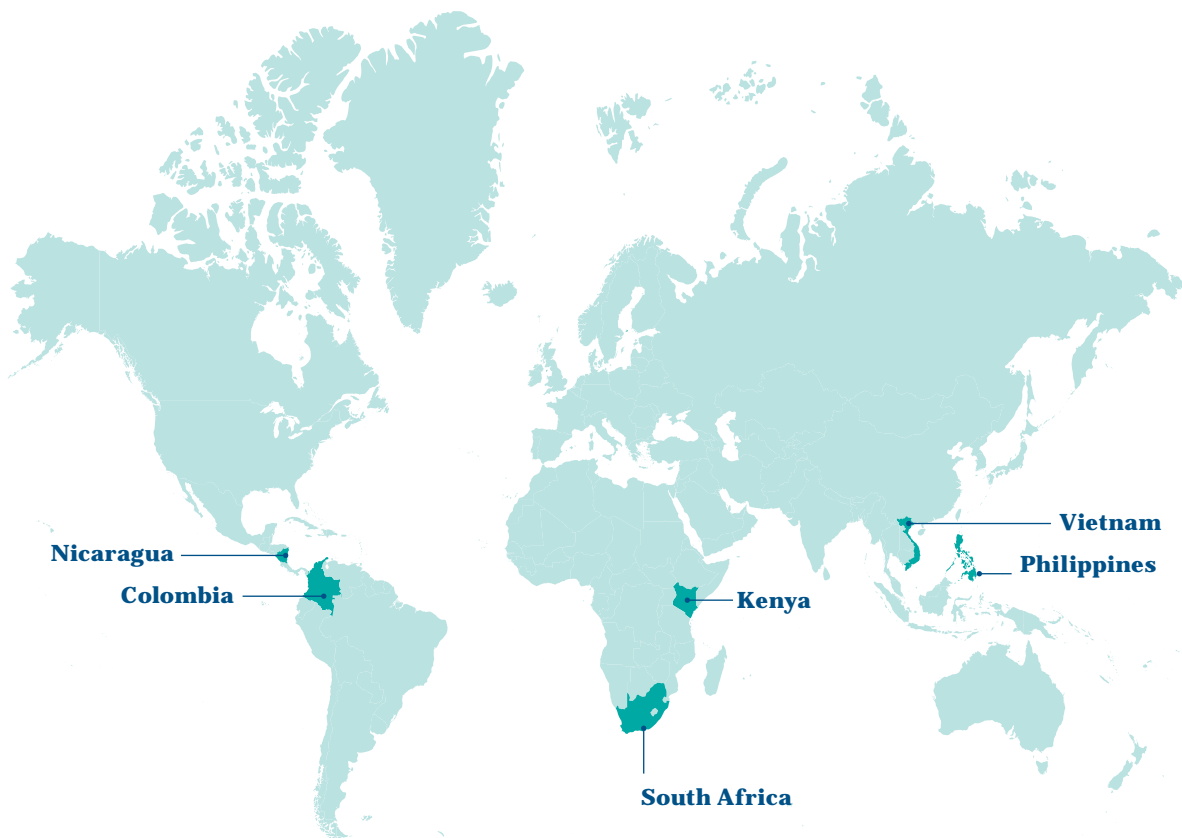
## The context of this report

This **PMCR Global Report** aims to reach several stakeholder groups including international development organisations and donors, private sector associations, policymakers, academic institutions, and enterprises in agriculture and the transport sectors, among others.

The working assumptions underlying this report are that most people:

- Recognise that our climate is changing, but lack an understanding of the associated risks and uncertainties for implementing practical measures to protect their businesses and communities from these risks.
- Do not realise that the private sector is already supplying products and services to meet a growing demand for privately produced products to help buyers better manage their exposure to climate risks, and that this demand represents a business opportunity for firms of all sizes.

This report was compiled by 25 team members across eight countries, including international experts not based in PMCR countries, and builds on the findings of national reports produced by the country teams, resilience dialogues and national consultation workshops in each country. **Colombia, South Africa and the Philippines** were Tier 1 countries, in which extensive field data was gathered through workshops and resilience dialogues. Tier 2 countries were **Nicaragua, Kenya and Vietnam**, where the same approach was implemented but mostly through desk studies made inside the countries.



## 2. PMCR Analysis



# PMCR Analysis - Selection and Analysis of Resilience Solutions



The PMCR project has shown that awareness of the general impacts of climate change is well established across all the selected agriculture sectors in the project countries, including **Colombia, South Africa, the Philippines, Kenya, Nicaragua and Vietnam**. However, PMCR findings show that awareness in the transport sector is much more limited than in the agriculture sector. Nevertheless, private and public stakeholders in the sector are fully aware of their interdependence with climate conditions.

Although there is a lot of uncertainty around the timing and specifics of climate change impacts, many global, national, and regional studies have addressed current and expected impacts on the production of *rice, coffee, maize, wine, cocoa and potato*<sup>1</sup>. Although not as many as for agriculture, there are also global and national assessments for the *road and port sectors*.

In general, risks related to extreme episodic events, fluctuating temperatures, and changes in precipitation patterns are well understood by sector stakeholders, whether or not they relate such risks to climate variability or climate change. Other impacts, such as sea-level rise, saline intrusion and ocean acidification, are less accounted for by stakeholders in both sectors. However, uncertainty over the precise impacts of climate change is frequently cited as a reason for inaction.

There is no single solution but instead hundreds of options available for increasing the climate resilience of the agriculture and transport sectors. Practical and often cost-effective climate resilience solutions are already in place across the agriculture and transport sectors in the PMCR countries, supplied by private enterprises of all sizes. Some emerging options likely to lead to climate resilience, but not yet fully established in the market, are reported here as resilience innovations.



<sup>1</sup> See section: *List of Selected References*.



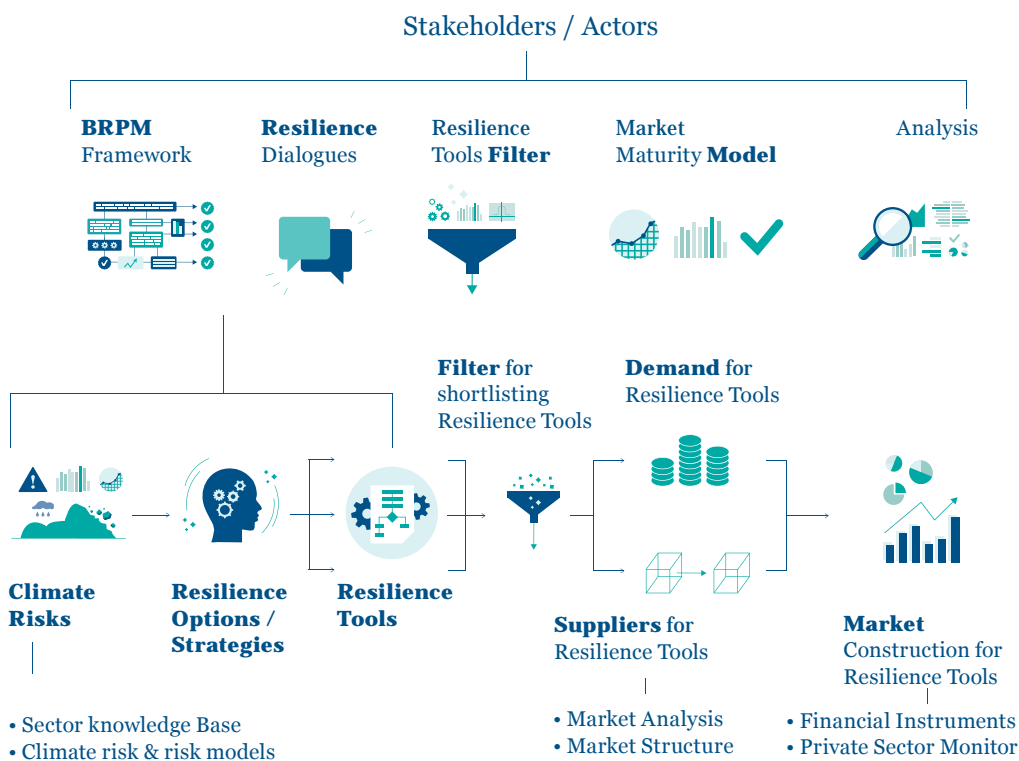
## PMCR Analysis

**Resilience dialogues** were conducted within each target country to understand the supply and demand for products and services that enhance climate resilience. While this approach has been applied elsewhere, the PMCR study anchored its dialogues in the realities of enterprise-level decision-making using the **B\*Resilient Process Model (BRPM)**<sup>2</sup> tool.

The BRPM approach connects the context of value-chain stakeholders to their priorities in decision-making processes. The BRPM enables stakeholders participating in the resilience dialogues to identify and connect current climate risks to specific decision-making processes and to clarify how those risks are imputed in their decisions, such as whether or not to construct a port, or plant a particular crop variety.

In each country, having mapped decision-making processes, including exposure to climate risks, sector stakeholders identified *options, strategies and technologies* that are mitigating climate risks in their value chains.

### PMCR Data Collection & Analysis



The BRPM is based on an analytical process in which key sector stakeholders (producers, designers, transporters, engineers, operators, etc.) are at the centre of decision-making processes. This process identified a total of **190 solutions**, in the form of products and services, which contextualised to the climate risks faced by stakeholders, their needs and level of awareness, have the potential of reducing the impacts of climate variability or extremes in their operations. By using a standardised selection criteria and focusing on solutions provided by the private sector and with the highest contribution to climate resilience, the country teams filtered the **long list of options**.

<sup>2</sup> A detailed description of the BRPM approach is presented in **Private Markets for Climate Resilience: Description of Methods**

## Long list of identified climate options

The following tables present all the identified climate options, strategies and technologies for the **agriculture** and **transportation** sectors. All options listed here have a direct link to climate risk reduction or climate resilience strengthening, as identified by stakeholders from each sector.

### AGRICULTURE SECTOR

Categories	Options currently available to address climate risks
<b>Knowledge services</b>	Expertise, special knowledge, capacity building and training, and technical assistance relating to agro-forestry systems, crop management and diversification, including soil conditions, planting techniques, input selection, use of fertilisers, irrigation, quality control, harvesting and others. Support for certification processes, conservation agriculture practices, good agronomic practices, etc.
<b>Meteorological products and services</b>	Early-warning systems, climate datasets, climate projections, agrometeorological stations, local weather predictions, scenario analysis, etc.
<b>Environmental diagnosis toolkits</b>	Farm mapping, cartography, mapping of soil classification and overall environmental conditions, soil analysis, diagnosis and classification, analysis of microbes and soil fungi, etc.
<b>Software and other datasets</b>	Software for weather, crop and yield projections and simulations.
<b>Good practice manuals, checklists and protocols</b>	Good practice manuals, checklists, protocols, floral calendars and registers, staff health & safety.
<b>Farm infrastructure and machinery</b>	Mechanical land preparation and harvesting, soil management infrastructure, integrated pest management, automated post-harvest processes, mechanical dryers, washers and fermenting machinery, storage facilities, renewable energy sources, machinery for temperature regulation, specialised on-farm transport devices, etc.
<b>Certified seeds and varieties and other farm inputs</b>	Certified and good-quality seeds, climate-resistant seed varieties, seed multiplication, certified nurseries, organic fertilisers and inputs, soil moisture conservatives, etc.
<b>Water infrastructure</b>	Irrigation systems, water-management plans, systems for water harvesting, storage, treatment and transportation, drainage channels, water filters, wells, soil moisture conservation, etc.
<b>Storage and milling facilities</b>	Post-harvest facilities that consider climate risks and challenges for storage, drying, cooperative-type or farmer-owned enterprises, cold storage, on-farm grain silos, seed storage facilities.
<b>Financial services</b>	Farmer-friendly financing and loan packages, credit lines, relevant and accessible insurance, technical bank staff to support farmer-borrowers, financing mechanisms for post-harvest facilities, distribution and trading, contract farming, etc.
<b>Research and market information</b>	Research farms, piloting programs, seed banking, research and development for climate-resilient production inputs, research on plant life-cycle relationships with climate, trading mechanisms.
<b>Regional approaches and improvement programs</b>	Watershed management, watershed reforestation, farmer cooperatives, alternative transport routes, large-scale shift to organic farming.
<b>National government policies, regulation and initiatives</b>	Development of more agriculture resilience-focused laws and ordinances, stronger and better implementation of existing land use laws, climate-resilient farm-to-market roads and seaports, policies to ensure food security and stable pricing, price control mechanisms during post-disaster and emergency situations, buffer funds/aid for vulnerable groups during post-disaster and emergency situations, public awareness on policies in place, etc.

## TRANSPORTATION SECTOR








Categories	Options currently available to address climate risks
<b>Knowledge services</b>	Expertise, special knowledge, capacity building and training, technical assistance relating to creating awareness, assessing and managing climate risks, designing, constructing, operating and maintaining climate-resilient transportation infrastructure, mainstreaming the use of climate data and forecasts in climate-resilient design.
<b>Good practice manuals, checklists and protocols, environmental impact assessments</b>	Good practice manuals, checklists, protocols, construction codes, inclusion of climate resilience and climate-related risks in feasibility studies and environmental impact assessments, and staff health & safety (e.g. communications, evacuation routes and protocols).
<b>Innovative materials</b>	Use of new and innovative climate-resilient materials in construction and maintenance, including recycled materials, bio-materials, bio-filters, use of permeable pavement, etc.
<b>Refitting and climate-resilient design</b>	Climate-resilient design of bridges and drains, coastal defences, slope management design, inclusion in design of adjacent ecological infrastructure (e.g. green verges) for protection and ecological sensitivity.
<b>Procedures against service disruptions</b>	More frequent “blading” of gravel roads, drainage maintenance, paving of gravel roads, improved drainage and stormwater infrastructure in areas predicted to become wetter with climate change, etc.
<b>Machinery</b>	Operational and maintenance (e.g. docking systems, cranes, pumps, etc.).
<b>Software</b>	Scenario projections, simulation programs, geographic information systems, etc.
<b>Comprehensive risk registers</b>	Real-time climate monitoring and weather prediction, cargo monitoring systems, ballast water operations, assessment of dredging needs, etc.
<b>Early-warning systems</b>	Early-warning systems and alarms
<b>Financial services</b>	Bonds, green infrastructure bonds, insurance, inclusion of climate resilience and climate risks in financial assessments, climate-related insurance included in project financial plans and budgets projects.
<b>Research and development</b>	Climate-resilient design, materials and technology for construction.
<b>Regional approaches and improvement programs</b>	Maintain structural integrity of infrastructure, regular surveys on performance of infrastructure, regular quality checks, expenditure allocated to adjacent ecological infrastructure, public works and community programs to monitor and maintain roads.
<b>National government policies, regulation and initiatives</b>	Construction codes, constant monitoring to assess infrastructure status to inform users in time about conditions and enable necessary repairs, update and revisit design and construction manuals, inclusion of climate resilience and climate-related risks in design and policy manuals, stakeholder engagement, inclusion of climate resilience in terms of reference and tender processes of public projects, incentives for climate-resilient design and practices, project budgets sensitive to the demands of climate resilience conditions, etc.

## Stakeholders providing identified climate options

A finding that emerged from the PMCR analysis is that private-sector actors are already supplying a wide range of products and services that provide climate resilience benefits in the agriculture and transport sectors in the selected countries. However, in general, recognition of the climate benefits of these solutions is limited. While in many instances, the role of private sector actors in the context of resilience solutions might not be highlighted, this role can be potentially significant.










The role of different stakeholders in the provision of the identified resilience solutions is presented in the table below. A common assumption is that private actors are external to building resilience and that it has been a public sector priority, nevertheless, the PMCR project found that private actors are providers of most of the solutions strengthening climate resilience, and at national level, many of these actors are MSMEs.

### AGRICULTURE SECTOR

Technology/service	Private sector	Farmers	Public sector	International agencies, NGOs
<b>Knowledge services*</b> (technical assistance, specialised consultancy, certifications, weather forecasts & projections, data management etc.) 	Buyer Provider	Buyer	Buyer Provider	Buyer Provider
<b>Environmental diagnosis*</b> (environmental impact assessments, soil analysis, etc.) 	Buyer Provider	Buyer		
<b>Manuals, checklists, protocols*</b> 	Buyer Provider	Buyer	Provider	Provider
<b>Farm infrastructure</b> (storage facilities, water infrastructure in farm, post-harvest management, etc.) 	Buyer Provider	Buyer		
<b>Inputs</b> (seeds, fertilisers, transport bags, etc.) 	Buyer Provider	Buyer		
<b>Regional approaches</b> (local irrigation schemes, reforestation, watershed management) 			Implementor	Implementor
<b>Research and development</b> 	Buyer Provider		Provider	

\*The solutions marked are those in which small business knowledge providers within the countries are important providers of innovative solutions.

## TRANSPORTATION SECTOR

Technology/service		Private sector	Public sector	International agencies, NGOs
<b>Management of operations</b>		Implementor		
<b>Early-warning systems</b>		Implementor	Implementor	
<b>Real time climate monitoring and weather prediction*</b>		Buyer Provider	Data provider	
<b>Knowledge services: Health &amp; safety, Environmental diagnosis (EIA)*, insurance, design upgrade*</b>		Buyer Provider	Buyer	
<b>Materials, infrastructure refitting</b>		Buyer Provider	Buyer	
<b>Risk Registers</b>		Buyer Provider		
<b>Knowledge services</b>		Buyer Provider	Buyer	Provider
<b>Research and development</b>		Buyer & implementor	Buyer & implementor	
<b>Permits</b>			Provider	

*\*The solutions marked are those in which small business knowledge providers within the countries are important providers of innovative solutions.*

## Selection criteria for resilience solutions

From the long list of identified resilience options, the project team selected the most promising options for detailed analyses. During the selection process, resilience dialogues were maintained with key stakeholders, including providers of financial services.

Resilience options were assessed and contextualised in terms of their demand, supply, and economic viability. The assessment distinguished between the needs of potential users of resilience solutions and the characteristics and approaches of enterprises providing these solutions. By examining both supply and demand in this way, the study was able to identify challenges and opportunities in scaling markets for climate resilience. In addition, the analysis included an assessment of how the selected solutions were being financed by buyers and providers.

The selection process was conducted by each country team using the following **selection criteria**:

1. The option is currently provided by a private-sector actor;
2. The usefulness and relevance of the option across key value-chain processes;
3. The scale of the current demand for the option and its economic viability for the end-user or buyer;
4. There is a direct link between the implementation of the option and building climate resilience;
5. The option provides benefits to a wide range of stakeholders across the value chain.

## Selected PMCR resilience solutions

The described process resulted in the selection for further analysis of **eight resilience solutions for the agriculture sector** and **four resilience solutions for the transportation sector**.

AGRICULTURE	Country, sector
<b>Knowledge services: Sustainable practices</b> 	Colombia, coffee
<b>Knowledge services and technology: Agro-climatic services</b> 	Colombia, rice
<b>Knowledge services: Conservation agriculture</b> 	South Africa, maize
<b>Knowledge services: Alley cropping</b> 	South Africa, wine
<b>Knowledge services and technology: Precision farming</b> 	South Africa, wine
<b>Knowledge services: Certification schemes</b> 	Nicaragua, cocoa
<b>Water-management and infrastructure solutions</b> 	The Philippines, rice; Colombia, coffee
<b>Seed development</b> 	The Philippines, rice; Vietnam, rice; Kenya, potato
<b>On-farm storage solutions</b> 	South Africa, maize; Kenya, potato

**TRANSPORTATION**

**Country, sector**

**Knowledge services: sediment monitoring and climate-resilient road design**



Colombia, ports; South Africa, roads

**Resistant and innovative construction materials**



Colombia, roads; The Philippines, roads

**Road network management and upgrade**



South Africa, roads

**Refitting infrastructure**



Colombia, ports

**Country-sector analysis of selected resilience solutions**

As part of each country assessment, an in-depth analysis of each sector was conducted, using the BRPM tool, including a value-chain analysis focusing on climate conditions, risks and impacts in key processes, as well as on actors and activities leading such processes. Demand and supply characteristics of selected resilience solutions were then analysed, resulting in a systematic assessment of the resilience contribution and market opportunities of the solutions in the selected sectors and countries.

The conducted country-sector analysis resulted in the following **Factsheets**:



**Factsheet: Resilience Solutions for the Rice Sector in Colombia**



**Factsheet: Resilience Solutions for the Wine Sector in South Africa**



**Factsheet: Resilience Solutions for the Maize Sector in South Africa**



**Factsheet: Resilience Solutions for the Rice Sector in the Philippines**



**Factsheet: Resilience Solutions for the Coffee Sector in Colombia**



**Factsheet: Resilience Solutions for the Cocoa Sector in Nicaragua**



**Factsheet: Resilience Solutions for the Rice Sector in Vietnam**



**Factsheet: Resilience Solutions for the Potato Sector in Kenya**



**Factsheet: Resilience Solutions for the Port Sector in Colombia**



**Factsheet: Resilience Solutions for the Road Sector in Colombia**



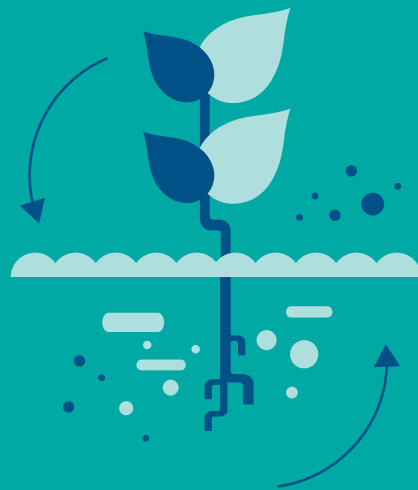
**Factsheet: Resilience Solutions for the Road Sector in South Africa**



**Factsheet: Resilience Solutions for the Road Sector in the Philippines**



### 3. Resilience Solutions in the Agriculture Sector



# Resilience Solutions in the Agriculture Sector

While the private sector in the agriculture sector in the selected PMCR countries is already supplying products and services that provide climate resilience benefits, in general, the recognition of these climate benefits is limited and their supply is in response to other drivers of market demand.

The selected resilience solutions in the agriculture sectors of Colombia, South Africa, the Philippines, Nicaragua, Kenya and Vietnam, include the following:

- 1. Knowledge services**, including agro-climatic services, conservation agriculture, alley cropping, precision farming, and certification schemes;
- 2. Water-management and infrastructure solutions**, including irrigation and water infrastructure and equipment that provides and/or maximises the uses of water as a resource;
- 3. Seed development** of appropriate climate-resistant varieties; and
- 4. On-farm storage solutions**



## Knowledge services

Knowledge services are increasing climate resilience in the coffee and rice sectors in **Colombia**, the maize and wine sectors in **South Africa**, and the cocoa sector in **Nicaragua**. Knowledge services, which include technical assistance, extension programs, specialised consultancies, weather projections, data innovation management, crop management, know-how, training, capacity building, best practices and certification schemes, smart agriculture and expertise, are used in businesses and across value chains to improve stakeholder capacity to build resilience to climate risk. Knowledge interventions related to climate adaptation, however, are often not promoted as climate adaptation, but as ‘good practice’ or innovation.



There are private-sector organisations across the agriculture sector that are already providing knowledge services focused on the agricultural value chain in all the PMCR project countries. These services represent a new niche within the long-standing agricultural extension and consultancy industry. The growth in the market for knowledge services is testimony to the new demand and economic benefits that these services bring to the sector.

**Knowledge services** identified in the PMCR analysis include:

- **Agro-climatic knowledge services** that integrate information from meteorological stations with plant conditions, good practices and capacity building, helping producers plan and manage their farms.
- **Conservation agriculture** for increase in soil carbon, managing carbon-nitrogen ratios and water retention, brings co-benefits in terms of jobs, improved soil fertility, fewer chemicals in the agricultural system and better water management.
- **Alley cropping** is a potential means to diversify income streams and enhance the resilience of crops to extreme heat, pests and disease, and the loss of soil fertility, all of which are affected by climate change.
- **Precision farming**, often with drone or satellite technology, allows farmers to effectively plan their application of water and fertiliser and identify localised problems earlier.

- **Certification schemes** can support socially and environmentally sustainable production, promoting good practices and potentially increasing producer revenues.

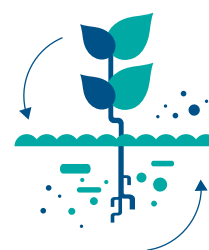


**Key findings** related to knowledge services include the following:

- Knowledge service providers that could be interlinking agriculture services and climate services do not appear to be interacting with the ‘known’ actors in the sector, such as the providers of technical assistance or extension services.
- The known actors in the sector or typical agriculture service providers, do not seem to be mainstreaming climate impacts into their activities. These initiatives, with exceptions, up until now have been led by multilateral development organisations rather than the private sector.

**Main challenges** related to knowledge services include the following:

- While the impacts of climate change on the agriculture sector are recognised, the challenge of describing the economic value of potential risks and associated uncertainties remains.
- Although the value of knowledge production and sharing as a service is largely recognised, it is not easily monetised.
- The direct impacts of climate change on producers are clear, but most producers lack the financial capacity to purchase the knowledge services needed to become more resilient. Some producers even lack awareness that such services exist or where and how to procure them.
- Access to knowledge services is largely income-dependent. Many rice producers in Colombia and wine and some maize producers in South Africa are able to access them, but the majority of Colombian coffee producers, Filipino and Vietnamese rice producers and Nicaraguan cocoa producers are not able to afford such services.
- Scientists, technicians and sector professionals, rather than business managers, are managing most of the knowledge service companies. Consequently, there are limitations to explaining and understanding the commercial value of the services provided and to their negotiation abilities.
- Companies providing knowledge services have more difficulties accessing financing from financial institutions than companies providing machinery and fixed assets.
- Local knowledge service providers are often in competition with large multinational companies that do not have the local knowledge but do have the administrative capacity that most local companies lack.



Resilience dialogues in the Philippines, Maria Eliniesa A. Lucas

**“P**private sector actors are aware about climate change and the need for resilience in the agriculture sector; they even suggested projects for government such as, weather stations and rainwater harvesting systems... Farmers are aware of climate change – e.g., they say, “We are getting confused already, we don’t know when is the right time to start planting...” Weather data and prediction are improving but farmers still get confused as to when to prepare their fields and start planting.”

**PhilRice Munoz, Nueva Ecija, the Philippines.**

**Main opportunities** related to knowledge services:

- In addition to increased general awareness, producers are realising the added value of quality, certifications and better management of their production processes.
- There are significant amounts of information available that have not been assessed or used at maximum capacity.
- Large guilds, associations and institutions within the sectors are realising the financial challenges producers face and that key questions regarding the influence of climate variability on their sector have not been clearly answered. Moreover, financial institutions are starting to turn to these services to monitor their clients.
- There is room for local independent institutions that can efficiently provide services to sector stakeholders by integrating environment, climate, sector and financial knowledge and best practices.
- Weather variability and climate change in recent years, has made it necessary to improve the planning and execution processes in agricultural activities to reduce production losses as well as increase the quality of life of producers.

### **General considerations related to knowledge services**

The long-term benefits of good practices, including alley cropping, conservation agriculture, and certification schemes, among others, have already shown positive results in the coffee, maize, rice, wine and cocoa sectors in Colombia, South Africa and Nicaragua. Such practices provide long-term soil protection and micro-climate and pest management. In some instances, short-term cash flow benefits are possible, as are social benefits and the employment of local experts.

There is limited visibility on how the market for knowledge services will develop over the next decade largely due to the fact that the growth potential of the market is still early-stage. However, the PMCR resilience dialogues indicate that demand for knowledge services is currently higher than 10 years ago, perhaps due to the current availability of technologies for interpreting environmental conditions and greater accessibility to professional assistance. This positive demand trend is further supported by decreasing prices, economies of scale and technology advances.

However, for many companies providing knowledge services and solutions, and with a solid understanding of the climates, sub-climates and other environmental conditions, there are more barriers than incentives. Financial constraints and a lack of adequate financing instruments, in particular, pose significant challenges to companies with knowledge as their main asset. In this context, one positive development is that the insurance and banking sectors are starting to take climate risk more seriously and are subsequently seeking knowledge to produce adequate financial products and calibrate insurance products.



*Fedearroz, Colombia*



## Agro-climatic knowledge services

Agro-climatic knowledge services include weather monitoring and forecasting, climate projections and mapping of specific climatic characteristics, agro-climatic models for agriculture yield, temporal space analysis of crop behaviour, early-warning systems, workshops with producers (agro-climatic committees), and support for crop management decisions (for example, planting timing, irrigation volumes, materials to be sown, main crop management practices, etc.), among others.

The integration of climate information with plant health and conditions, good practices and capacity building provide instrumental support to farmers in planning and managing their production processes and, consequently, have the potential to contribute significantly to the resilience of agricultural value chains.

Agro-climatic knowledge services and programs, such as the Massive Adoption of Technology Program, AMTEC, in the **rice sector in Colombia**, managed by the Rice Producers National Association (Fedearroz), provide valuable input to the farmers' decision-making processes. AMTEC collects meteorological and climate information and disseminates it to rice producers, coupled with advice on the implications for soils, plant interaction, seeds, and production requirements.



**Input selection**



**Planting & cultivation**



For more information on the AMTEC program and agro-climatic knowledge services in Colombia, see ***Factsheet: Resilience Solutions for the Rice Sector in Colombia.***

**“The impacts of climate change, and appropriate resilience solutions, vary significantly across the different growing regions of Colombia. The rice federation is investing large amounts of resources in combatting climate impacts as a means of improving production and livelihoods across the country. The federation is engaged in extensive international collaboration to promote its understanding of technical improvements in rice farming, including climate-resilient methods.”** **Elkin Florez, Fedearroz, Colombia.**



*Fedearroz, Colombia*

## Conservation agriculture

Conservation agriculture involves farming in line with the following principles:

- Minimum soil disturbance – reduced or no-till practices and planting with different equipment that compacts and disturbs the soil less.
- Establishing or maintaining organic soil cover with mulch or cover crops. In maize cultivation, this often involves leaving maize residue in the field.
- Implementing crop diversity or rotations, as opposed to mono-cultures.

Conservation agriculture involves significant benefits in terms of improved soil fertility, fewer chemicals in the agricultural system and better water management. Conservation agriculture typically reduces or reverses soil degradation and can increase the depth of the healthy soil horizon. Other benefits involve improved water-use efficiency, improved biodiversity, better weed control and breaking of disease and pest cycles. Where correctly applied, conservation agriculture also reduces the chemical pollution of water resources and soil. Ultimately, conservation agriculture can enable sustainable production in marginal production areas, sustained and more resilient yields in spite of drought and other adverse weather conditions, and result in higher profitability due to reduced input costs.

In addition, the PMCR analysis of the **maize sector in South Africa** found additional co-benefits from conservation agriculture.

Identified challenges and barriers for large-scale uptake include financial constraints associated with relatively high initial implementation costs (e.g. herbicides, equipment and seeds), capacity limitations during intensive learning and transition phases to conservation agriculture (e.g. pest management), and the lack of standard or label to distinguish farmers adopting conservation agriculture in their production.

**“Farmers are seeing the value of crop rotation, but few understand the value of nitrogen fixing by planting non-traditional crops such as beans or other legumes.”** *Farmer, BRPM Workshop with farmers in South Africa.*



Reduced till



Soil management



Residue cover



For more information on conservation agriculture in South Africa, see [\*\*Factsheet: Resilience Solutions for the Maize Sector in South Africa.\*\*](#)



Maize focus group, South Africa, Peter Johnston

## Alley cropping

Alley cropping is rarely associated with climate change adaptation or climate resilience. The practice of alley cropping involves planting arable or ground-cover crops between vines, or other orchard crops, so as to ensure soil cover and enhance biodiversity. Diversity is a key feature of stable and resilient systems, and by converting a mono-culture into a more biodiverse system, alley cropping contributes to climate resilience in a number of ways:

- Alley cropping impacts *water management* by altering the hydrologic cycle through increased water infiltration and by preventing surface run-off of water and top-soil during rain events and irrigation.
- *Nutrient cycling and soil quality* are impacted as alley crops cycle the nutrients to the surface through plant litter. Reduced soil erosion by wind and water help maintain soil quality, and the leaf canopy of the alley crop can reduce soil damage by rain.
- *Pest management* can be strengthened through the habitat diversity created by alley crops, which in turn attracts a more diverse set of pests and predators. Pest cycles can be interrupted, reducing the need and cost of chemical sprays.
- Microclimates within the crop are modified and typically become more humid and cooler due to reductions in wind velocity, which reduces *evapotranspiration*.
- Other benefits identified are related to increased *revenues* from other crops especially while crops are young, *animal forage* and the associated increased *employment* and revenue opportunities out of harvesting season.



**Assessment of microclimate and pest threat, choice of alley crop**



**Growing alley crops**



**Sales of alley crops**

The PMCR analysis of the **wine sector in South Africa** showed that alley cropping and cover cropping is one example of an innovation that requires a programmatic roll-out targeting full uptake.



For more information on alley cropping in South Africa, see ***Factsheet: Resilience Solutions for the Wine Sector in South Africa.***

There is scope for ensuring that the benefits derived from alley cropping are substantial for individual farmers. However, very few farmers currently apply alley cropping in their farm management. Large-scale uptake would require detailed research, extensive capacity building and technical assistance, which combined would allow farmers to tailor and manage their alley cropping decisions in their specific context.



*Anton Cartwright, South Africa*

**“S**outh African farmers used to treat soil as a medium that they controlled and which held their plant nutrients. Only recently have they begun to realise that soil is more complex, and they have begun working with the idea of terroir. It is a new approach that offers new potential.” **Wine farmer, BRPM Workshop with sector stakeholders in South Africa.**



Moreover, an industry champion would be required to cooperate with farmers, research institutions, universities, financial institutions and technicians, in developing and producing the type of fine-grained information on alley crops that farmers could use to reduce climate risk and improve profits. This information would also benefit banks and insurance companies, which could factor the information into their financial products and the risk premiums that they offer farmers and, ultimately, develop and provide adequate financial products. The combination of the aforementioned developments has the potential to substantially contribute to the climate resilience of the entire value chain.

## Precision farming

Precision farming involves the use of on-site equipment to measure plant conditions and environmental variables, for example, soil humidity at the root level, facilitating management of soil water conservation through mulching, bio-char and the installation of moisture probes. Through continuous soil moisture content logging, farmers are able to prevent over- and under-irrigation and unnecessary crop stress, promote root development and improve fertiliser uptake. This refined management capacity can save electricity and expensive farming inputs. In practice, precision farming, leads to the enhanced climate resilience of crop management by the timely identification of issues as well as reducing water use and other agriculture inputs.

In the **South African wine sector**, precision farming with overhead surveillance using satellite and, more recently, drone imagery, is being used to identify soil moisture and plant stress. This surveillance allows for more precise application of water and fertilisers and is being used to support the South African agriculture sector, as well as in many other crops across the world.

Commercial farmers are increasingly paying for precision farming services, often linked to contracts that provide fertilisers and irrigation infrastructure. Growth in this market suggests that these services offer value for money and has been supported by advances in drone technology and flight times. The net returns to the farmer in terms of water and electricity costs are reported to be very favourable.



For more information on precision farming in South Africa, see **Factsheet: Resilience Solutions for the Wine Sector in South Africa.**



**Terroir selection**



**Precision farming**



**Resource efficiency**



Soil moisture probes in apple orchard, South Africa. Peter Johnston

**“A**erial surveillance used to be expensive and crude. Drone innovations in recent years have changed that. We can now identify which plant is doing well and which one is not within an orchard or a vineyard.” **Aerial surveillance representative for Yara (fertiliser company), South Africa.**



## Certification schemes

Certification schemes do not presently focus directly on climate adaptation, as the promoted activities are based on the production of stipulated product quality through the application of good practices. In certification and traceability schemes, good practices include specific activities such as the implementation of agro-forestry practices, conservation of biodiversity and systematic soil, water, pest, shade and watershed management, among others. While not specifically targeting climate change adaptation, many of the good practices promoted by certification schemes contribute to reducing risks from temperature extremes, sudden changes in environmental conditions, soil humidity, solar radiation, etc.

Good and alternative practices in certification schemes can lead to increased production, reduced losses and guaranteed production in a changing environment. Certification schemes have been found to reduce the environmental impacts of production processes, leading to higher prices and profits in the value chain by capitalising on the use of greater knowledge and technical support. Certification schemes therefore contribute to the financial sustainability of farmers, and other value-chain stakeholders, by encouraging entrepreneurial activity and diversifying the available income options for farmers. In this context, certification schemes can potentially make a significant contribution to climate change adaptation and resilience along agricultural value chains.

In the **cocoa sector in Nicaragua**, the uptake of certification schemes has been largely driven by international buyers that rely on the supply of high-quality cocoa to produce premium products for international fine cocoa markets (mainly Europe & North America). Meeting the quality standards of the international market is the main target of cocoa production in Nicaragua. Moreover, although cocoa farmers are not required to have certification, certified cocoa beans that meet the quality standards for the international market, obtain a premium price. An advantage of the Nicaraguan cocoa sector is that plantations have been traditionally grown as part of agro-forestry systems, with cocoa plants mixed with timber or fruit trees to provide some level of shade, thus the certification process can be quicker.

Certification requires implementation alongside training and capacity building to guarantee that producers and cooperatives are able to meet quality standards. Financial constraints among farmers are the main barrier to large-scale uptake, as initial investment costs related to upgrading farming practices and infrastructure to comply with the certification requirements can be significant and require additional administrative effort. Furthermore, maintaining certification requires annual payments from farmers, which can also be an extra burden, and even more when certification criteria vary with importing countries' regulations.

By overcoming the financial challenges related to uptake, cocoa certification schemes in Nicaragua have brought several benefits to farmers, including sustainable crop management and increased ability to face price variability in the market. In order to strengthen the link between adaptation and certification schemes, criteria and practices enhancing climate resilience could be incorporated into major and emerging certification and traceability schemes, thereby serving as a major stimulus to resilient practices.



For more information on certification schemes in Nicaragua, see ***Factsheet: Resilience Solutions for the Cocoa Sector in Nicaragua.***



*Ingemann Adapta, Nicaragua*

**“Climate change is rapidly challenging our assumptions of the world and our expectations for the future. It is forcing us to find new solutions or rediscover old ones. It is becoming a transversal theme to facilitate cross-sectoral dialogue and boost collaboration and learning in innovative ways.”**  
***Claudia Munera, Biologist and Climate Adaptation Expert.***

## Water-management and infrastructure solutions

Distribution and access to water is a critical issue for the agriculture sector in the short-, medium- and long-term, as climate change continues to impact access to freshwater, water flow patterns and increase both seasonal and prolonged water scarcity. These impacts are further exacerbated by deforestation, changes in land use and alterations in the natural drainage of rivers and streams. Water management and infrastructure technologies during crop management and post-harvest processes are facilitating reduced costs and increased productivity in agricultural value chains.

The PMCR project showed that water management and infrastructure solutions aiming at the more efficient use of water resources was common to all analysed value chains, including the **rice sector in the Philippines** and the **coffee sector in Colombia**. Irrigation and water management technologies during crop management and post-harvest processes, in particular, were found to contribute to reduced production costs and losses, leading to increased productivity in these sectors.

**Irrigation** is a key input in agricultural production and critical in the context of the impacts of climate variability on production yields. For example, in the rice sector in the Philippines, the negative climate impacts on production yields are uneven across all regions, being significantly higher in non-irrigated production areas. It is estimated that productivity in irrigated rice fields is 43% higher than rain-fed non-irrigated areas. In addition to ensuring required water availability, irrigation contributes to the adequate use of chemical inputs, such as fertilisers, which in turn also minimise the negative impacts of climate variability on production yields.

In addition to irrigation, **water storage** and other technologies improving the **management and efficient use of water resources** were identified as a key resilience solution. For example, water management machinery used in the production of coffee in Colombia is helping to improve efficiencies in post-harvest activities and reducing the consumption of water and energy in the pulping, fermenting and washing processes.

Farm-level water management has been highlighted as a resilience solution, particularly in those areas prone to drought. This category includes means for water preservation, mechanisms and devices for water extraction, water transportation and distribution mechanisms to and within farms and factories, and storage devices and mechanisms that enable adequate and efficient use of water. Efficient water management and infrastructure lead to maximising water, energy and labour resources in production processes, allowing producers to better manage resources and maintain product quality along the value chain. It was found that equipment-use during post-harvest processes improves water efficiency and strengthens the resilience of the coffee sector in Colombia.



For more information on irrigation systems in the Philippines, see ***Factsheet: Resilience Solutions for the Rice Sector in the Philippines.***



For more information on coffee farm-level water management in Colombia, see ***Factsheet: Resilience Solutions for the Coffee Sector in Colombia.***



Mary Anne Velas-Suarin, the Philippines

**“**The National Irrigation Authority would like to see private sector participation through capacity building in operational management, helping farmers’ and irrigators’ associations take on more enterprising qualities in the way they operate.”  
**National Irrigation Authority, the Philippines**

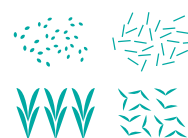
## Seed development

As an outcome of the PMCR resilience dialogues, the development of new seed varieties was identified as a measure that addresses the negative effects of climate change on rice production in the **Philippines** and **Vietnam**, and the potato sector in Kenya.

With genetic enhancement, local seed varieties are able to better tolerate adverse conditions without compromising yield potential. With climate-resistant seed varieties, crops could potentially be less vulnerable to floods, droughts and heat waves, and continue producing favourable yields. Consequently, the financial profitability of farmers and other value-chain stakeholders could be resilient and sustainable despite the impacts of climate change.

In the **Philippines**, two research institutions focusing on the rice sector, the International Rice Research Institute (IRRI) and the Philippine Rice Research Institute (PhilRice), are working on the development of high-yield and cost-reducing technologies to support farmers and attain rice sufficiency. Both institutions are developing new varieties of rice, including climate-smart varieties capable of withstanding floods, drought, increased salinity, and heat. In a similar manner, collecting and creating new salt-resistant rice varieties for saline intrusion prone regions, drought resistant varieties for dry areas and flood resistant varieties for areas prone to flooding are presented as a national priority in **Vietnam**. In **Kenya**, new potato varieties were identified as a resilience solution responding to various problems attributed to the systematic use of recycled seeds, including low yields, high vulnerability to disease and pests, and poor storability.

Seed research and development requires significant investments, which drive up costs. For example, in the **Philippines**, there are very few companies currently providing climate-resistant seeds to the local market, limiting their availability on a commercial level. As a result, seed production still has a weak institutional base, and developing climate-resistant varieties and having them adopted by farmers is costly, making large-scale uptake difficult. However, opportunities for private sector engagement in seed production, marketing and extension services are significant. Public-private partnership models have yet to be explored, such as terms for sharing seeds of parental lines, developing community seed bank systems for farmers, and training on seed production, processing and storage.



For more information on seed development, see ***Factsheet: Resilience Solutions for the Rice Sector in the Philippines.***



For more information on seed development, see ***Factsheet: Resilience Solutions for the Rice Sector in Vietnam.***



For more information on seed development, see ***Factsheet: Resilience Solutions for the Potato Sector in Kenya.***



Carlo G. Dacumos, the Philippines

**“A**rmy worms (insects/pests) are mostly caused by climate change and use of excessive chemicals and imported fertilizers that are not approved by FDA. Farmers do not usually attend agriculture-related training; this is among the main reasons why they are not informed on new technologies.” ***Nueva Ecija Fruits and Vegetable Seed Center, the Philippines.***



## On-farm storage solutions

The shifting of maize production areas in **South Africa** due to climate change is already causing a dislocation between production regions and the location of storage and processing facilities, and ultimately markets. Low-cost on-farm storage solutions, such as silo bags and bunkers, can be used as an alternative to conventional silos to give farmers more flexibility over where production is located and the timing of delivery to processing facilities and markets. On-farm storage allows farmers to take advantage of price fluctuations and to sell their production at the most convenient time for them, for example, when market prices are higher. Moreover, the use of silo bags and bunkers potentially increases production resilience at the farm level, as it increases the control of pest and moisture management.

Farmers have three options after harvesting: i) deliver immediately to a silo owner or miller; ii) store in silo bags and bunkers at any convenient location offered by the service provider, and iii) erect their own silos, or use on-farm silo bags and bunkers. Currently, the first option is the most common. The building of new large-scale storage facilities, such as grain silos, is often prohibitively expensive and unattractive to most farmers. Consequently, due to the inability to cover the extraordinary costs of silo construction, farmers use large-scale commercial silos located off-farm. In addition to flexibility related to location constraints, alternative storage options provide an opportunity to lower costs related to post-harvest processes, of which storage costs are generally significant.

In the **maize sector in South Africa**, silos were built historically by state-funded agricultural co-operatives and were linked to an active public sector rail network that connected farms, silos and ports. In the past three decades, the climatic zones in which maize is grown have shifted eastwards in the country, state-support for agricultural co-operatives has also been removed and the rail network has all but collapsed, leaving many farmers to rely on road transport. These trends have resulted in a disconnection between maize production and maize storage silos. In this context, the use of on-farm storage bags instead of conventional silos that are no longer proximal to functional transport, holds potential in overcoming the difficulties and lack of flexibility for growers in maize storage.



**Discharge and sales**



For more information on on-farm storage solutions, see ***Factsheet: Resilience Solutions for the Maize Sector in South Africa.***



*Peter Johnston, South Africa*

**“We** are at the mercy of the traders. They know if we are lacking our own storage facilities, we have to sell, and they take advantage of that by offering us lower prices for grain and (where applicable) livestock.” **Farmer, BRPM Workshop with Farmers, South Africa.**

In the **potato sector in Kenya**, in line with general agricultural production systems, production is rain fed. Planting and harvesting occur almost simultaneously country-wide, resulting in cyclical gluts and shortages at predictable times of the year. There is no storage facility with the capacity to absorb potatoes during gluts to meet the demand of consumers and processors during shortages. Apart from stabilising markets and therefore prices, on-farm storage would also reduce post-harvest losses. Additionally, adequate seed storage, making seeds available for farmers whenever needed, would ensure timely planting, thereby reducing exposure to climate risks as farmers would be able to plan their production.



**Harvesting**

Despite lower implementation costs relative to traditional storage facilities, on-farm silos represent significant capital investments and high up-front costs to be borne by the farmers, therefore, the solutions are not accessible for all farmers. With on-farm storage solutions, the responsibility of pest and moisture control remains with the farmer. Some silo bags may increase exposure to pests; these are also more delicate than steel or concrete silos and need careful handling. Consequently, the large-uptake of on-farm storage solutions are to be built up through systematic capacity building and financial incentive schemes.

**“Storage solutions are a solution for farmers because of cheaper capital outlay for suppliers and farmers, their flexibility, which allows farmers (and our company) to expand or contract our maize business as required by demand and by the weather related production. Silo-bags can be easily moved as maize producing areas shift, they require fewer skills to operate storage, lower transport costs, much lower capital investment and can be located at any suitable site in a short time.” Resilience Dialogue with BKB GrainCo, South Africa.**



For more information on on-farm storage solutions, see **Factsheet: Resilience Solutions for the Potato Sector in Kenya.**



*Vivian Atakos (CIP-SSA)*

# 4. Resilience Solutions in the Transportation Sector





# Resilience Solutions in the Transportation Sector

Maintenance and operational costs in the transportation sector are expected to increase significantly in the future, as climate change exacerbates the rate and nature of asset deterioration. In a time of increasing climate variability, transportation infrastructure is key in supporting reliable services, and resilient economies.

The PMCR project identified climate threats to the transportation sector in **Colombia, South Africa** and the **Philippines**, as well as solutions that would enhance the resilience of the sector, ensuring permanent and safe services in the face of climate change. The analysis focused on identifying existing market barriers and the potential reconciliation between demand and supply. The PMCR analysis focused specifically on the road and port sectors in Colombia, and the road sector in South Africa and the Philippines.

The private sector is involved in various processes in the road sector, including design, construction, operations and maintenance, mainly as a service provider. In the selected PMCR countries, procurement and road design, including key decisions such as route, materials and amount to be invested, are almost exclusively public-sector decisions. This role division is largely due to the concentration of government ownership of key decision processes in the transportation sector of the selected countries.

In the PMCR countries, investment in the road sector is conditioned by the significant role of the public sector. Whereas public taxes are funnelled into road infrastructure and maintenance, the allocated budgets are insufficient to keep the required quality and maintenance. Government infrastructure procurement is also notoriously difficult to innovate. Potential financial instruments to support pre-emptive investments include infrastructure and climate bonds in which financial institutions could take a role in strengthening the preparedness for climate change of the road sector.

*“In terms of resilient infrastructure, we have to quantify resilience first because of the multi-hazards that we are experiencing now”. **Cebu Provincial Office (provincial government), the Philippines.***

Additional constraints to the resilience of the transportation sector include the lack and the limited use of climate change data in the design, selection of construction materials, construction techniques and maintenance of roads. Currently, most road design and construction assume stationary climates, and designs are very often based on historical weather data. Neither of these would be the most appropriate approach in a changing climate as temperature, precipitation and run-off varies with climate. Special care would need to be taken to incorporate uncertainty into any new values in road maintenance and replacement design specifications.

A better understanding of climate change and expected impacts on weather conditions will enhance the preparedness and resilience of the sector to changing conditions and more extremes. A climate-resilient transportation sector benefits upstream and downstream value chains of raw materials and processed goods and key economic activities, and ensures the sustainability of societies.

The selected resilience solutions in the transportation sectors in Colombia, South Africa and the Philippines include the following:

1. **Knowledge services** including improved and innovative road design and sediment monitoring programs in ports;
2. **Innovative and resistant construction materials**;
3. Road network maintenance and upgrades;
4. **Refitting infrastructure** during maintenance works.



*“Identifying and implementing adaptation measurements in the port sector represents a critical aspect to guarantee the country’s competitiveness in a changing climate.”*  
**Carlos Andrés García, Ports & Logistics Consultant, Colombia.**

## Knowledge services

Knowledge services play an important role in the design, construction, maintenance and operations of roads and ports. Knowledge services include technical assistance, specialised consultancies, and expertise used in all transport infrastructure process models with the exception of the 'decision to build a port or a road'. These services include advising public authorities on road planning and path design, material selection, and construction techniques, among others. In the case of ports, services also include the provision of environmental impact assessments, infrastructure monitoring and replacement and innovative approaches to the monitoring of changes in coastal dynamics, among others. Current road and port design parameters, including the selection of materials, if not adjusted will become inappropriate in a changing climate.

In **South Africa**, most road construction assumes no changes over time in weather and climate conditions, and designs are often based on weather data that dates back to the mid-20th century. This approach is clearly inappropriate, as data show that localised temperatures, precipitation and run-off are changing in warmer global climates. The Weinert Index, used to adjust the bitumen binder content in asphalt used in road construction, is one example of a design parameter that, if not adjusted, becomes inappropriate under climate change.

Calibrating design parameters used to inform designs and select construction materials, such as the Weinert Index, would incorporate climate change and, therefore, strengthen material resistance and increase preparedness for changing climate conditions and more extremes. Moreover, in addition to contributing to safety for the users of infrastructure, climate-resilient design and construction is associated with lower repair and maintenance costs in the long term, as well as lower insurance claims and costs.

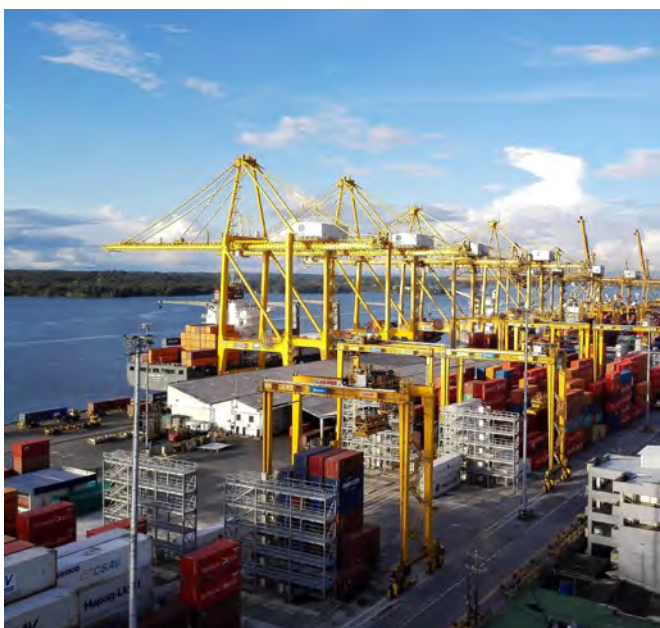
In the port sector in **Colombia**, special attention is drawn to risk assessment, as part of the environmental impact assessments, sediments monitoring and planned dredging actions, and compliance with the regulations of the National Authority of Environmental Licensing. Across all decision processes in the port sector, there are providers of knowledge services (private, mixed and public) creating awareness. However, a general understanding of the impacts of climate change is still limited. An advantage of the port sector is that operations are based on commercial profitability and activities are highly professionalised. Consequently, most commercial ports have the financial capacity to contract knowledge services and the operational capacity to monitor and assess the application of these services.



For more information on knowledge services in the transport sector, see ***Factsheet: Resilience Solutions for the Road Sector in South Africa.***



For more information on knowledge services in the transport sector, see ***Factsheet: Resilience Solutions for the Port Sector in Colombia.***



Buenaventura Port. Carlos A. García, Colombia

**“**Year after year, we are seeing more and more accumulation and transport of sediments in the bay, we think this is the result of two processes: increase in rainfall and deforestation upriver and in the mountains surrounding the bay.” **Miriam Mosquera, Environmental Chief, Sociedad Portuaria de Buenaventura, Colombia.**

## Innovative and resistant materials

Innovative materials that take advantage of knowledge and technological development have the potential to transform the climate resilience of the road sector. Particularly, alternative materials to traditional construction materials can provide climate resilience benefits and extend the life and resilience of roads in the face of extreme weather conditions and climate variability.

In the context of the BRPM analysis, construction materials used during the construction, maintenance and rehabilitation processes were found to represent a good investment for climate resilience. In addition to minimising potential climate-related disruptions to operations, pre-emptive resilience investments in road projects represent financial savings in the long term, bringing lower repair and maintenance costs and strengthened safety for users.

Resilience dialogues with road sector stakeholders in **Colombia** showed that national agencies are increasingly understanding the importance of including climate change risks and related impacts in road infrastructure development. In the context of government programs created directly to address climate risks, incentives are being created to motivate companies building and refitting road projects to use innovative and resistant materials. Moreover, the analysis showed that the use of resistant materials, such as the recycled rubber asphalt being used in road construction in Colombia, involve mitigation co-benefits and, consequently, represent a win-win adaptation and mitigation solution.

In the **Philippines**, alternative materials for road construction, such as the Expanded Polystyrene (EPS) Geofoam, are being used to provide climate resilience benefits and extend the life of roads. EPS Geofoam is a lightweight, cellular plastic material that is strong but has a low density, with a weight of approximately 1% of usual earth fills or soil and less than 10% of other lightweight fill alternatives. The material has been used by the construction industry in Europe since the 1960s. In the Philippines, it is used for embankment projects, slope stabilisation and construction in soft soils, and as a geotechnical material usually for ground fill application. While EPS Geofoam reduces the stress of loads imposed on the underlying or adjacent soils and structures, its greatest resilience benefit arises from the possibility of building throughout the year as it is unaffected by prevailing weather, lowering the probability of climate-related delays during the construction phase.



For more information on materials strengthening climate resilience in the road sector, see ***Factsheet: Resilience Solutions for the Road Sector in Colombia.***



For more information on materials strengthening climate resilience in the road sector, see ***Factsheet: Resilience Solutions for the Road Sector in the Philippines.***



*Pumarejo Bridge, Magdalena river Delta, Colombia,  
Jose Luis Castiblanco*

***“The Disasters Risk Management Unit has produced guidelines that we welcome everyone to use in the design of infrastructure projects, and to analyse and assess risks in intervention areas, including those related to climate changing conditions.”***

***Martha Ochoa, Disasters Risk Reduction National Office, Colombia.***



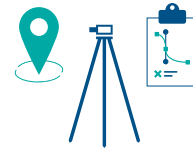
## Road network maintenance and upgrade

Good infrastructure management is key for resilient infrastructure, but targeted actions are also needed. The evidence from road maintenance standards show that early and preventative action saves money in the long run and makes roads safer. Road upgrades and maintenance represents a long-term option with immediate benefits and high economic multipliers.

Pre-emptive upgrades of gravel roads and the more regular maintenance of paved roads can potentially hasten the transition to climate resilience, while saving money and creating new employment. In conjunction with actual road construction and the paving of gravel roads, other adaptation opportunities exist. On gravel roads, options include increasing the sub-base drainage capacity and more frequent grading to ensure rapid and regular water runoff. Paving gravel roads is usually in the interests of resilience, but has to be justified in terms of use and associated costs.

Road upgrades represent financial business opportunities for private-sector companies providing products and services and creating job opportunities as it is labour intensive. Co-benefits include a mobile economy that creates more jobs and greater access to markets for all producers. Good roads benefit upstream and downstream value chains of raw materials and processed goods, tourism etc. The fact that additional up-front investment would save money represents a quintessential ‘financing’ opportunity for the road sector and financial institutions.

There is a recognised gap in the available information on the state of roads and the cost and processes for repairing and building roads. Research and development, and greater science-policy interactions, would increase the skill with which road construction and upgrades can be tailored to changing climates. This will require better projections, monitoring of weather-related impacts, research into new and innovative construction materials and their resistance to climate variability, and new engineering and design skills that factor climate change into road construction and maintenance. Better communication of the extent and state of roads could systematically improve the resilience of road networks.



For more information on road management and upgrades, see ***Factsheet: Resilience Solutions for the Road Sector in South Africa.***

***“I cannot store roads, so during the rainy season I make sure my operations and logistics departments are tuned in with IDEAM’s weather forecasts and early-warning systems.”***  
***Gabriel Molina, Incoasfaltos, Colombia.***



*Secondary road in the Garden Route, South Africa. Claudia Munera*

## Refitting infrastructure

Coastal conditions require constant maintenance to ensure that infrastructure can keep operating without disruptions. Sea-level rise and freshwater flooding pose serious risks to business continuity in the port sector. The PMCR analysis of the **Colombian** port sector demonstrated that there is limited understanding of the consequences of climate change to the sustainability of the sector. Particularly, despite the existence of a sector adaptation plan, very few port terminals are aware of the potential impacts of climate change to their infrastructure and businesses in the medium and long term.

In the context of strengthening the resilience of ports, operators can choose between periodic maintenance activities, including upgrading and refitting infrastructure that addresses climate and sea-level rise related risks, or a one-off adaptation intervention designed to address long-term risks. Due to the longer-time horizon, the latter option involves decision-making with greater uncertainty of risk magnitudes, around the economic benefits and higher investment costs.

Upgrading and refitting infrastructure while performing maintenance works has been identified as a cost-effective alternative for adapting ports to climate change impacts. Also, with the uncertainty related to the characteristics of climate-change impacts in coastal zones, refitting and upgrading infrastructure are a flexible short- and medium-term solution that enhances pre-emptively the sustainability and competitiveness of ports.

Upgrading and refitting activities include the alteration of port infrastructure designs, adapting drainage, slope management, and raising docks, among others, which strengthen the resilience of ports by preparing them for climate-change impacts. For example, an identified resilience solution in Colombia focused on raising port infrastructure above the floodplain, elevating facilities, and designing a system to accommodate the difference in height between the water level and the port infrastructure.



For more information on refitting infrastructure in the port sector, see ***Factsheet: Resilience Solutions for the Port Sector in Colombia.***



*Santa Marta Port, Colombia, Sergio Moreno*

# 5. Private Action on Climate Resilience





# Private Action on Climate Resilience

Most private resilience activity in the **PMCR countries** is not currently described as climate resilience or adaptation by the companies themselves or by public authorities. This is consistent with most other markets, where the private-sector response to climate risks has gone largely unlabelled and is only beginning to be recognised. More often, the private sector is seen only as a source of climate finance or as a passive investor, rather than a driver of innovative solutions or a broker of market intelligence that can inform future action.

Whether acknowledged openly or not, climate-related risks are eliciting actions to protect business operations as well as driving business opportunities across many sectors. Such actions and opportunities enhancing climate resilience are often specific to particular geographic exposures and vulnerabilities, market structures and technical and economic requirements in each sector.

In the agriculture sector, weather and the natural environment have always played a key role including episodic and chronic weather events. Many traditional approaches or highly similar measures that agriculture has used to manage weather as usual are also used to respond to weather plus climate change types of risks. The same holds true for many measures to deal with climate risks facing road and port construction and operations.

Based on the characteristics of products and services highlighted by PMCR country teams, three broad categories for private climate resilience action were identified:

- 1. Defensive:** all solutions protecting existing operations or infrastructure in the face of a changing climate. The main driver of defensive solutions is to protect profits.
- 2. Innovative:** solutions involving new methods, practices and technologies that can spawn new social or value-chain relationships.
- 3. Transformative:** solutions that can change the nature of a company or sector, disrupting business as usual, or finding new applications for existing tools or practices.

In practice, all three categories can overlap, play complementary roles and act in synergistic ways to promote new and more effective climate-resilience solutions. Plus, regardless of the motive for building resilient solutions, all three categories are currently generating business opportunities and would benefit from scaling.



*Fedearroz, Colombia*

## Defensive resilience

As global climate change manifests in episodic weather events and increased climate variability, private actors are expected to increase defensive measures to protect their operations and business assets. Greater availability of targeted climate analytics and other measures that yield more accurate climatic projections are key tools in defensive resilience in business operations.

Identified solutions as examples of defensive resilience include:

- **Agro-climatic knowledge services** providing value-chain stakeholders with critical information for all climate-relevant processes.
- **Conservation agriculture** is a beneficial response to existing and future climate risks, and is both defensive in nature and a potentially transformative strategy.
- **Improved seed varieties** and **efficient irrigation systems** are examples of defensive measures that allow plants to resist episodic and chronic environmental conditions.
- **Silo bags and on-farm storage** facilities are a defensive mechanism to manage humidity during storage and protect against price fluctuations in the market.
- **Innovative construction materials** are a defensive tool that in many cases increases the resistance of transportation infrastructure and/or allows for the efficient construction of infrastructure regardless of weather conditions, thereby reducing costs associated with delays.
- **Refitting infrastructure** is a cost-effective defensive strategy to decrease climate risk and increase the resilience of key transportation infrastructure.



## Innovative resilience

Innovations are generating new practices and value-chain relationships. Fast-moving technology, access to information, and the growing threats posed by climate change to productive operations and assets, are driving a range of innovation in production processes, products and services. Innovation that increases resilience comes through a combination of knowledge of local conditions, climate risks and informed responses.

Many businesses seek greater efficiency through new processes, technologies, products and new markets. Existing processes or technologies may be adapted to build resilience in some cases, in others it may be necessary to design and implement completely new processes and technologies. New technology is often a challenge to users that are accustomed to existing tools and methods. There is, of course, a cost and affordability component, but evidence of a positive benefit-cost ratio seems to support innovation. For small holders in many countries, these technologies are not yet affordable, and other barriers to uptake include knowledge and service levels available at remote locations.



A workshop organised by Ecosaga with local farmers on climate data services. Ecosaga, Colombia



For more information on agro-climatic knowledge services in Colombia, see ***Factsheet: Resilience Solutions for the Rice Sector in Colombia.***

Identified solutions as examples of innovative resilience:

- **Precision farming** is an approach that directly targets resilient agriculture practices by using innovative tools, such as digital soil moisture probes, satellite imagery and drone technology. The uptake of this approach is being accelerated by technological advances that are increasing the availability of tools coupled with decreasing costs for users.

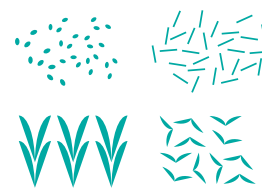


- **Alley cropping** is a simple but underutilised option that innovates crop management. The technological and cost requirements are relatively low and while more research is needed these measures hold the promise of enabling cost-effective solutions for small farmers.

- **Agro-climatic knowledge services** are using innovative methods to assist farmers in crop management. Increased availability of high-quality and precise climate data and information provide critical support to farmer decision-making processes.

- **Certification schemes** that incorporate climate-resilience enhancing practices provide new and innovative opportunities to farmers to improve entrepreneurial and productive processes, reduce environmental impacts and help them achieve financial sustainability.

- **Improved rice seed varieties** are considered as innovative resilience, given that a change in the status quo of rice cultivation is required. Research, particularly on rice seeds, has led to reported efficiencies in both cultivation and crop management.



- **Water management and infrastructure** comprise innovative resilience solutions that improve water efficiency and reduce energy consumption in agricultural production processes.

- **Knowledge services** in the port sector, particularly in the context of sediment monitoring and planned dredging actions, have the potential to innovate traditional approaches to better suit rapidly changing operational conditions.

- **Innovative construction materials** used in the transportation sector allow the efficient construction of infrastructure regardless of weather conditions, reducing costs associated with delays.

## Transformative resilience

This category comprises processes, products and services and companies that disrupt sectors and business practices using new technologies, techniques, or the repurposing of activities. Transformative actions often generate new products and business models and create new markets. A lack of awareness is the greatest barrier facing transformative resilience.

As noted throughout this report, the awareness of climate variability as manifest in episodic and chronic weather events is high. People can see that weather patterns are shifting and that in many places weather fluctuations have become more extreme. Moreover, climate change is changing the probabilities and distribution of weather events and that the past is no longer a reliable signpost for strategic planning.

Identified solutions as examples of transformative resilience:













- **Conservation agriculture** deploys a new complement of machinery and production methods, thereby transforming the interaction between farmers and their ecosystems. Transformative resilience is enhanced by synergistic responses of supply and support industries to the evolving demand arising within this transformative approach.

- **Community irrigation systems** can potentially lead to a transformative path by reshaping the role of the farmer from 'just producer' to 'co-owner' of production processes. These systems are governed by a close relationship and new partnership models between private and public stakeholders.

- **On-farm storage solutions** have the potential to transform the agricultural sector by allowing farmers to have ownership of decision-making processes relating to the supply of products to the market.

• **Innovative construction materials** have the potential to transform the road sector by creating and capitalising on expected adaptation and mitigation benefits, and contributing to the reduction of greenhouse gas emissions and maintenance costs, as well as ultimately unlocking climate-resilient financing to the sector.

A summary of the categorisation of **selected resilience solutions** in terms of the three broad categories for private climate-resilience action is presented below.

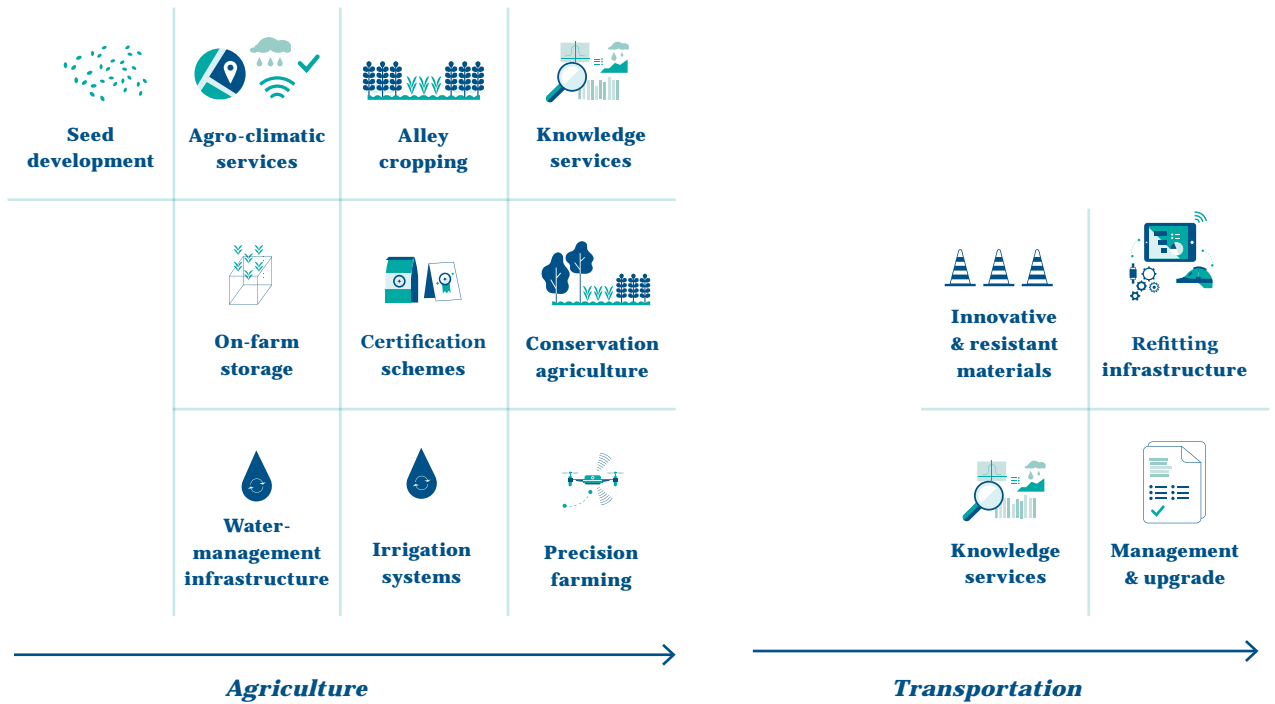
		<b>AGRICULTURE</b>		
<b>Resilience solution</b>		<b>Defensive</b>	<b>Innovative</b>	<b>Transformative</b>
	<b>Agro-climatic knowledge services</b>	<b>X</b>	<b>X</b>	
	<b>Conservation agriculture</b>	<b>X</b>		<b>X</b>
	<b>Alley cropping</b>		<b>X</b>	
	<b>Precision farming</b>		<b>X</b>	<b>X</b>
	<b>Certification schemes</b>		<b>X</b>	<b>X</b>
	<b>Water-management machinery</b>		<b>X</b>	
	<b>Irrigation</b>	<b>X</b>		<b>X</b>
	<b>Improved seed varieties</b>	<b>X</b>	<b>X</b>	
	<b>On-farm storage</b>	<b>X</b>		<b>X</b>
		<b>TRANSPORTATION</b>		
	<b>Knowledge services</b>		<b>X</b>	
	<b>Innovative materials</b>	<b>X</b>	<b>X</b>	<b>X</b>
	<b>Refitting infrastructure</b>	<b>X</b>		

## Graphical analysis of resilience solutions

The diagrams below represent graphical comparisons of the resilience solutions selected and analysed in terms of their contribution to *resilience*, to what extent *solutions address climate risks directly*, and the demand and availability of *technically viable solutions*. Each solution is represented within the country and sector context.

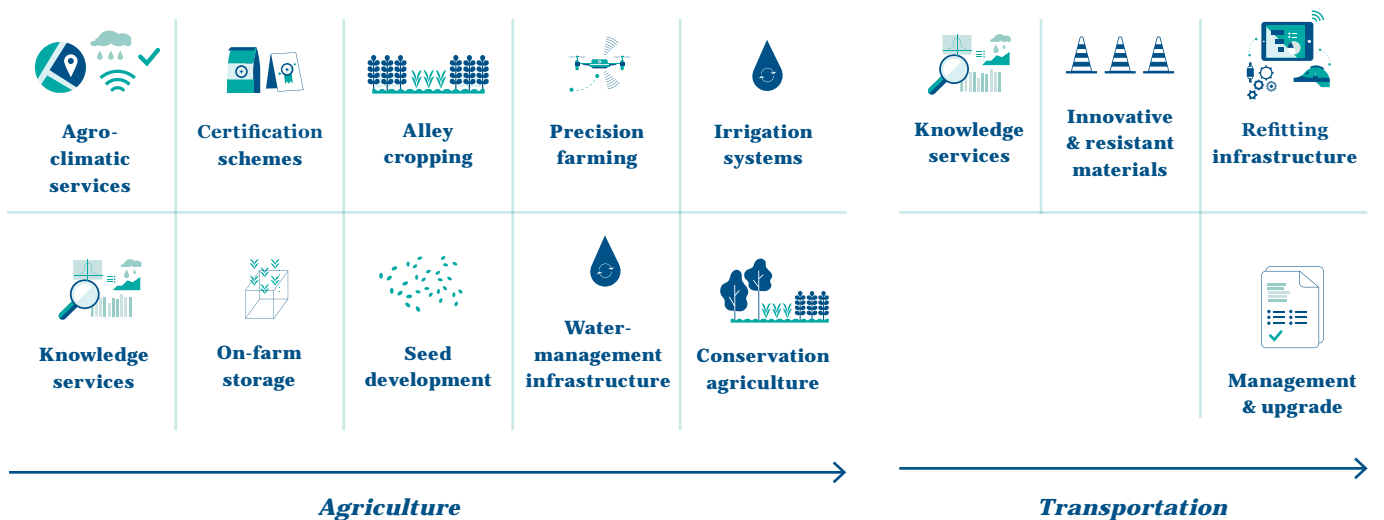
### Contribution of solutions to climate resilience

All solutions in the diagrams contribute to climate resilience in their respective sectors and countries. Towards the right end of the axis are those with a clearer and more direct contribution towards achieving climate resilience.



### Solutions addressing climate risks directly

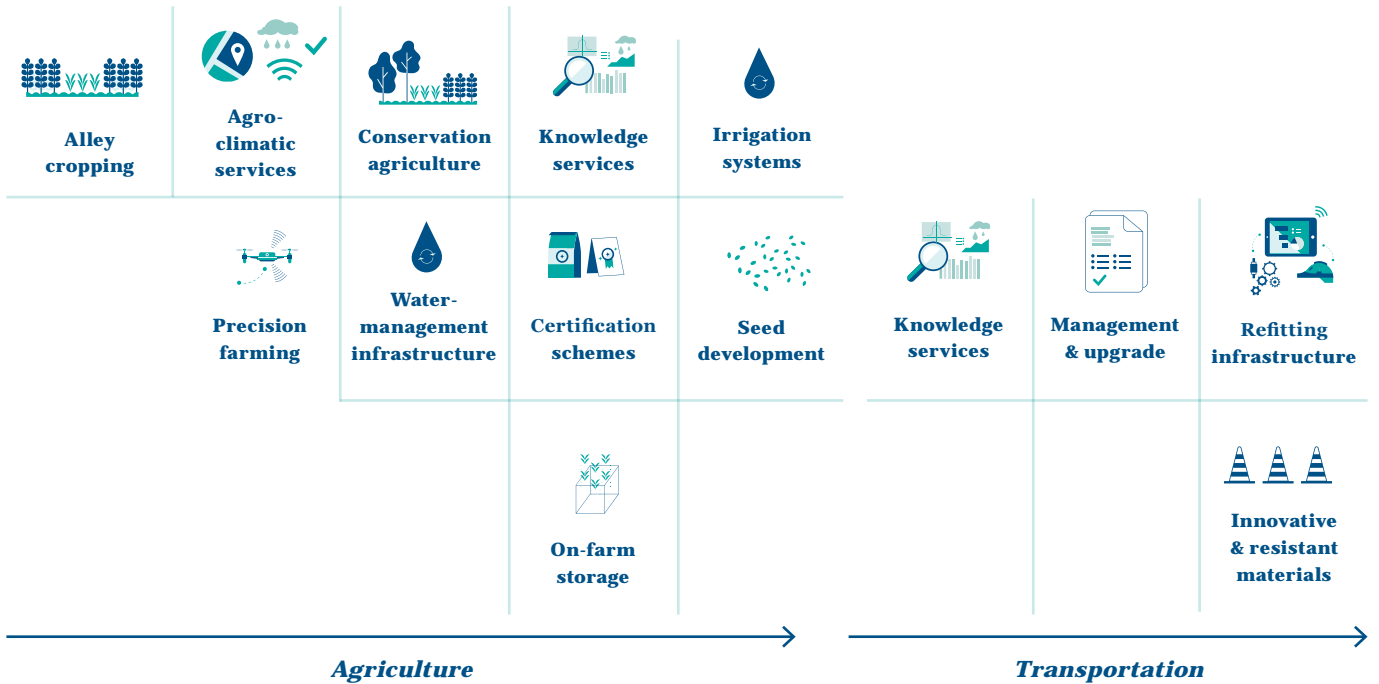
Towards the right end of the axis are those solutions that directly address one or more climate risks. Towards the left end are solutions that require further action or stakeholders to reduce climate risks, for example, knowledge services could provide the best advice, but advice, per se, does not reduce risk, rather its implementation.





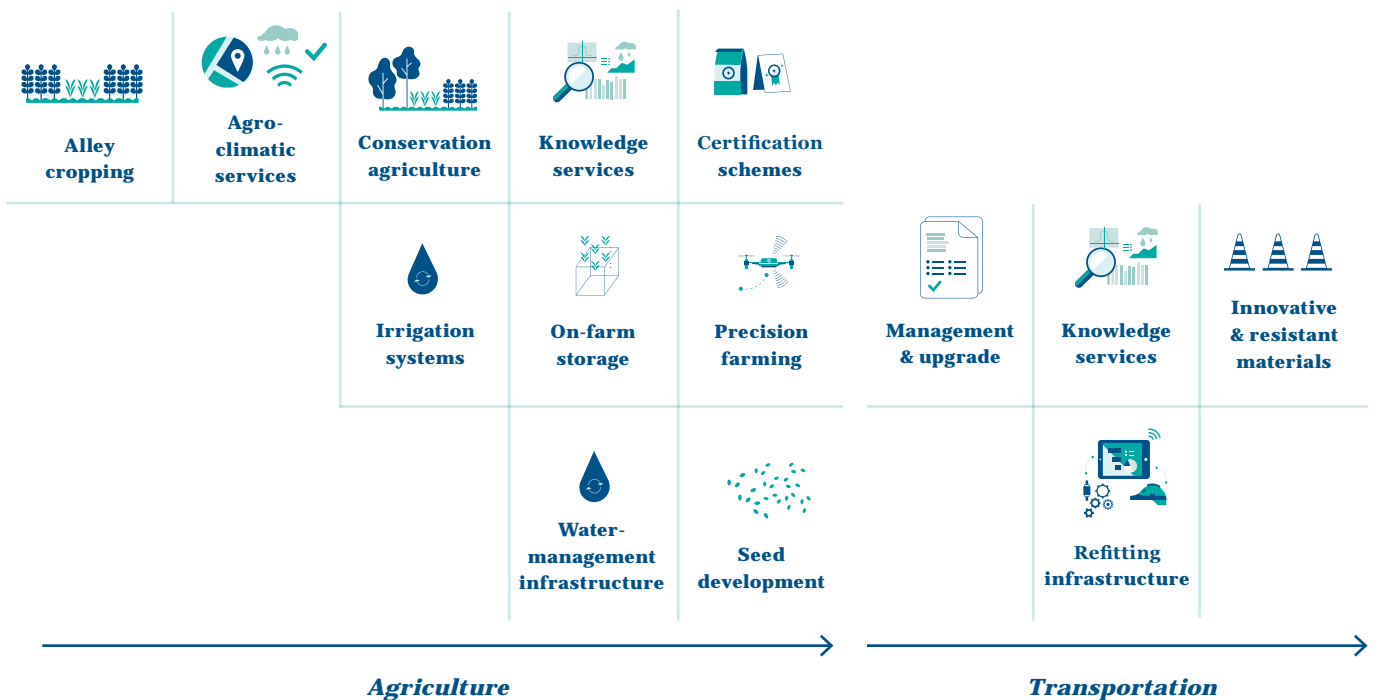
## Market demand for solutions

Towards the right end of the axis are those solutions highly demanded by consumers, even if the link with increasing climate resilience is weaker. Solutions towards the left end are less in demand with consumers; this does not mean they are not being demanded by users.



## Solutions technically ready to apply

Towards the right end of the axis are those solutions with a solid business case, even if not yet fully established in the market, as these could be entering the market at the moment of this assessment. Solutions with a weaker business case are located on the left of the axis.





## General conclusions

### Agriculture

- **Knowledge services**, such as *those involving good agriculture practices, conservation agriculture and precision farming*, appear to provide greater resilience among the solutions that are already available within the market.
- **Alley cropping** requires a stronger demonstration, in terms of climate resilience building, price and affordability, to fully represent a sound investment and business case.
- **Water-management infrastructure, certification schemes, agro-climatic knowledge services and irrigation systems**, although enhancing climate resilience, might be considered expensive and inaccessible for farmers. Efforts that improve accessibility and lower costs will benefit both buyers and suppliers of these resilience solutions. Communal irrigation systems in the Philippines are a step forward in that direction.
- The results for **seed development** differ among the three selected examples of the resilience solution. In the Philippines, rice seed development scores well on contribution to resilience and availability of technically viable solutions in the market. In Vietnam, the development of rice seeds is championed by the public sector, while distribution is the main private-sector role. In Kenya, potato seed development, which is at an early market stage, also requires a stronger case for creating climate resilience and economic viability.
- **On-farm storage solutions and precision farming**, although well placed in the market, still require a better business case to increase climate resilience.



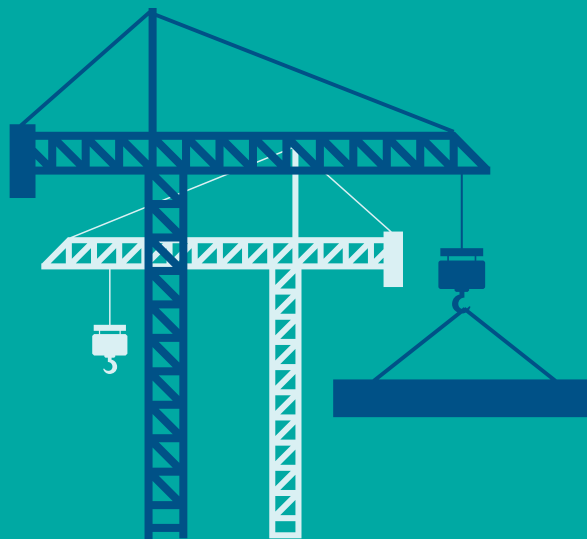
### Transportation

- **Innovative and resistant construction materials** have an established market and are technically viable solutions. However, these materials remain more expensive than traditional materials, affecting demand. Also, a stronger link between the use of these materials and their contribution to climate resilience must be proven in order to attain significant scale-up.
- **Knowledge services**, such as the sediment monitoring of ports, include various technical, logical and viable solutions. However, the establishment of a market lags behind other resilience solutions.
- While the contribution of **refitting infrastructure** has a strong link to climate resilience, the availability of technically viable solutions is at an early stage in the development curve. Greater capacity needs to be created among private sector stakeholders, so that they can properly address climate impacts.



Coffee farm, Nicaragua, Claudia Munera

## 6. Challenges for Resilience Solution Suppliers



# Challenges for Resilience Solution Suppliers

In all of the PMCR countries and sectors, there is a clear demand for products and services that enhance climate resilience. This growth in demand gains additional momentum during particular environmental crises. While most of these products and services are marketed without explicit reference to climate change, resilience is increasingly evoked as one of the many benefits of some products. There are also some solutions that could play a key role in increasing climate resilience, for which viable business models still need to be developed.

Customer profiles vary with geography, financial status, purchasing power and access to information, among other variables. Customers of the selected PMCR resilience solutions include farmers, intermediaries, NGOs, governments and their support agencies. There are, however, common challenges that currently hinder the development of a mature market for these products and limit the ability of the private sector to more actively engage in climate adaptation.

The characteristics of companies providing climate resilience solutions in the PMCR countries are diverse in terms of size, experience, resources and capabilities. Some companies are start-ups providing services and products that address specifically the impacts of climate variability. Others are long-established companies offering services that have either been available in the market and have gained new demand in the context of climate change or have been designed specifically to address new challenges.

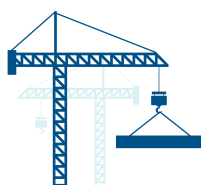
Suppliers of resilience solutions in the PMCR countries identified a variety of factors that limit their ability to expand the market for their products and services. While some of these barriers are specific to climate resilience, many reflect the more general challenges of doing business in the selected countries. While the conditions that shape the market for resilience products and services cannot be separated from wider conditions within sectors and countries, it remains critical for any discussion on how to improve market conditions for the suppliers of resilience solutions to consider where resources would best be targeted in the context of a changing climate.

## PMCR findings on supplier challenges

### Resilience as a business case

There are a number of solutions, which could potentially play a key role in increasing climate resilience in the assessed sectors. However, for most of the identified solutions, there is a need to develop a viable business model that would lead to large-scale commercialisation and sector-wide resilience. New models would support suppliers in taking advantage of opportunities to expand their customer base and, for example, to include those at the 'base of the pyramid,' and to create viable business models for those resilience solutions that currently lack one.

During the resilience dialogues, suppliers noted the difficulty in making a 'return-on-investment' case for their resilience solutions. This was particularly true where the transition to a climate resilient solution involved additional costs or required the running of old and new systems in parallel for an extended time during the transition. In the **Philippines**, for example, while contractors understand the value of building in line with climate-resilient approaches, in the absence of clear policies and standards mandating resilience, these transitions are seen as an additional cost rather than a long-term investment with a return. In this regard, the lack of accessible case studies on the economic value of investment in resilience was also highlighted.



***“Integrating climate resilience at first is an additional cost... who is to say that that is really effective in the long run? Someone has to do a test case, a pilot project. If they are willing to do it, then it's well and good... We can't fight nature. All we can do is to prepare.” International Builder's Corp. (IBC) (private contractor), the Philippines.***

## Affordability of solutions

The affordability of resilience solutions to potential customers was identified as an important barrier preventing suppliers from serving a larger market. In the resilience dialogues, it was repeatedly emphasised that affordability of the product or service among poorer customers was a key factor limiting growth and demand. This is as much a supply issue as a demand issue, representing an opportunity to innovate and reach out to a large group of potential new customers. It is also a finance-related issue as insurance companies exposed to industry-wide risks and agri-processors with sunk capital have strong reasons to invest in their farmers' climate resilience in order to sustain their own businesses.

In **Colombia**, resilience dialogues emphasised that many solutions were too expensive for individual farmers and the difficulties in assessing the monetised value of climate risk in the final harvest prices create challenges for the justification of specific investments. In **South Africa**, the shift to conservation agriculture or precision farming requires both new equipment and new approaches adopted at both a management and a field-labourer level.

## Access to finance

A major constraint for many suppliers of resilience solutions is related to difficulties accessing credit and loan facilities. Lenders often apply stringent lending criteria to MSMEs, which leads to many start-ups and small companies failing to acquire financing. Access to credit is a critical issue particularly among knowledge service providers. This could be the result of not having tangible assets to provide as collateral against a loan or a lack of understanding on the part of lending institutions as to the nature of the business and its value.

The lack of policies to incentivise the integration of climate resilience into existing practices, or encourage the private sector to engage in the development of products or services to address climate resilience was noted during the resilience dialogues. Linked to the perceived lack of a clear business case for addressing resilience, suppliers in the **Philippines** suggested the need for tax breaks or financial products to catalyse private-sector investments in resilience. For example, financial institutions in the Philippines are offering incentives for companies to invest in renewable energy and energy efficiency through risk-sharing facilities, providing guarantees and technical assistance for integrating renewable energy or energy efficiency into business operations. These types of products that would incentivise resilience are largely unavailable in the PMCR countries.

*“Private sector actors are not (yet) ready to embrace climate resilience because it is an “added cost”... (but they) could go the extra mile, if there were government subsidies or tax rebates... (these companies) are not violating anything because we are following the minimum standards.” **Private contractor, the Philippines.***



*Maria Eliniesa A. Lucas, the Philippines*

## Additional challenges

- **Challenges in running small businesses:** These are particular to knowledge-based companies, which are often start-ups or small consultancies with limited business experience or financial and human resources. While the understanding of climate change as an issue and of adequate solutions is strong, these companies often struggle with navigating the rules and regulations governing business activities, which are more appropriate for larger companies.
- **Lack of incentives for MSMEs:** The difficulties for MSMEs associated with competing under the same tax and regulatory regime as large companies were highlighted in all PMCR countries. These difficulties include the lack of incentives to support the development of new product areas addressing climate resilience. Beyond tax policies, the need to support business innovation in general and understanding of where business opportunities lie was also highlighted as a barrier preventing firms from creating new products and services to support climate resilience.
- **Limited integration of climate change into regulation:** The degree to which climate change is integrated into regulations governing different sectors varies by country. In many instances, it was highlighted that the integration of climate risk considerations into sector policies and contracting, budgeting and procurement processes, would enhance significantly the business case of climate-resilient approaches.
- **Changing international standards:** For high-value commodities, such as wine and cocoa, with well-developed international markets, there is a strong business incentive for certification. However, continuous changes in international standards place a burden on certified companies, both in terms of additional costs and updated internal knowledge and procedures.

## Main barriers faced by suppliers of climate resilience products and services

**Challenge**                                            **Consequence**

### Factors affecting business growth

Limited access to credit and financial support.	→	Limited investments, growth and innovation in new products.
Difficulties in proving a business case for individual products or services.	→	Harder to increase coverage without a clear business case for a product.
Difficulties in communicating instructions or product specifications to end users.	→	Failure to provide the expected outcomes and avoid reputational damage.
Regulatory, tax and financial frameworks are not sufficient to provide support for small businesses.	→	Challenges for small suppliers to operate under same regulatory regime as larger firms.
Limited support for innovation.	→	Limited development of new products and services.
Constantly changing international standards.	→	Additional costs and increased risks that realised investments are not profitable.



## Climate-specific factors

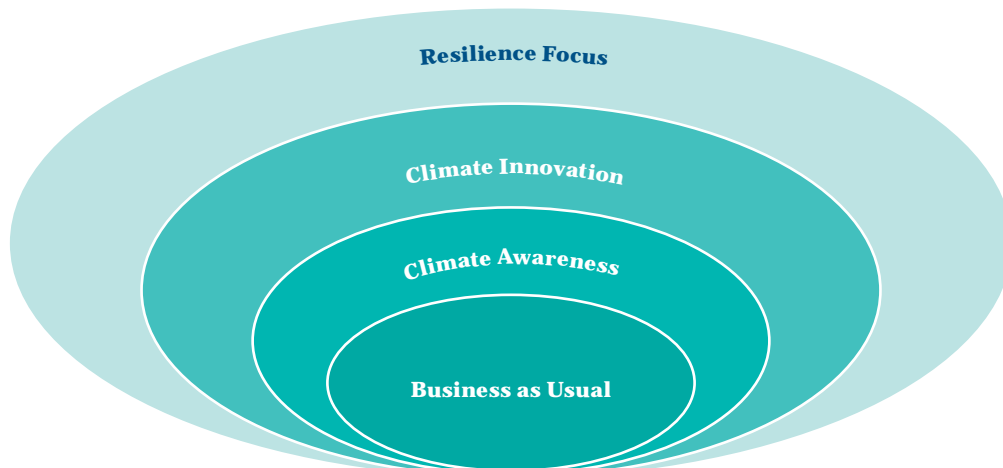
High 'switching' costs and risks in transitioning from existing practice to climate-resilient practice.	→	Farmers continue with existing and sub-optimal practices.
Limited integration of climate change into regulation.	→	Limited uptake, scale-up and market expansion.
Lack of incentives for addressing resilience.	→	Higher barriers to entry for enterprises with resilience solutions.
Poor awareness of climate-change impacts as a business opportunity.	→	Limited uptake and innovation required to respond to climate-change impacts.
Final users are not aware of, or interested in, climate solutions and prioritise more urgent risks.	→	Difficulties for resilience enterprises in proving the business case for new solutions.
Difficulties in predicting climate risks accurately and quantifying future impacts in financial terms.	→	Continued management of impacts reactively, in the form of loss and damage avoidance.

## Integrated climate resilience of PMCR suppliers

For individual companies within the different typologies, operational integration of climate resilience can vary greatly. Individual suppliers share features of an emerging market that should be taken into account as project managers develop investment opportunities. These features include:

- **Awareness** of climate variability and risks and **capacity** to invest in climate resilience;
- **Knowledge and technology** to reduce risks to business processes and take advantage of new opportunities; and
- **Management processes** and **financial products** that are appropriate to the companies' business models.

The PMCR suppliers of resilience solutions were assessed using a **Climate Resilience Maturity Model** with the following four levels:



**1. Business as Usual:** The baseline of an organisation that has not considered climate change in its business processes, whether from ignorance or focus on day-to-day operations.

**2. Climate Awareness:** The first level is being aware of the threats and their impact on existing business processes.

**3. Climate Innovation:** Beyond climate change awareness and its impacts on business activities, organisations responding to demand by innovating and creating new products or business models that deliberately contribute to climate resilience.

**4. Resilience Focus:** As with any new challenge, there are organisations with an explicit mandate to provide products or services that increase resilience. While more common for climate mitigation, this is an emerging class of organisation with a resilience focus that is expected to grow.

The majority of companies providing resilience solutions identified by the PMCR project can be placed in the *Climate Awareness* category. Companies are generally aware that climate variability is a factor driving demand for a specific product. While many have seen increased awareness of climate change among their customer base, most companies have not developed products or services with the specific aim of providing customers with a way of adapting to climate change.

In certain cases, such as the port sector in **Colombia**, while there is growing awareness, current operational risks are addressed in a *Business as Usual* manner. For this category, the primary challenge is making it easier to adopt available climate-resilient solutions, either through better-equipped stakeholders that support capacity building or through the adoption of innovations that do not disrupt day-to-day operations.

*Climate Innovators*, or companies that have developed products or services specifically aimed at increasing resilience, were much rarer in the PMCR countries. Ecosaga, a Colombian company offering agro-climatic services designed specifically for climate variability, is an example of this category. In **South Africa**, companies classified as *Climate Innovators* were identified, offering climate resilience as part of their services or products, in line with increasing impacts on agriculture and roads. For example, individual wine farms in South Africa are actively innovating and exploring new techniques and locations for producing quality products under higher temperatures.

At present, there are very few private-sector companies considered as having a *Resilience Focus*. However, there are several think tanks, NGOs and research organisations with a clear climate focus in the target countries.



For more information on agro-climatic knowledge services in Colombia, see ***Factsheet: Resilience Solutions for the Rice Sector in Colombia.***



For more information on resilience solutions in South Africa, see ***Factsheet: Resilience Solutions for the Wine Sector in South Africa.***

# 7. Financing Climate Resilience in PMCR countries



Nicaragua

Colombia

Kenya

South Africa

Vietnam

Philippines

# Financing Climate Resilience in PMCR countries

The global financial sector has a crucial role to play in supporting the emergence of climate resilience in private markets. All products and services analysed in the PMCR project have some form of contact with the finance sector, whether through traditional banking services (e.g. bank deposits, credit and debit cards, transfers of funds, etc.), insurance or equity investments.



Generally, the finance sector, which is itself exposed to climate change, can support private sector climate resilience by:

- *Supporting allocations of funds* that recognise the requirements for a climate-resilient economy. This may involve reallocation of funds away from maladaptive practices to new products and services;
- *Boosting the rate of investment* in assets and services that deliver resilience; and
- *Paying closer attention* to the systemic nature of resilience, so as to ensure that jobs are created, social vulnerability is reduced, poverty is alleviated, and the use of the natural environment and natural resources are adequate and sustainable. These co-benefits are central to the feasibility of a climate resilient future, and their inclusion in finance sector considerations could enhance the viability of products and services for climate resilience.

## Existing financial instruments for climate resilience

While this study did not find bespoke products purporting to support climate resilience, a number of commercial banks and institutional investors are paying closer attention to climate risk and support for products that are labelled '*climate smart*', '*green economy*' or '*developmental*'. In part, this is due to global pressure on the financial sector to report on its environmental, social and governance performance.

In some countries, *public-private partnerships* are being used in innovative ways to finance infrastructure. However, in no country is there a deliberate effort or capacity to blend outcomes, so as to ensure that public and private financing could be blended in support of resilience. Blending outcomes



**“F**armers find it hard to avail of crop insurance for vegetables because they can only claim small amounts; many avail of insurance for rice (especially if they are subsidised). Insurance pay-out takes 3-4 months of processing. During a dialogue where municipal agricultural officers, traders and farmers were made to play a dice game that put them through decision making situations on purchasing insurance or investing in development, most of them said, “It is better to buy insurance rather than experience being wiped out by climate-related disasters.”  
**Municipal Agriculture Office, Bongabon, Nueva Ecija, the Philippines.**

Ma. Eliniesia A. Lucas, the Philippines

would involve collaborative efforts to document and align incentives and risks and contribute finances proportionately. This capacity to blend outcomes is critical to the development of private markets for climate resilience. While multilateral organisations and developing agencies are funding knowledge services closely related to capacity building and training, it is still the private sector that delivers these services.

In the PMCR resilience dialogues, small farmers stated that *traditional loans* are too expensive or require *guarantees* they cannot provide, and loans by *micro-financiers* do not provide the required funds to transition to climate resilient operations. Larger producers frequently self-finance these activities, but this can limit the pressure for change and innovation that could be provided by a financial institution. Companies designing, building and maintaining roads and ports appear to have very low levels of innovation, with financiers preferring solutions that are perceived as low risk and familiar, even when these were designed for historical climates. Inserting resilience into these modalities has proven difficult in all PMCR countries.






As the insurance industry has particular exposure to climate variability, it has an incentive to insert conditions that would reduce climate risk into its products. In terms of financing climate resilience, *insurance contracts* of various types are often seen as part of the climate resilience toolkit for hedging against climate-related losses. However, it should be noted that insurance is about financially transferring climate risks and not about building climate resilience or promoting it. The insurance industry does not yet actively incentivise adaptation or resilience building in infrastructure or agriculture, but a movement in this direction would greatly facilitate the private market for climate resilience. In any case, except for *subsidised crop insurance schemes* that are often inaccessible to smaller farmers, or *small parametric insurance programs* that are still in the pilot stage, most small holders in this study lack any formal financial mechanism for transferring climate risks.



While the climate awareness of financial institutions, including banks and insurance companies, is growing, a number of limitations for launching new products were identified. These included environmental variability and extreme events in rural areas, social-cultural and geographical isolation, imperfect information, context- and sector-specific challenges and centralised approaches.

## Barriers limiting the development of financial products:

- > **Very similar to those of the underbanked**
- > **Products available are not really reflecting these realities**

 <b>Environmental variability</b>	 <b>Social, cultural and geographical Isolation /Distance</b>	 <b>Imperfect information</b>	 <b>Context-specific challenges</b>	 <b>Centralised approach</b>
<p>Hinders the management of the liquidity of the investor and the farmer</p> <p>One event can become systemic</p>	<p>Poor infrastructure makes operations (i.e distribution, inputs access) more expensive</p> <p>Uncertainty on payment delivery</p>	<p>Moral risk and adverse selection demotivate investors</p> <p>Lack of mechanism to ensure delivery prices</p>	<p>In a sector that is used to homogenous products</p>	<p>Traditional approach to all clients</p> <p>Even customer services is thought from the urban perspective</p>



## Emerging instruments for resilience

Given the need to foster private sector involvement and to stimulate the growth of enterprises providing resilience solutions, there is scope for national adaptation and private sector development programs to provide technical assistance and financing for the large-scale uptake of resilience solutions.

National and regional *climate resilience finance facilities* could add value by linking existing instruments, such as microfinance and credit lines, with new financing modalities that encourage climate resilience. Such facilities could complement financial instruments with innovation grants, or catalyst funding, in the form of credit and guarantee schemes, and possibly equity, and quasi-equity/mezzanine financing.

Other financing structures that can foster climate resilience include emerging environmental impact bonds. These structures, modelled on social impact bonds, involve partnering investors in climate resilient initiatives with governments to finance services targeting rigorously defined outcomes. Where these efforts achieve their goals, investors receive back the full value of their investment, plus a return. This model is ideal for funding resilience building while generating economic benefits for low-income populations in emerging and developing markets. The structure of environmental impact bonds is built on the active participation of enterprises producing resilience solutions as part of any operation, thereby building capacity and awareness of the business opportunities associated with resilience.

Other areas where business and investment opportunities in resilience can be promoted include:

- *Value-chain financing* through the provision of credit, guarantees and insurance along the agricultural value chain with the objective to incentivise resilience building;
- *Franchising finance for MSMEs* that sell climate-resilient products or services;
- *Developing climate analytics and information technologies* for monitoring, accounting and financing resilience;
- *Piloting business and financial models* related to resilient infrastructure and public-private partnerships;
- *Targeted support* for investment products such as green bonds, resilience bonds and catastrophe bonds;
- Developing financial instruments and monitoring tools to ensure that maladaptive interventions and operations are not financed.

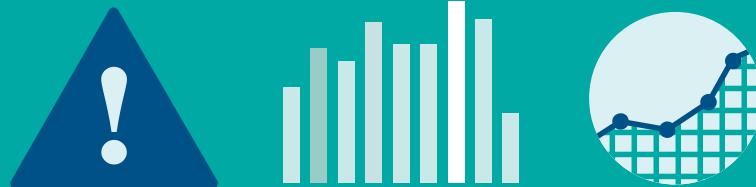
Efforts to help financial institutions identify and reduce climate risk in portfolios is an area of high interest that is undergoing rapid development. Financial institutions in most emerging markets have been slow to respond to or recognise climate risk as a material threat to their portfolios. This is beginning to change. The work of groups such as the Task Force on Climate-related Financial Disclosures on the material nature of climate risks, comprised of many of the largest global financial institutions, is gaining the attention of financial institutions around the world. This will drive demand for a range of financial analysts and other specialists with training in climate adaptation and resilience.



*Coffee producers, Nicaragua, Claudia Munera*

**“E**ach stakeholder faces a decision point in which adaptation and resilience solutions could have a make or break difference. Such a decision is based on the perceived risk, the availability of resilience solutions, the stakeholder’s capacity to afford them, and, on the financial outcome of applying a particular solution. The combination of these criteria will result in a stakeholder incorporating a solution or set of solutions or doing nothing.” **Cesar Cortez, Agricultural Engineer, Colombia.**

# 8. PMCR Findings in Focus



# PMCR Findings in Focus

The Private Markets for Climate Resilience (PMCR) study took a frontlines look at how the private sector in six developing countries is addressing climate risk in agriculture and transportation. Along with identifying a vast range of promising resilient business examples and solutions, the study also came up with findings and recommendations on how private stakeholders could become more active, as well as gain a better understanding of the business case for doing so.

## ***Going green versus addressing risk***

While there is some awareness of climate-change impacts, the PMCR resilience dialogues conducted at the outset showed a tendency among private sector participants to see climate change largely through the lens of environmental and social responsibility, rather than as an inherent risk to their business continuity. The dialogues with representatives of enterprises would often start as a feel-good conversation about ‘going greener’. It was only after the finance and operations people were brought into the room that the conversation could open up to discussing climate impacts on their respective future business operations.

## ***Private sector activity hidden in plain sight***

Stakeholders in the agriculture and transport sectors, both local and global, are very aware of the impacts of weather events on their value chains. It is also known that these events affect regional climates differently across the world – some regions experience floods, while others can be hit by droughts. As a result, much of the current resilience activity among agriculture or transport sector actors is not classified as such, but considered business as usual. So, although the study found that activity is going on, it is not necessarily talked about as climate resilience or adaptation. Similarly, as discussed earlier, resilience efforts along these value chains, initiated by individual companies, are often not visible to banks, insurers and governments.



### **Something to consider:**

Climate variability is not a new risk for business and society. But climate change is changing and shaping existing types of risk with increasing complexity and severity.



*Ma. Elmiesa A. Lucas, the Philippines*

### **Enterprises leading resilience action**

Looking through the lens of the countries and sectors under study, climate resilience actions are being led by enterprises of all sizes (micro, small, medium and large) and can be classified loosely into three main types: *defensive*, *innovative* and *transformative* – with many that can be considered cross-cutting.

#### **Defensive**

The main driver of *defensive solutions* is to protect operations and business assets. For example, greater availability of targeted climate analytics and other measures that yield accurate climatic projections are key tools in business operations. Improved agro-climatic projections provide farmers with critical information for the selection and sequencing of their crops. Improved seed varieties, more efficient water irrigation, storage solutions, and conservation agriculture could also broadly be considered as defensive solutions already being applied to the agriculture sector, allowing crops and harvested products to resist episodic and chronic climate-related events.

Innovative materials in road construction and refitting infrastructure can also be considered *defensive solutions*. The former in that it allows for rapid construction regardless of weather conditions and the latter as it directly addresses coastal flooding. Recycled tyre rubber (RTR) asphalt is another defensive solution against weather extremes, but also has several mitigation-adaptation benefits, in addition to reducing maintenance costs and environmental impacts.

#### **Innovative**

Fast-moving technologies like soil sensors, surveillance drones, digital software and satellite imaging that bring information to promote resilience through resource efficiency can be classed as innovative solutions. In Colombia, the Rice Producers National Association is integrating agro-climatic projections with soil, water and crop data to inform key production decisions. Through precision farming, commercial agriculture in South Africa is using innovative tools to identify disease, water deficits and irrigation scheduling. Climate-smart seeds in the Philippines, Vietnam and Kenya are good examples of innovative technology and science, bringing efficiencies to both crop cultivation and crop management, as well as promoting higher yields. Good practices, certification and traceability initiatives in the Colombia coffee and Nicaragua cocoa sectors also fall under the category of innovative resilience. Lastly, alley cropping is an innovative practice, which brings long-term benefits to soil quality, micro-climate and pest management, while boosting cash-flow and revenue diversification.



*Fedearroz, Colombia*



## **Transformative**

Transformative solutions can be defined as market actions that change the nature of a company or sector, disrupting business as usual, or bringing new applications for existing tools or approaches. In some sectors and geographies, disruption may require radical new strategies, while in others it may be as simple as taking an existing proven resilience solution and ramping it up to maximum capacity, with maximum system-wide involvement. Conservation agriculture in South Africa, for example, integrates machinery and production methods, changing the interaction between farmers and ecosystems. Community irrigation systems in the Philippines can potentially transform the role of the farmer to becoming the owner of the system, rather than just a user. Silo bags in the maize sector in South Africa, although defensive in that they protect harvested products against humidity, also empower farmers to decide when to take their products to market.

## **Key cross-cutting themes also emerged**

### ***Power of precision***

Whether it is the maize and wine sectors in South Africa, the coffee and rice sectors in Colombia, or the rice sector in the Philippines, as climate conditions worsen in the form of extreme temperatures, intense precipitation or prolonged droughts, growers are increasingly finding value-add in a more precise and geographically contextualised farming approach and implementing good practices. This might be in adapting planting and harvesting schedules, actively managing soil health, diversifying products or using surveillance to determine how much water or fertiliser should be used to optimise resources. In agriculture, resilience innovation services are predominantly coming from small- and micro-businesses, even from individual farms, whereas products and equipment are more likely to be provided by larger organisations.

### ***Access to knowledge***

Linked to precision, is the power of information, where access to knowledge services is also becoming more and more valued. Climate projections, weather monitoring and forecasting, combined with early-warning systems, crop simulations, agro-climatic models designed to drive quality yield, water efficiency and crop management techniques are all among the many promising resilience solutions studied.

### ***Information drives incentives***

Data collection and dissemination from individual growers can also inform agricultural practices as well as potentially drive credit access and build resilience incentives. In South Africa, potential was seen for financial institutions, such as credit and insurance providers, to take advantage of the data generated by precision farming solutions to develop incentives for resilience in the form of reduced premiums or other rewards. For example, insurers could sponsor the purchase of surveillance drones or data analysis software in exchange for data that would not only allow farmers to better manage their resources, but also give the insurer greater insight into the business viability of their clients. The PMCR study found that any move by the insurance industry to go beyond a defensive case-by-case approach towards actively incentivising climate resilience in agriculture and transport would be considered a major step forward in getting the private sector more engaged.



### ***On-farm storage facilities ripe for scale***

In the Kenyan potato sector, planting and harvesting happen at almost the same time right across the country, resulting in excesses and shortages at predictable times each year. Storage facilities are not sufficient to accommodate the amount of potatoes during gluts and are expensive to develop individually. Ramping up the potato storage market in Kenya would reduce post-harvest losses, cushion against shortages, and be crucial in stabilising prices. Providing adequate seed storage for farmers in Kenya would also facilitate better production planning, enabling timely planting, and reducing exposure to climate risk.

Similarly, for most maize farmers in South Africa, investments into storage infrastructure are prohibitively expensive, and developing a market for low-cost on-farm maize storage options such as silo bags and bunkers are offering maize farmers less exposure to price volatility and more flexibility



to sell their products opportunistically at a time when prices are high. Also, as production areas gradually shift in response to a changing climate, on-farm storage can help farmers address the growing dislocation among maize production regions and storage and processing facilities, as well as market destinations.

Storage facilities for all crops and in all PMCR countries can climate-proof harvested products allowing farmers and farmer cooperatives and associations to protect their harvest, and also to decide when to take it to market.

### ***Potential gains from sector interdependencies***

In agriculture and transport, a climate resilient road and port sector are tantamount to delivering quality agricultural products securely to market in a timely way. In all PMCR countries, the study found agreement with the basic premise that resilient transport infrastructure development is key for the long-term sustainability of the agricultural sector.

In South Africa, most road construction had previously assumed no climate change, with designs based on weather data from the mid-20th century. New informed design parameters and climate resilient materials are now being seen as the way forward for increasing disaster preparedness, strengthening resilience as well as contributing to road-user safety. Climate-resilient design and construction is also associated with lower repair and maintenance costs as well as lower insurance claims and costs.

In Colombian road building, recycled tyre rubber (RTR) asphalt is a resilience solution with benefits that have been reported in developed countries since the 1960s. Compared with traditional asphalt, RTR asphalt is more resistant to extreme temperatures, less degradable by water, and less susceptible to solar radiation absorption. On top of that, from an environmental impact standpoint, recycled tyres also maximise existing resources by repurposing waste; and from a mitigation standpoint, co-benefits are achieved by replacing practices responsible for large emissions (i.e. the burning of tyres). Mindful of this, local and national authorities in Colombia currently award higher scores in tendering processes to bidding companies committed to using environmentally-friendly materials to build and repair the nation's roads.



*M.A. Velas-Suarin, the Philippines*

### ***Actor and context specific findings***

Customer profiles vary by geography, financial status, purchasing power as well as access to information, among others. Currently, international assistance and government subsidies are used to bridge the affordability gap. To date, however, this support only reaches a relatively small portion of potential stakeholders. In the transport sector, barriers are linked more to transport infrastructure budgets and policies set by governments or standards imposed by the public sector, and less related to the sector's financial capability.

Suppliers of resilience products and services face constraints specific to both climate resilience and in-country business environments. Formal incentives are limited for companies to expand their portfolio or offer solutions specifically designed to increase climate resilience. There is a large untapped opportunity for suppliers of resilience solutions to widen their customer base to include those at the 'base of the pyramid', to whom these services are unavailable but where demand exists. New business models will be required to take advantage of this potentially large opportunity.

There are common challenges hindering the development of a mature market for these products and limiting the ability of the private sector to more actively engage in climate adaptation. Access to finance is one of the main challenges faced by buyers and providers of climate resilience solutions. In this context, a strong need was identified to engage local multi-stakeholder groups, including public, private and civil society, to build stronger cooperation and transparent dialogues around resilience building.

### ***Right incentives for the private sector***

When policies are weak, the private sector tends to take a short-sighted view on climate-proofing infrastructure, treating it as an 'added cost'. But when policies are strong, the private sector must for the sake of future business continuity be ready to rally.

Clearly more work needs to be done at public policy levels to frame resilience in the context of 'What's in it for business?' Business with its short-term earnings imperative is unlikely to embrace resilience for its own sake, but could be compelled to go the extra mile, if in pursuit of government subsidies or tax rebates.

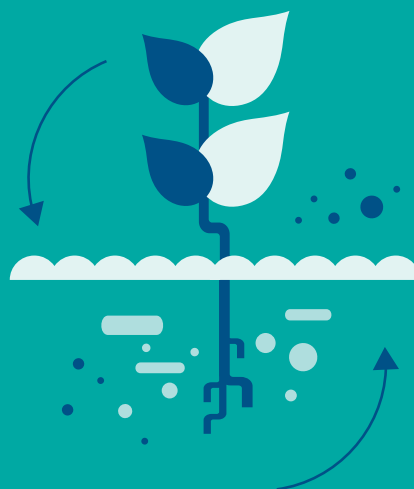
The financial sector also has a key role to play in providing investment dollars, affordable insurance, credit and other blended financing products. However, barriers to investment still exist, not least uncertainty and long-term horizons for credible returns.



*Ysalina Bridge, Cagayan de Oro. M.E.A. Lucas, the Philippines*

***“In the Philippines, transport infrastructure is government controlled but serviced by private sector, which is not required to factor resilience into bids because it is not required nor incentivised by the government and therefore is considered an added cost.” Perpi Tiongson OML Center, the Philippines.***

# 9. Climate Resilience and the Road Ahead



# Climate Resilience and the Road Ahead

Climate risk is driving a large and growing demand for private climate resilience solutions. A lot is being done. But it is unclear how much, or whether it will be enough to avoid significant economic loss. More importantly, will it be enough to create the right conditions to drive market transformation? And aside from climate change, what other market drivers are there to consider?

Clearly, private solutions can protect many types of assets, property and businesses from climate risks, and in turn strengthen the global response to climate change, while also generating economic opportunity and social benefits. Although the solutions selected for detailed presentation in this study were those with the most potential for each specific context, they are only a fraction of the hundreds of other solutions identified and therefore just the ‘tip of the iceberg’.

PMCR resilience dialogues show that demand and supply exist. Agricultural producers do want affordable products and services that will solve their short-term problems while helping them build longer-term climate resilience. They also want climate resilient supply chains, access to sustainable markets and financial mechanisms that will lead to sector transformation. Similarly, in the transport sector, stakeholders have significant expectations for more resilient infrastructure. All this is easier said than done, especially as most of the related challenges are not directly linked to climate change, but rather the prevailing operational and regulatory environments.

## Private adaptation action in all PMCR countries

### *Climate change mitigation versus adaptation spending*

International policy and funding on climate mitigation currently far outweigh that of climate adaptation or resilience. However, in developing countries domestic spending on disaster risk reduction outweighs that of greenhouse gas emission (GHG) reduction and international funding, with investments mostly occurring post-disaster and during reconstruction. Given the exposure these countries have to extreme events, this perceived funding imbalance should not be ignored.

It has, in part, grown from the view that cutting GHG emissions is an urgent global mandate, whereas climate adaptation, while necessary, is a longer-term proposition. However, while mitigation is critical for the stabilisation of our global climate, the best science indicates that in the counterfactual case of zero emissions today, the planet would still be locked into a warming climate and its related consequences for at least 50 years.

Under this scenario, a re-framing of the climate transition might be in order, purporting that climate mitigation involves the longer term, while climate resilience brings significant economic and social returns in the short to medium term, especially for vulnerable populations.

### *Tracking adaptation finance and uptake of solutions in Colombia*

The Colombian government, since 2017, has been tracking private and public investment in adaptation through the SISCLIMA platform. Although there are challenges around which criteria should be used to classify adaptation investments, there is a conscientious effort being made to understand the role of the private sector and to better understand the value of investing in adaptation. Also, in the context of the uptake of resilience solutions, the AMTEC program, developed by the National Rice Producers Association, is currently being considered and tested in the cotton and maize sectors.



**“Climate change is rapidly challenging our assumptions of the world and our expectations for the future. It is forcing us to find new solutions and rediscover old ones. It has become the transversal theme of our time to drive cross-sector dialogue and boost collaboration and learning in completely new ways.”** **Claudia Munera, PMCR Nicaragua.**

### ***Systemic response to drought in South Africa***

If there is hope for climate resilience markets in South Africa, it is because the worst drought in more than 100 years disrupted the current system, necessitating a more systemic response and reinforcing the power of partnership: academics have intensified their interaction with farmers, government officials and media outlets are providing more considered climate communications, and more systemic responses like conservation farming practices are being implemented.

Similarly, insurance companies, unable to underwrite all their risk in this changing environment, have sought new ways of working with both the government and farmers. Consultancies have also emerged advising farmers not only on how much fertiliser to apply to maximise yields but on how whole farming enterprises might better align to the surrounding environment on which they depend.

Anton Cartwright of PMCR South Africa recalls that only those farmers who had adopted the conservation agriculture approach prior to the historic drought were able to survive. “As an approach,” says Cartwright, “conservation agriculture can be seen as a defensive action, but it’s potentially transformational if taken to scale.”

### ***Powering up public-private partnership in the Philippines***

Public and private stakeholders in the Philippines, brought together by the Oscar M. Lopez Centre, are exploring opportunities, pathways and business models to promote private-sector participation and contribution in building the climate resilience of the rice sector through irrigation initiatives.

### ***Business stepping up in Nicaragua***

After a period of suffering shortages of quality cocoa due to climate variability, Ingemann, a Nicaragua-based exporter of high-quality cocoa and honey, decided to invest in agro-climate information to empower their small-scale farmer suppliers. Ingemann subsequently developed a tool that correlates environmental conditions, including climate data and soil conditions, with productivity, yield and crop simulation, among others. This tool can be applied to other agricultural products, beyond cocoa and honey.

## **Finding the way forward**

Global climate change is now shifting the probabilities and magnitudes associated with episodic and chronic weather in ways that make looking backward no longer as reliable a guide for planning forward. Environmental conditions not directly related to weather, such as saline intrusion, sea-level rise and ocean chemistry are also changing. While climate models, data and analytics are not crystal balls, they are continually advancing and can inform iterative decision-making through the ‘fog of climate uncertainty’ to the extent that it is possible to foresee increased demand for a wide range of current resilience solutions in some areas as well as the need for entirely new solutions in others. Today’s prevailing conditions can indeed be characterised as a ‘climate of opportunity’.



*Claudia Munera, South Africa*

**“The intuitive appeal of resilience thinking lies in the ability to look beyond a single goal such as profit maximisation, and to address entire systems.”** **Anton Cartwright, PMCR South Africa**



### ***New industries in the advisory space emerging***

As stated earlier, while climate change is global, its risks and impacts are local and specific to sector, geography and a host of socio-economic variables. This complexity presents scope for a wide range of existing, modified and new products, services and approaches.

For example, as climate variability increases, farmers in the PMCR countries increasingly find value-add in the power of contextualised precision. Whether in studying the health of individual plants, adapting planting schedules or using surveillance intelligence to determine the exact temperature or amount of water or fertiliser to use in given conditions. Linked to this is the power of information, where data collection and dissemination can inform agricultural practices and even drive credit access and build resilience incentives. Emerging to fill the growing demand gap in both these areas are various types of industries in the advisory space.



#### **Something to consider:**

Most private climate innovation occurs in the market, the size of which is unknown, but may be larger than the total sum of global public adaptation and resilience programs and finance.

### ***Who will succeed in these new convening roles?***

Advisors on resilient farming techniques, as well as consultants gathering data related to market intelligence, weather surveillance and building capacity in the field, or new certification bodies and financing partners are some examples. And many have already been providing services at the local, national and regional level for some time. Sector-level associations are also well-positioned to play a key role in scaling good practices to achieve sector-level transformation – and many identified by the project have been active for decades. However, it is still not clear who will succeed in these new convening roles and how they will build sustainable business cases. Manufacturers and sellers in the various markets and geographies also have a vested interest in staying the course and supporting the supply chains they depend on. Partnerships among different stakeholders have significant potential in increasing the resilience of entire value chains.

### ***Business favours the short-term***

The PMCR project showed that a lack of clear visibility and understanding of the longer-term impacts of climate change tends to discourage decisive action. Business in particular tends to prioritise short-term financial imperatives over longer-term resilience and adaptation measures.

In the transport sectors of all PMCR countries, with the exception of Nicaragua, infrastructure development and management are government controlled and serviced to a large and varying extent by private sector companies. Only in Colombia, environmental impact assessments, which are compulsory for environmental licencing, include disaster and climate risks assessments. In other PMCR countries, climate impacts only in the form of extreme events are being factored into decision-making processes and public bids. Consequently, there are no incentives to introduce much-needed measures into the planning and development of infrastructure projects.

Without clear criteria, factoring resilience could pose a challenge, as resilience can mean different things for different disciplines. Ultimately, business will need to demonstrate economic returns for greater climate resilience – both for defensive investments in their own operations and for making the opportunistic business case to customers.

### ***Calculating the benefits of investments in resilience is still a challenge***

While this market assessment did not focus on finding examples of formal cost-benefit calculations for resilience among private actors, it did identify the need for better clarity in this area. The ability to calculate the benefits of resilience will be vital for companies in making comprehensive risk assessments. However, there are methodology challenges. It is not a straightforward process to reflect resilience costs and benefits, which can be spread across multiple actors, or over time, or manifest as non-monetary environmental benefits. More work is still needed to make the business case to financial stakeholders as well as to users of resilience products and services. Success will be backed by the presence of skilled consultants to help educate markets by promoting and disseminating relevant research material.

### ***Success will also come from system-wide collaboration***

In dealing with the uncertainty of future climate change impacts, governments, local academics, businesses and communities are looking more and more to each other in collaborating on planning and investment decisions. While avoiding loss is the most obvious incentive for investing in resilience, looking at these losses on their own does not factor in the potential total benefits to society.

It is worth noting that adaptation actions also have the power to generate significant additional economic, social, and environmental benefits, as well as mitigation co-benefits, which can accrue over time and are not directly dependent on future climatic conditions.

### ***Resilience building should not be ‘one-off’***

Building resilience will involve the continual incorporating of new data and market intelligence into feedback loops that will inform actions across the sectors. Innovation will drive advances in digital technologies, climate analytics, precision agriculture, and materials science. However, much of this innovation need not depend on ‘hi-tech’ solutions, but on advances in the way production processes incorporate climate resilience into planning.

### ***Public and private sector – markets need both***

At the moment, public financing for climate resilience, where it exists, is setting priorities more at the macro level, focused on positive societal outcomes. Public policy is also largely focused on traditional disaster risk management and reduction, which normally does not factor in climate change. The private sector is generally reacting to various components of these.

Although collectively, the PMCR efforts would appear to have the makings of private markets for climate resilience, on closer scrutiny while these piece-meal efforts are each impressive in their own right, they still only amount to the building of climate resilience in the specific markets analysed by the PMCR study. Understanding the broader long-term benefits of resilience and finding a common language will both be important in finding the way forward.

### ***Markets, if left alone, are unlikely to achieve resilience***

To flourish, sustainable markets need more than just willing buyers and sellers, they also depend on relevant public services, including access to reliable information to promote behavioural change, as well as favourable policies, enabling market conditions, trust and oversight. These markets also need access to capital investment flows to scale up promising technologies and services. Which brings us to the investor community.



*Cartagena de Indias, Colombia, Jose Luis Castiblanco*

### ***Stakeholders need actionable knowledge***

Companies, entrepreneurs and investors need actionable knowledge on climate risks and resilience – as well as strategies for the business and investment opportunities these risks present. While there are already many participants in the private market for climate resilience, few would see themselves as part of such a market. As previously noted, businesses, large and small and across sectors, do not generally use climate terminology to describe their activities. In turn, most public actors do not recognise the contributions represented by private climate resilience solutions.

The difference in the way public and private actors frame one of the greatest challenges of our time demands a serious examination of the status quo. This is all the more important given that public action alone will not be sufficient to address the scale of the climate threat without private innovation, initiative and resources.

### ***For investors, the climate threat is now***

For the global investor community, climate change is no longer a theoretical future risk. Losses are piling up in the real economy, including recent record losses in the insurance and reinsurance industries. While climate variability and weather extremes are not a new investment risk, climate change is shaping existing types of risk with increasing complexity and severity.

### ***The pivot is there is also an opportunity***

In private markets, wherever there is a very large challenge there is potentially a very large opportunity. Investors are now in the midst of recognising the scale of this opportunity. In the climate adaptation space, the PMCR study alone identified manifold target market segments in areas like climate-resistant seeds, irrigation, drone technologies, weather surveillance and climate-resistant infrastructure, which have been able to capitalise on the business benefits of climate resilience. And these are active and ready for scale.

PMCR has also shown that companies taking proactive measures to increase their resilience or to create new products or services, even in the face of uncertainty, can maintain their viability and gain competitive advantage. Importantly, they can also create local capacity that can contribute to the public response to climate change.

### ***Right business models can be richly rewarded***

Businesses able to truly succeed will need to share the characteristics of other successful businesses in that they will know how to use market intelligence strategically; be actively aware of frontlines technology and scientific developments; understand client demands and actively deliver quality



*Fedearroz, Colombia*

products and services at competitive prices. And, if the right enabling conditions prevail, pools of private equity market capital should flow towards them and their prospective investors should be richly rewarded.

### ***MSMEs the biggest contributors***

MSMEs are actually among the most innovative in climate resilience across the countries studied, innovating both in terms of building their own climate resilience, and opportunistically, by selling climate resilient services and products to a range of clients. Among the most innovative enterprises in this space are specialised consultancies offering knowledge and technical services, such as new types of analytics or digital solutions in agriculture or sediment monitoring on ports.

As discussed above, current financial frameworks and markets often deny many smaller companies the credit needed to grow. Most MSMEs in developing or emerging markets rely on internal funding more than their counterparts in developed markets. But because MSMEs are usually the largest employer in these economies, a lack of credit hits jobs and becomes a drag on overall economic growth and social development. This then also impedes innovation in important areas like resilience, which is why it makes sense to direct financing and technical assistance towards innovative MSMEs.

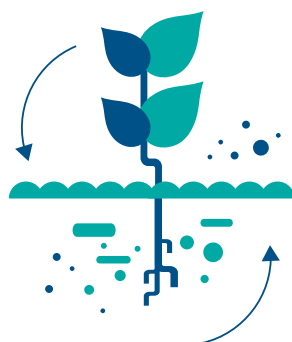
### ***There are no simple resilience solutions***

No single technology, product, information set, or risk management procedure will be able to solve the many challenges ahead. A growing private response in the form of climate-resilient products and services will be required to generate cost-effective packages of solutions. Current and growing demand for climate-resilient products and services is driving a growing market that remains largely misunderstood and for which no data on private resilience is being systematically collected.

In the context of climate change, research and development along with incremental continual improvements to processes and products will help companies adapt to risks and opportunities, as well as develop new solutions to meet shifting and as yet unknown climate risks. The complexity of both climate risks and the private response holds huge potential to generate many kinds of business opportunities for enterprises of all sizes and types, while creating economic and social benefits across all geographies.

### ***Moving to the transformative***

Clearly, radical strategies will be needed if we are to transform key economic systems to be more resilient, and productive in the face of a changing climate. As in climate mitigation, where the world is seeking a system-wide shift away from incremental reductions in oil, gas and coal outputs towards a completely new clean energy mix; in climate resilience, the PMCR study gave a glimpse of a similarly transformational perspective to be argued for. It would mean moving away from the current reactive, short-term actions of rebuilding and repairing after weather events, like adding just a little more irrigation to defend against drought, or raising sea walls just another half-metre to combat sea-level rise, and instead finding a longer-term, collaborative way forward that integrates transformative system-wide strategies quickly and at scale.



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