Diversification for climate resilience

Thirty options for forest and farm producer organisations

Duncan Macqueen

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Forest and Farm Facility

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Acronyms

AF	Agroforestry
BIT	Business incubation team
CA	Conservation agriculture
CbA	Community-based adaptation
CBD	Convention on Biological Diversity
CBNPL	Chaudhary Biosys Nepal Pvt Ltd
CBO	Community-based organisation
CCHPI	Chisapani Community Herbal Processing Industry, Nepal
CCROs	Certificates of Customary Rights of Occupancy
CFUG	Community forest user group
COPRACAO	Confederation of Bolivian Producers and Collectors of Ecological Cacao
CPC	Centre for Producers of Cereals, Togo
CSA	Climate-smart agriculture
CTNGAK	Community Tree Nurseries Growers Association of Kenya
DRC	Democratic Republic of the Congo
DRR	Disaster risk reduction
FAO	Food and Agriculture Organization of the United Nations
FEDECOVERA	Federación de Cooperativas de Las Verapaces Responsabilidad Limitada
FEDPRACAO CBBA	Federation of Agroecological Producers and Collectors of Cocoa in Cochabamba
FFF	Forest and Farm Facility
FFPO	Forest and farm producer organisation
FF-SPAK	Farm Forestry Smallholder Producers Association of Kenya
FLR	Forest landscape restoration
GhaFFaP	Ghana Federation of Forest and Farm Producers
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environmental Facility
GHG	Greenhouse gases
IAS	Integrated agricultural systems
ICT	Information and communications technology
ILA	Integrated landscape approach

INRM	Integrated natural resources management
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
ISET	Institute for Social and Environmental Transition-International
IUCN	International Union for Conservation of Nature
KANBAOCU	Kassena-Nankana Baobab Cooperative Union
KENAFF	Kenya National Farmer's Federation
KFS	Kenya Forest Service
LHWG	Laliguras Herbal Women Group
MA&D	Market analysis and development
MEA	Multilateral Environmental Agreements
NbS	Nature-based solutions
NGO	Non-governmental organisation
NCTNA	Nakuru County Tree Nurseries Association
NEMA	National Environment Management Authority, Kenya
NTFP	Non-timber forest product
OA	Organic agriculture
ODA	Official development assistance
ORGIIS	Organization for Indigenous Initiatives and Sustainability
PFAG	Peasant Farmers Association of Ghana
PFP2	Participatory Plantation Forestry Programme, Tanzania
PNFDDSA	National Platform for Women, Sustainable Development and Food Security, Madagascar
SA	Sustainable agriculture
SCoopS	Simplified Cooperative Society, Togo
SDG	Sustainable Development Goal
SES	Social-ecological systems
SEWA	Self Employed Women's Association
SHARP	Self-evaluation and holistic assessment of climate resilience of farmers and pastoralists
SI	Sustainable intensification
SL	Sustainable livelihoods
TFS	Tanzania Forest Services Agency
TGAs	Tree grower associations
TTGAU	Tanzania Tree Growers Associations Union
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
VNFU	Viet Nam Farmers' Union
VSLA	Village savings and loans association

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Glossary of terms

Adaptation
Adjustments in socio-cultural, ecological, economic or physical and technological systems in response to actual or expected climatic stimuli and their effects or impacts.

Agroecological approach (AA)
The application of integrated ecological, economic and social principles to the transition of smallholder farming systems, towards greater resilience.

Agroforestry (AF)
Different combinations of trees, crops and animals on the landscape over different spatial arrangements or temporal sequences.

Community-based adaptation (CbA)
A bottom-up and strengths-based approach to strengthening community-level adaptive capacity, focused on vulnerable communities.

Conservation agriculture (CA)
Agriculture based on three practices promoted as a means for sustainable agricultural intensification: minimum tillage, mulching with crop residue and crop rotation.

Climate resilience
The ability to anticipate, prepare for, resist, recover and reorganise in the face of hazardous events, trends or disturbances related to climate change.

Climate-smart agriculture (CSA)
A concept that calls for integration of the need for adaptation and the possibility of mitigation in agricultural growth strategies to support food security.

Disaster risk reduction (DRR)
A systematic approach to identifying, assessing and reducing the risks of disaster.

Exposure (to risk)
The measure of potential future loss resulting from a specific activity or event.

Forest landscape restoration (FLR)
A landscape approach that combines adaptive management and multistakeholder governance to unite forest restoration and regeneration with improvements in local livelihoods, well-being and climate-change resilience.

Hazard

A physical process or event (eg physical, hydro-meteorological or oceanographic variables or phenomena) that can harm human health, livelihoods or natural resources.

Integrated agricultural systems (IAS)

Agricultural systems that contain deliberate combinations of three possible components of agriculture – crop, livestock and forests.

Integrated landscape approach (ILA)

A governance strategy that engages multiple stakeholders in attempts to reconcile societal and environmental objectives at the landscape scale to identify trade-offs and potential synergies for more sustainable and equitable land-management landscape approaches.

Integrated natural resource management (INRM)

A conscious process of incorporating multiple aspects of natural resource use into a system of sustainable management to meet explicit production goals of farmers and other uses (eg profitability, risk reduction) as well as goals of the wider community (sustainability).

Mitigation

Efforts to reduce or prevent emission of greenhouse gases (GHGs)

Nature-based solutions (NbS)

Solutions to societal challenges that involve working with nature.

Organic agriculture (OA)

A production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects.

Persistence

The socio-cultural, ecological, economic, physical and technological measures taken to survive a particular hazard or mix of hazards.

Prosperity

A negotiated vision of that which humans value in line with the common good.

Recovery

The measures a group or community can undertake to re-establish individuals back into their original context following a climate hazard in which individual resistance was overwhelmed.

Resilience

Living with true uncertainty and making use of that uncertainty.

Risk
Socially specific consequences of a hazard (eg climate change hazards) including how societal constraints shape those consequences.

Sustainable agriculture (SA)
A whole-systems approach to food, feed and other fibre production that balances environmental soundness, social equity and economic viability among all sectors of the public, including international and intergenerational peoples.

Sustainable intensification (SI)
Approaches to increase crop and livestock yields and associated economic returns per units of time and/or land without negative impacts on soil and water resources or the integrity of associated non-agricultural ecosystems.

Transformation
The socio-cultural, ecological, economic, physical and technological measures taken within a wider system to build back better to reduce vulnerability to future hazards.

Vulnerability
The degree to which a system is susceptible to and unable to cope with hazards associated with climate change, including climate variability and extremes.

Summary

Forest and farm producer organisations (FFPOs) show extraordinary capacity to build resilience in the face of climate change. They act routinely to assess climate and other risks and adopt practical climate-resilience responses to help their members thrive. This report is written primarily for FFPOs and their technical support partners. It aims to build confidence in an approach and options for how FFPOs strengthen climate resilience to the benefit of local forest and farm producers. A secondary target audience is that of donors and government decision-makers who can upscale financial support for strengthening climate resilience to FFPOs based on their effectiveness in that area.

The report results from a partnership that directly funds FFPOs and co-produces knowledge, the Forest and Farm Facility (FFF). From the academic side, a review of recent climate-resilience publications distils a framework with 30 practical climate-resilience options that are widely used. From the technical support side, the report summarises organisation innovations in resilience that have been seen in the work of the FFF to support FFPOs in 10 partner countries. Finally, from the forest-farmer side, analysis of 10 country case studies, previously written by FFPOs and their technical support partners for peer-to-peer learning, enriches our understanding of how these options are being advanced in practice.

The scale of expected impact faced by forest and farm producers from various climate-related risks is truly frightening. Increasing risks are expected in temperature extremes, more variable rainfall patterns, droughts, fires, storms, flooding, pest and disease outbreaks, landslides, rockfalls and avalanches and in some locations salination and sea-level rise. Impacts by 2050 are expected to include an increase of 250,000 climate-related deaths per year from heat and disease exposure, 529,000 additional deaths per year from food shortages and 720 million people pushed into extreme poverty. Building climate resilience requires two interrelated processes of risk assessment followed by adaptive resilience responses. Resilience responses include actions of persistence, adaptation and transformation that can also be thought of as applying at the level of an individual, a group or a system. Responses involve practical actions in four different dimensions of resilience: socio-cultural, ecological, economic, and physical and technological infrastructure.

FFPOs are often among the only organisations able to build resilience in remote forest areas. So, they provide vital agency (numbers, scale, relevance) in climate-resilience action. Such FFPOs themselves are increasingly prioritising climate-resilience action. The world's remaining forest landscapes are inhabited by 500 million indigenous people, and 800 million other forest-dependent people. These people form many different types of groups (here called FFPOs) to pursue prosperity for their members, sometimes around indigenous territories or community forests, in the patchwork of forest and farmlands controlled by smallholders or even in peri-urban forest-product processing centres. For those FFPOs, climate resilience is a matter of survival. They take it seriously. Surveys of FFPO knowledge needs covering 41 FFPOs in six countries show that the top priority for FFPOs was to have increased access to knowledge on how to cope with climate change. Moreover, when looking at resilience principles developed by the Global Resilience Partnerships and the characteristic of FFPOs, there is a close fit. For this reason, programmes to strengthen climate resilience would do well to make FFPOs a central implementing agency.

A climate-resilience framework for FFPOs is presented which aims to help FFPOs think about and act on climate resilience. However, the concept of resilience must always remain rather fluid, open to context-specific and often subjective perceptions of what is or is not resilient. Nevertheless, helpful common elements are distilled from the published work of many programmes and alliances that have studied climate resilience:

- The first involves defining the scope of resilience – how broad its coverage should be (eg from the individual smallholder to the domain of an FFPO or for an entire landscape or country).
- The second common element is that of risk assessment – including predicting likely weather hazards, mapping the exposure of producers to those hazards and assessing their vulnerability.
- A third element is on resilience responses – what they are, and how FFPOs can put in place conditions for those responses.
- Finally, there is the element of monitoring progress – assessing whether an FFPO has become more climate resilient.

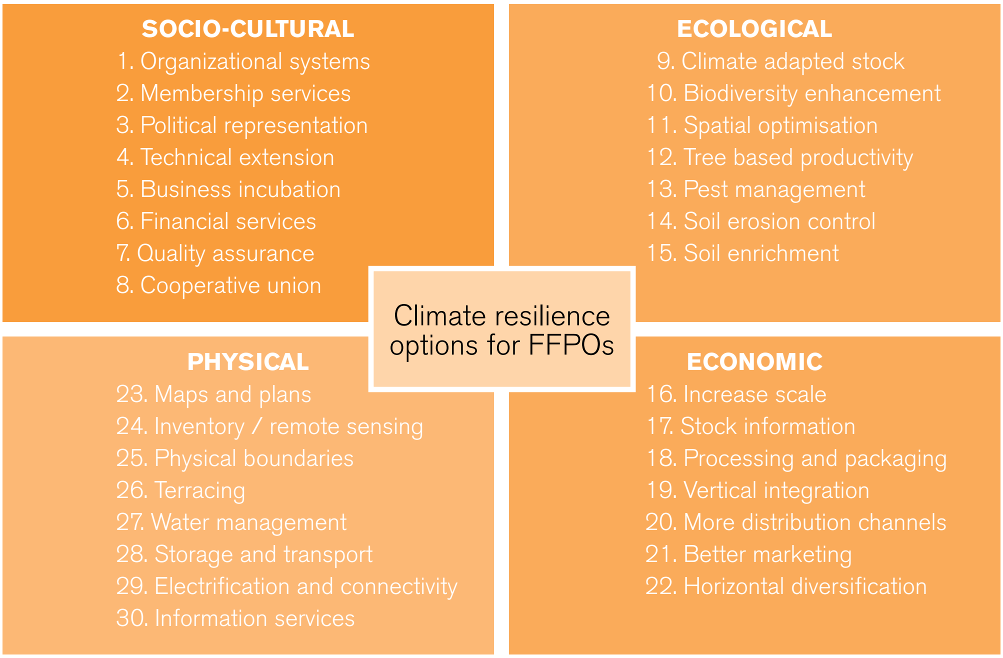
Care must be taken not to ignore the broader political forces that exacerbate vulnerability – and a framework on resilience must therefore include an element of fighting for both climate change mitigation and climate justice. This should also include fighting to overcome gendered climate vulnerabilities through simple measures that include disaggregated gender collection and gender-differentiated resilience responses.

Organisational innovations within and between FFPOs help improve both climate risk assessment and resilience responses. For example, it seems a great advantage to have nested tiers of organisations from local first-tier producer groups linked through district or provincial second-tier associations to regional or national third-tier unions or federations. Such tiers do not imply superiority of knowledge or function in upper levels – but rather useful and different information and function at each level. Tiered structures greatly improve the downward spread of useful risk assessment information (eg on weather) and finance to help develop approaches for risk self-assessment that include, but also go beyond, climate risks to other critical areas of risk. Such structures also improve the horizontal spread of useful information on resilience responses (eg diversifying crop species or varieties) that can benefit from partnerships to 'co-produce' useful knowledge. Finally, such structures improve the potential upward spread of local solutions (farming methods, cultivars and so on) in addition to monitoring that can inform future approaches.

There are a finite number of ways in which FFPOs can diversify their options to face climate change risks. From existing climate-resilience literature, a total of 30 climate-resilience options are presented here. The universe of FFPO options includes subsets of options in socio-cultural, ecological, economic, and physical and technological dimensions. There is some sort of logical flow between these dimensions. For example, improvements in an FFPO's social networks can pave the way to technical inputs that improve its ecological resilience. This in turn can improve the economic prospects or an FFPO's business. And profits from the latter can allow investment in physical or technological infrastructure. But the order is not rigid, and for FFPOs seeking to enhance their climate resilience many things can be put in place at once (see Figure 1):

- 8 options for diversifying their social networks
- 7 options for diversifying their ecological systems,
- 7 options for diversifying their economic systems, and
- 8 options for diversifying their physical or technological infrastructure.

Figure 1. Summary of 30 diversification options for FFPO climate resilience



Analysis of 10 previously published international case studies on FFPO climate resilience shows the rather extraordinary extent to which even very localised FFPOs are found to have been diversifying into many (always more than half) of the 30 climate-resilience options presented in this book. The case studies summarised in Annex 1 were originally written in 2020 prior to this book to allow peer-to-peer learning among FFPOs on climate resilience. The FFPOs in each case study had been supported by FFF to develop their own climate-resilience responses to specific climate risks in 10 countries: Bolivia, Ecuador, Ghana, Kenya, Madagascar, Nepal, Tanzania, Togo, Vietnam and Zambia. Through this new analysis of those case studies, it is readily possible to illustrate each of the 30 options presented in this book. FFPOs clearly apply a diverse range of climate-resilience options across multiple domains.

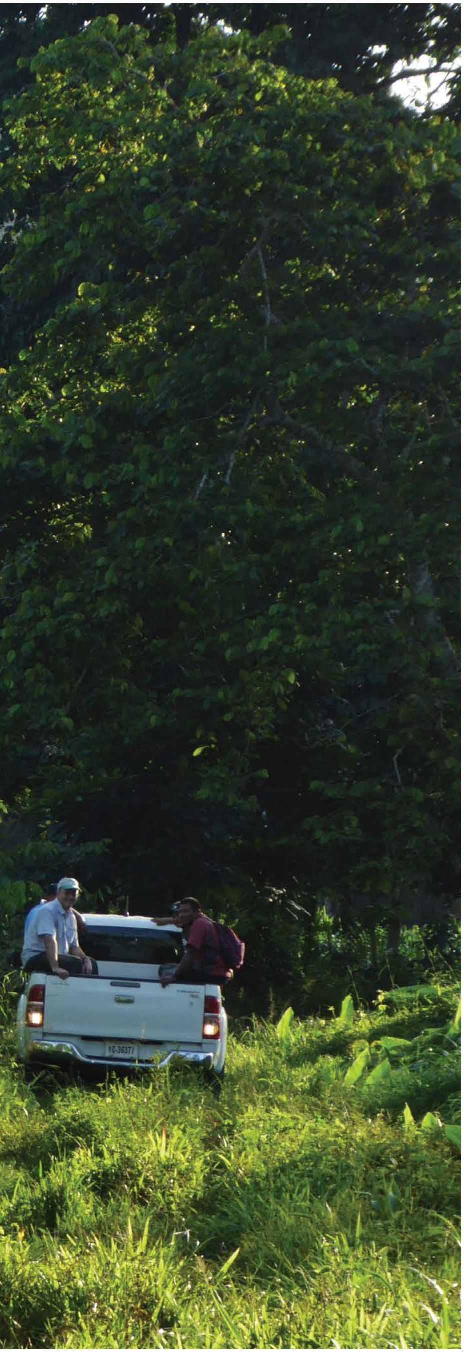
Climate-resilience actions by FFPOs often have positive co-benefits for poverty reduction, biodiversity conservation, forest landscape restoration and climate change mitigation. One whole dimension of resilience relates to economic issues that play directly into poverty reduction. While only one of the 30 climate-resilience options is directly about enhancing biodiversity, several others imply biodiversity enhancement (eg horizontal diversification into new value chains that would often require a different crop). Additionally, many of the options also reverse land degradation and enhance carbon sequestration by increasing on-farm woody vegetation and soil organic matter.

FFPOs represent unique organisational pathways to scale up these efforts to build resilience, reduce poverty, conserve biodiversity, restore forest landscapes and mitigate climate change. Mutual benefits for FFPOs, technical support partners, donors and government decision-makers could emerge from greater efforts to:

- Better document the beneficial impacts of FFPO climate-resilience action
- Strengthen the multiple levels of organisation that will allow their climate-resilience knowledge and practice to spread
- Build capacity for risk assessment and resilience responses within FFPOs
- Improve FFPO representation in funding processes related to the Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD) – such as the Global Environmental Facility (GEF) and Green Climate Fund (GCF), and
- Channel more climate finance through FFPOs from mainstream climate programmes.

Indicators must be sharpened on how much climate finance reaches field-level FFPOs. Support could focus on mainstreaming FFPO risk assessment methods and broadening understanding and uptake of the 30 climate-resilience options, not least through peer-to-peer exchanges. COVID-19 has introduced additional stresses to those of climate change which have also required resilience on the part of FFPOs. As agencies grapple with how to build back better from COVID-19, investing in the resilience of FFPOs seems to offer beneficial outcomes at the same time.

A diverse Mayan agroforestry system in Southern Belize © Duncan Macqueen



1 Climate resilience – why it matters and what it is

Forest and farm producer organisations (FFPOs) represent those at the front line of climate impacts. This report is written for FFPOs and their technical support partners. It describes and shares an approach, options and examples of how FFPOs can strengthen climate resilience to the benefit of local forest and farm producers. This chapter introduces the nature of the climate change problem and discusses what climate resilience is and why it matters. It outlines why it is necessary to improve both preparedness (risk assessment) and climate-resilience responses.

1.1 The problem of human-induced climate change

Human-induced climate change is a recent phenomenon observed by the World Meteorological Organization (WMO 1979). Scientists have increasingly agreed on the reality and threat it poses. Evidence of what is changing is currently gathered by the Intergovernmental Panel on Climate Change (see IPCC 2001). Concentrations of atmospheric CO_2 now exceed anything in the last 800,000 years (IPCC 2018). As a result, many elements that make up our climate, such as annual and seasonal rainfall, temperature and moisture stress are moving rapidly outside the known historical range of variability (USGCRP 2017).

Likely impacts of these changes on human health are bleak. For example, globally it is estimated that an additional 250,000 people will die annually between 2030 and 2050 due to climate-related heat exposure in elderly people, as well as increases in death due to diarrheal disease, malaria, dengue, coastal flooding and childhood stunting (Haines and Kristie 2019). Additionally, a net increase is projected of 529,000 adult deaths annually from expected reductions in available food (particularly fruit and vegetables) by 2050 (Springmann *et al.* 2016). Agriculture yields may reduce by up to 30% by 2050 affecting smallholder farmers the most (Porter *et al*. 2014). Food prices are also expected to increase by 20% for billions of low-income people (Nelson *et al.* 2014). There is also new evidence that climate risks are linked to increasing armed conflict, with a positive relationship between conflict and temperature across sub-Saharan Africa since 1960 that translates to projections anticipating a 54% increase in armed conflict (equivalent to 393,000 deaths) by 2030, in the absence of climate change mitigation.

An extra 100 million people are at risk of being pushed into extreme poverty by a range of climate risks by 2030 and 720 million by 2050 (Hallegatte *et al.* 2015). There are a range of external risks that are increasingly imposed by climate change (see Table 1). These have a range of direct impacts listed below. Some of these have been the subject of quantitative estimates. For example, sea-level rise is expected to force hundreds of millions of people in coastal cities from their homes, with a total cost to coastal urban areas of more than US$1 trillion each year by 2050 (Hallegatte *et al.* 2013). But it should be noted that there are also wider indirect impacts that often include loss of ecological functionality and production, market disruption and increasing recovery costs (and future insurance where applicable), and social tensions or conflict that often go unquantified.

Table 1. External risks imposed by climate change

External risk	Direct impact on forest and farm production systems
Temperature extremes	Increased mortality, morbidity, injury and illness
Variable rainfall patterns	Increased crop failure and reduction in crop yields
Droughts	Crop and livestock failures and increased mortality
Fires	Physical damage to humans, crops, livestock and property
Storms	Damage to crops and infrastructure
Flooding	Crop failure, increased mortality, destruction of property
Pest and disease outbreaks	Crop, livestock and human damage, illness and mortality
Landslide, rockfalls and avalanches	Localised destruction of crops and infrastructure
Sea-level rise	Coastal flooding affecting cropping land and property
Ocean acidification	Reduced stocks of shellfish and fish

1.2 Definitions of resilience

Within this worrying climate context, resilience is a term growing in popularity. From ages past, resilience was originally used to mean 'the ability to bounce back or return quickly, to a previous condition' (Bahadur *et al.* 2010). The word 'resilience' overlaps with other terms such as vulnerability, adaptability, stability, robustness and strength (for more detail see Urruty *et al.* 2016; Bankoff 2019). Research into what makes up resilience has exploded in recent years in part because the idea of resilience is found in so many different disciplines (Baggio *et al.* 2015).

Resilience is often viewed as an attractive word because it sounds positive in comparison with other terms such as vulnerability or disaster risk reduction (DRR) (Schipper and Langston 2015). There are also critiques, however, that focus on marginalised communities having to grow more resilient due to power and wealth differentials in society – a sort of enforced resilience (see MacKinnon and Derickson 2012). With that important political point in mind, resilience thinking has developed a rich meaning to do with 'how to live with true uncertainty and make use of it' including shaping the political context (see the overview of resilience science in Folke 2016). It has also begun to overlap more closely with 'sustainable development' to deliver things like food security – because development work increasingly needs to be resilient to be worth doing at all (Béné *et al.* 2016a).

It is important to distinguish between **general resilience** – 'the capacity of social-ecological systems to adapt or transform in response to unfamiliar or unknown shocks' and **specific resilience** – 'the resilience of a particular aspect of a social-ecological system to a particular kind of disturbance' (Carpenter *et al.* 2012). These authors note that the wide-ranging nature of general resilience makes it difficult to define specific steps for creating it – with it being best to put in place general enabling conditions for it as described here in Chapter 3, Table 3. More specific resilience, for example to particular climate risks, can be handled more exactly through a set of specific resilience options (eg the 30 options presented in this report).

Climate resilience is the ability to anticipate, prepare for, resist, recover and reorganise in the face of hazardous events, trends or disturbances related to climate change. It is not enough to live with the uncertainty of climate change and adjust to it: in other words, through adaptation. We also must ensure that climate resilience contributes to stopping the change and restoring forests and soils: through mitigation. Failure both to adapt and mitigate will mean that true resilience will slip away – with catastrophic consequences for our global economy, ecology and society (see Dasgupta 2021).

The IPCC now acknowledges that resilience is not only about adaptation and mitigation, but also transformation: 'The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation' (IPCC 2014a).

The social complexity of transformation processes is often underestimated in favour of technical solutions – but real resilience must engage not only technical options, but also the personal and political transformations that make them practicable. While there is no monolithic humanity responsible for climate change, there are largescale political and economic forces that exacerbate vulnerabilities to climate change, including gender-specific inequalities. Power and politics often lie behind local climate vulnerabilities and work against logical resilience actions (Crona and Hubacek 2010). These forces must be resisted by more than improved weather forecasting or farm-level adjustments to crop varieties. There are political dimensions to resilience that require consideration of the causes of vulnerability and that go further to fight for climate justice (Mikulewicz 2019) including gender-differentiated actions (Le Masson *et al.* 2016). These political dimensions provide a powerful justification for the importance of collective action mobilised through FFPOs.

In addition to such political dimensions, however, there are pressing immediate concerns of survival at the local level of farm and forest. Integrated thinking that incorporates trees on farm to improve resilience of farming systems is vital – because these options also help mitigate climate change. Why are on-farm tree planting and forest restoration important strategies for climate resilience that includes mitigation? The answer is simple.

Trees can take carbon out of the atmosphere in a uniquely low-cost and large-scale way – while also moderating local climate variables such as reflected heat (the albedo effect), evapotranspiration and organic volatiles emissions that are critical to local rainfall and heat (Huang *et al.* 2020).

1.3 The nature of resilience – three main elements

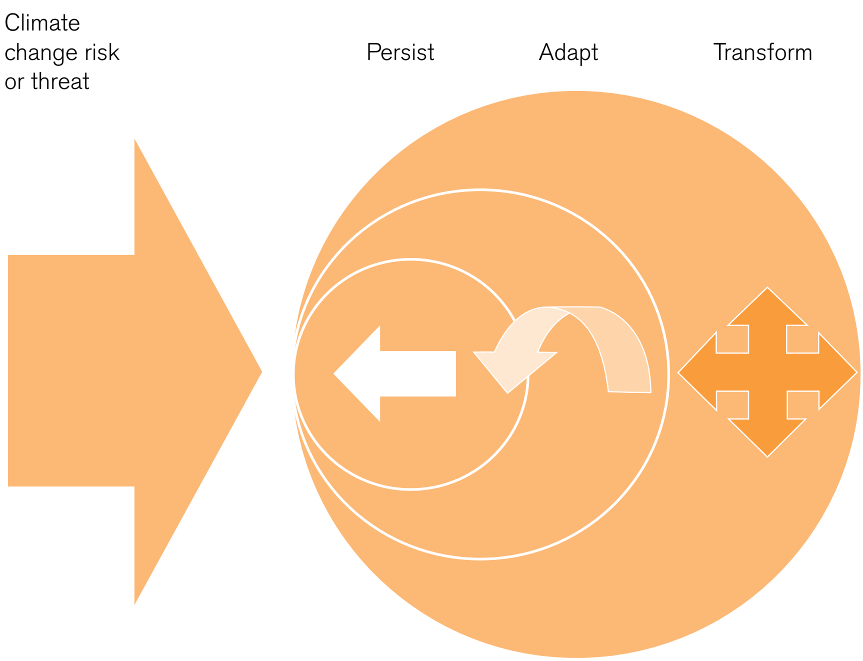
It is easy to get bogged down in a rather academic discussion around definitions of resilience or related words. But, having defined climate resilience, the real priority is to make it actionable and operational: to build resilience into forest and farm landscapes (and the broader political context). As the FFF has tried to strengthen FFPOs, it has sought to capture how people have been thinking of climate resilience so far and promote useful ways forward (Mayers 2019). The reasons are as follows. Implementing effective disaster-risk actions would result in a 90% decrease in people needing international humanitarian assistance by 2050 following climate-related disasters (IFRC 2019). Furthermore, 30% of greenhouse gases (GHGs) can be avoided by making food and agriculture systems more sustainable and resilient, including reducing food loss and waste (IPCC 2019). And there are potential financial win-wins too, since investing US$1.8 trillion in adaptation and resilience from 2020 to 2030 has been estimated to generate a potential US$7.1 trillion in total global net benefits (GCA 2019).

Climate resilience involves three main elements (Nelson *et al.* 2007). Figure 2 depicts these three elements of climate resilience as laid out by the Global Resilience Partnership (Wilson *et al.* 2019) – the capacity for an individual, community or system to:

- **Persist** (sometimes called 'resist') – this involves the measures an individual producer can take in their farm and forest to survive a particular climate hazard or mix of hazards. For example, increasing ecological diversity to maintain some production in the face of more-variable rainfall (Isabell *et al.* 2015), putting in irrigation channels to cope with longer dry seasons and so on. However, at some point climate change can overwhelm even the best individual responses (eg Orr *et al.* 2015).
- **Adapt** (sometimes the term 'recover' is used in the more limited sense of bouncing back) – this involves the measures a group or community can undertake to reestablish individuals back into their original context following a climate hazard in which individual resistance was overwhelmed. For example, recovery after a hurricane (Smith *et al.* 2018). Often this also involves necessary adjustments in practice – hence the use of the term 'adapt' which does not necessarily imply getting back to 'normal'. However, once again it is important to recognise that attempts to get 'back to normal' may eventually be overwhelmed in the face of repeated stresses (Hills 1998).

- **Transform** (sometimes called 'reorganise') – this involves the governance measures taken within the wider human system to build back better to reduce vulnerability to future hazards. For example, insisting on new building standards to cope with future storms. However, while reorganisation following climate-related disruption can be an opportunity to reduce risk for the more vulnerable, it can also be a moment at which the more powerful protect themselves at the expense of more vulnerable groups (Kammerbauer and Wamsler 2017).

Figure 2. Three main elements of climate resilience (individual, community and system levels)



Forest and farm landscapes are social-ecological systems (SES). This means that socio-cultural, ecological, economic, and physical and technological processes are inseparable and co-evolve over time. These inseparable connections need to be acknowledged in the pursuit to enhance human well-being and prosperity for all. Development interventions that prioritise economic development (or only ecological development), with little consideration of interdependencies, will ultimately undermine climate resilience and thwart efforts to deliver sustainable development outcomes.

1.4 Four main dimensions of resilience

How to build forest and farm systems which persist, adapt and transform is the challenge. There are many things to consider as part of that challenge which, for FFPOs, can usefully be grouped into four main dimensions of resilience (see Figure 3), including:

- **Socio-cultural resilience** (the resilience of social organisations, networks and cultural communities connecting individuals in forest and farm landscapes)
- **Ecological resilience** (the resilience of agroforestry systems in forest and farm landscapes)
- **Economic resilience** (the resilience of businesses based on agroforestry systems in those landscapes), and
- **Physical/technological resilience** (the resilience of physical and technological infrastructure underpinning those businesses and social networks in those landscapes).

1.4.1 Socio-cultural resilience

Socio-cultural sources of resilience are to do with people's social capabilities organisations, networks and cultural communities that help with persistence, adaptation and transformation – including their political capacity to change the enabling environment (Keck and Sakdapolrak 2013). It has its origins in psychologists looking at the capacity of human individuals to cope with and recover from trauma (Murphy 1974). Over time, this individualistic focus has broadened into the study of how generic hazards and the dangers these effect in socially specific risks affect the ability of groups or societies at large to cope (Adger 2000). Ideas about community resilience then started to take shape (Amundsem 2012, Berkes and Ross 2013). The gender dynamics within communities and their organisations also emerged as an important element of socio-cultural resilience (Smyth and Sweetman 2015). A group's self-organisation is seen as a key concept to enable people to persist, adapt and transform (Ostrom 2009). This requires attention to social networks connecting individuals and the organisations to which they belong (Smith *et al.* 2012). Indeed, at least six factors are known to affect socio-cultural resilience including (adapted from (Cinner and Barnes 2019):

1. The assets (natural, physical, human, financial) that people can draw upon
2. The flexibility to change strategies
3. The ability for social organisation to enable (or inhibit) cooperation, collective action and knowledge sharing
4. Learning to recognise and respond to change
5. Behavioural and cognitive factors (eg risk attitudes, personal experience, social norms) that enable or constrain resilience, and
6. The agency to determine whether to change or not.

Communities with 'higher social capital' or strong pre-existing ideas and organisations of trust and reciprocity are felt to be more likely to prepare for and recover more effectively from stresses. But even without such social capital, human groups can respond spontaneously and dynamically to disasters (Ntontis *et al*. 2019). Organisations such as FFPOs often enable collective groups to provide social and cultural protection services to their members (Bolin and Macqueen 2019). This can complement the broader national provision of social protection services that play a vital role in resilience (Ulrichs *et al.* 2019). It can be useful to think of socio-cultural resilience at three levels: individual (ie producer), group (ie institutions such as FFPOs) and system-wide (ie socio-political systems).

1.4.2 Ecological resilience

Ecological resilience is to do with natural persistence, adaptation and transformation. Knowledge is based on a mix of indigenous and academic study of what makes forest and farm ecosystems stable and how they respond to disturbance (Lewontin 1969; Holling 1973). Useful reviews have laid out 10 guiding principles for the integration of production and conservation in ways that maintain ecological resilience (Fischer *et al.* 2006):

1. Maintain and create large, structurally complex patches of native vegetation
2. Maintain structural complexity throughout the landscape
3. Create buffers around sensitive areas
4. Maintain or create corridors or stepping stones between patches of native vegetation
5. Maintain landscape heterogeneity and environmental gradients
6. Maintain key species interactions and functional diversity
7. Apply appropriate disturbance regimes
8. Control aggressive, over-abundant and invasive species
9. Minimise threatening ecosystem-specific processes
10. Maintain species of particular concern.

The ecological systems that form the bedrock of forests and farms are increasingly being overwhelmed. This seems to happen in sudden cascading collapses as the loss or failure of one element leads to knock-on failures in other elements of the system (Rocha *et al.* 2018). This has led to the understanding that ecological resilience is made up of resistance/persistence (the capacity of a crop individual, either plant or animal, to survive), recovery/adaptation (the capacity of a natural plant or animal community to replace any individuals lost) and reorganisation/transformation (system-wide changes in composition that affect future capacity to withstand the same disturbance) (see Falk *et al.* 2019). Once again, it can be useful to use these three levels more generally – talking in terms of the individual (ie an individual animal or crop plant), group (ie populations of plants or animals) and system-wide change (ie whole ecosystem).

1.4.3 Economic resilience

Economic resilience is to do with business persistence, adaptation and transformation. It has its origins in the world of business strategy both for the individual, the firm and the market system. Business strategies aim to manage risks to cope with disruptions in their everyday business activities (Fiksel *et al.* 2015). Practical frameworks of risk management for FFPOs consider climate-related risks alongside many other categories of risk (Bolin and Macqueen 2016). Business decisions and patterns of behaviour have the capacity either to lock in vulnerabilities to climate change (eg over-dependence on crops that are vulnerable to climate change) or to improve resilience in the face of climate change (Trabacchi and Stadelmann 2013). Group businesses of FFPOs that aggregate baskets of products for their members are particularly important for the economic resilience of their members (Hou-Jones and Macqueen 2019). And in such contexts, economic resilience can also usefully be thought of to involve at least three different levels: individual (ie product), group (ie group business portfolio) and system-wide (ie market system).

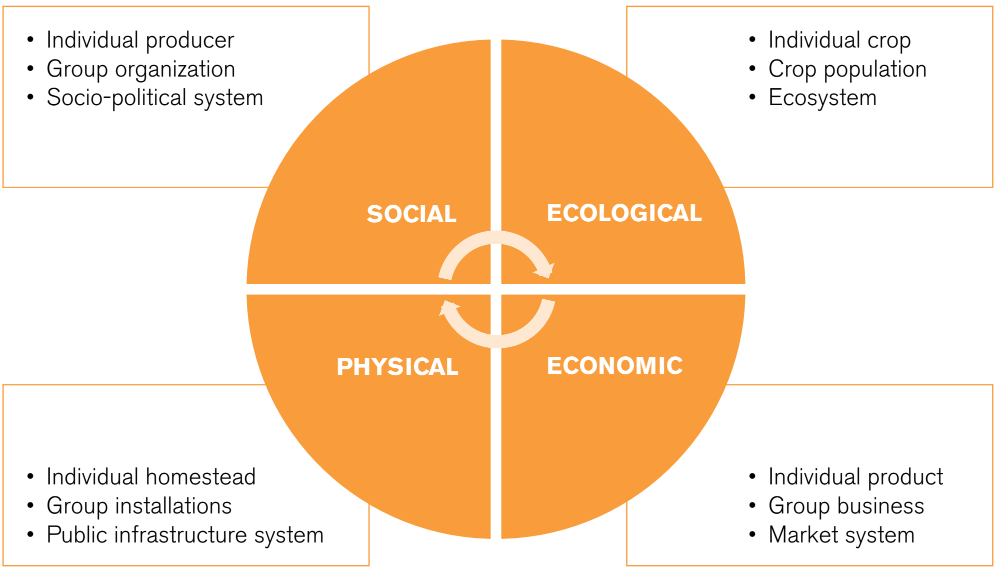
1.4.4 Physical and technological resilience

Physical and technological resilience has to do with the physical or technological capacity for persistence, adaptation and transformation. It has its origins in the study of materials and how resistant they are to physical shocks (eg Winson 1932). But as resilience studies have advanced, the physical dimension of resilience has increasingly been thought of in terms of physical and technological infrastructure (ie buildings, roads, services that include water, electricity, and information and communications technology or ICT). And there has been an evolution here too from approaches that try to build resilience through engineering resilience: from increasing the strength of engineering to withstand the impacts of climate change (ie stronger bridges) towards approaches that try to develop infrastructure that is locally diverse and variable (ie diverse local transport options or diverse communication options that can adapt and adjust in if one element fails) (see Hayes *et al.* 2019).

Often, globalisation sees physical infrastructure projects outsourced and privatised (see O'Brien and Leichenko 2000). This can lead to unequal provision because some people can pay while others cannot (Meerow 2017). In rural forest and farm settings, this may still be the case even when physical infrastructure development is often more modest and 'off-grid' compared with urban settings. As before, it may be useful to think of the physical or technological resilience in three levels: individual (ie homesteads), group (ie collective installations) and system-wide (ie public infrastructure).

To recap quickly, we have presented here four different dimensions of resilience. Each of these dimensions has within it three levels of the individual, the group and the system as a whole. And there will be options within each dimension for individuals, groups and system-wide structures to persist, adapt and transform. What those options are in practice is the focus of this report.

Figure 3. Four main dimensions of resilience and the levels at which they operate



1.5 Some important points of emphasis

1.5.1 Connectivity

The inseparable connections between these dimensions are the first crucial point of emphasis (Folke *et al.* 2010). In other words, what happens in one dimension affects what happens in another. If the ecological dimension fails (for example, if a farm is abandoned due to a drought or fire), then the economic dimension (ie the business) might also fail. This might then cause the socio-cultural dimension to fail (ie the various networks of suppliers, financiers, advisors etc) which will also affect the physical dimension (eg the mobile banking system etc). The dimensions are not independent of one another.

Connectivity can be shown pictorially. For example, the climate-resilience framework prepared for the northern Canadian prairies by the Government of Saskatchewan (2018) shows connectivity as the overlapping petals of a flower. Here, the flower's centre is 'climate resilience'. And it is made up of the overlaps in intersecting petals of physical infrastructure (ie physical), natural systems (ie ecological), economic sustainability (ie economic), community preparedness (ie socio-cultural), plus also human well-being. In resilience thinking, social and ecological dimensions have long been seen as integrated (Adger 2000) and separation between them viewed as artificial or arbitrary (Folke 2006).

Many guides to resilience talk in terms of social-ecological systems (SES) to describe the various dimensions of resilience. Indeed, SES is often used to describe all the dimensions, not just social and ecological but also economic, physical, political, cultural etc. (see Resilience Alliance 2010). Again, while people use different terms, the principal of connectivity holds true.

1.5.2 Arbitrary numbers of dimensions

Another important point of emphasis is that the number of dimensions of resilience is a bit arbitrary. For example, Figure 3 shows four dimensions of climate resilience for FFPOs (ie socio-cultural, ecological, economic, and physical and technological). This is not the only way things could be described – but it does encourage FFPOs to look broadly at all the things that might cause forest farms to fail. In the earlier example, the Government of Saskatchewan lists five dimensions. Other authors list many options for dimensions of development or prosperity within which resilience could be measured (see Nussbaum and Sen 1993, Alkire 2002, Mayunga 2007 Macqueen *et al.* 2020). Research and practice have made major progress in synthesising across disciplines, domains and systems to identify lists of resilience-enhancing elements or principles. Biggs *et al.* (2012a) is perhaps the most systematic attempt to identify some generic resilience principles (and see Table 2):

1. Embrace the complexity of managing diversity and redundancy
2. Recognise constant change in complex adaptive systems
3. Enable inclusive decision-making and broaden participation
4. Enhance system integrity and manage connectivity
5. Promote flexible experimentation and learning, and
6. Promote various centres of governance to leverage innovation.

1.5.3 Dimensions of resilience have adaptive cycles

A third important observation is that the different dimensions of resilience are not static but adaptive. Each dimension has an adaptive cycle that is linked to changes in the other dimensions (a phenomenon sometimes called 'panarchy' – see Gunderson and Holling 2002). For example, socio-cultural systems may be destroyed by a drought, but people then resettle, repopulate and re-establish institutional systems. Similarly, ecosystems may be destroyed by a flood, but then seeds germinate, vegetation grows back and ultimately the system matures towards its final 'climax' ecosystem (be that a natural or agricultural system). And economic systems like a rural market may be wiped out by a fire, but then traders move back in, service providers re-open and the market system is e-established. Finally, physical infrastructure may be destroyed by a hurricane, but individuals soon clear away the debris, then restore roads and water-pipes, and finally re-install grid electricity and other services. The stages in these various adaptive cycles may differ or be brought to the same point by some natural disaster. The resilience of the whole is affected by the resilience of the component systems and their position on their adaptive cycles. To build resilience, you must understand how these systems interact. And, as a result, it is not at all straightforward to establish thresholds at which a particular set of systems might be considered 'resilient'.

1.5.4 Gender must be considered

A fourth important observation is that there are gender-specific elements of resilience (Smyth and Sweetman 2015). Hazards and climate change risks affect gender groups in different ways as widespread patriarchal social norms often disproportionately restrict women and girls' equal access to rights and resources (Le Masson *et al.* 2016). These inequalities exacerbate women's vulnerabilities and culminate in a gendered experience of climate stress – highlighting the importance of a more transformational, gendered and power-sensitive frame for dealing with resilience (Jordan 2019). Putting gender empowerment at the heart of resilience can build towards positive outcomes. For example, in Latin America greater resilience was found in female-headed households where great diversification of income streams more than compensated for the usually lower education levels of women (Andersen *et al.* 2017). But carefully tailored strategies are needed – for example in livestock projects, where a strategy can be taken that focuses disproportionately on smaller local livestock breeds which are both better adapted to climate change and more often cared for by women nearer the household (Chanamuto and Hall 2015). Evidence shows how gender transformative strategies can increase resilience responses – although requiring intentional installation in many cases (Aipira *et al.* 2017).

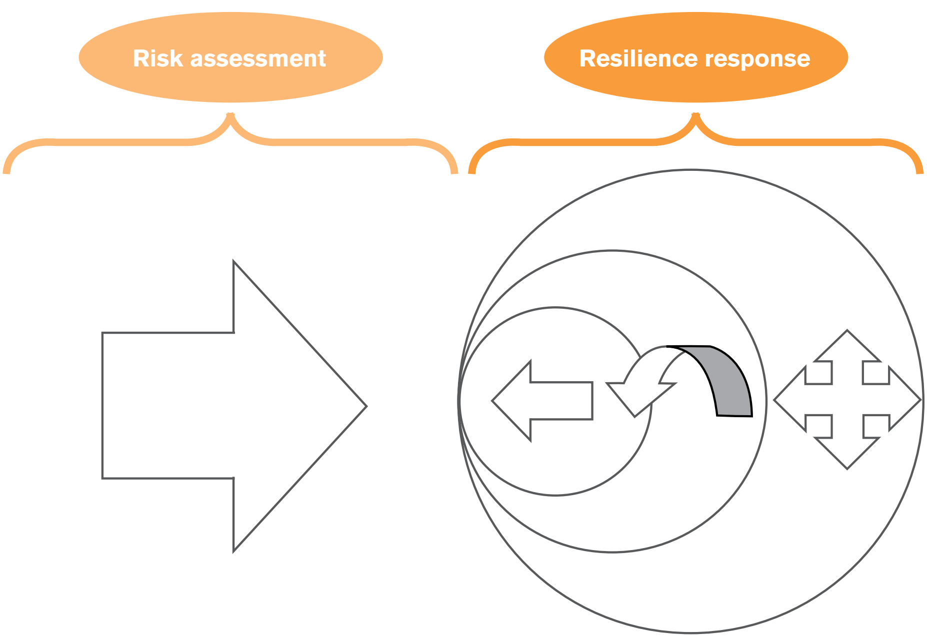
In summary, resilience is neither an easy nor an exact science – either in how many dimensions of resilience there are or in how those dimensions affect one another. While other frameworks exist, this one is broad enough to help FFPOs and their technical support partners prepare for, and respond to, the different sorts of stress that climate change will bring. Those wishing to explore further how to merge different approaches to resilience into an operational framework could look at Quinlan *et al*. (2015).

1.6 Climate-resilience actions: better preparation and responses

Many frameworks on resilience usefully distinguish between preparation and response. More precisely, they distinguish between predicting and preparing for likely risks (eg weather systems that can anticipate storms or floods) and putting in place measures to respond (eg once the storm has struck). These cycles of preparation and response are seen most clearly in the urban resilience framework produced by the Institute for

Social and Environmental Transition-International (ISET 2013). In that ISET framework, a preparatory set of activities assesses urban risk at three levels: the agent (individual), the institution (group) and systems (system wide). Note the striking parallels with how other authors have used these same three levels to describe ecological, economic and socio-cultural dimensions of resilience. The ISET framework then shows a second set of activities that builds resilience to climate change in urban areas at each level (eg agent, institution and system) through simple steps such as identifying possible actions, prioritising, designing, implementing and monitoring. Whatever the precise way of describing this (and different resilience frameworks vary) it does seem useful to distinguish between **risk assessment** activities and subsequent **resilience response** activities as shown in Figure 4 (including in remote disadvantaged communities – see Maru *et al.* 2014). The following sections introduce each.

Figure 4. The link between risk assessment and the three elements of resilience responses



1.6.1 Risk assessment

Risk assessment is a process by which the likelihood and severity of risks are better understood, such that preparations can be made. Forewarned is forearmed. A key point to make here is that FFPOs face many context specific risks. Climate risks, however important, may have a lower priority than other operational risks. If technical support partners force an overly limited focus on climate risk, this might prevent identification of key actions that build resilience. It is strongly recommended that risk assessment uses broad methodologies within which climate risk forms one of several areas of risk assessment (see Bolin *et al.* 2016 for a comprehensive risk assessment toolkit for FFPOs).

With that warning in mind, there is still a need for FFPOs to improve the assessment of climate risks within such a broad framework. In a synthesis of insights from 22 resilience projects across 16 countries, the use of information and technology specifically to provide early warning predictions of climate hazards was found to be an important dimension of resilience (Wilson *et al.* 2019). Perhaps the most useful framing of risk separates it out into three separate components of that risk assessment: hazards, exposure and vulnerability (Miola *et al.* 2015).

- **Hazards** can be defined as climate risks such as temperature extremes (see Table 1) that have an impact on human systems (Hallegatte 2014) where human systems are understood to include socio-cultural, ecological, economic, and physical and technological dimensions as described earlier.
- **Exposure** can be defined as the numerical and spatial extent to which climate risks impact human systems – ie the number of people (individuals, groups and social systems) and the size of the area that could be adversely affected (see IPCC 2014b).
- **Vulnerability** can be defined as the predisposition of those human systems to be adversely affected – with for example women often having fewer options than men due to the way property and land-use rules work (for a thorough review see Adger 2006).

The terms 'vulnerability' and 'resilience' have long been used in disaster literature (eg Carr 1932) and the history of the use of these terms has much to offer (Kelman *et al.* 2016). They are two related yet different approaches in understanding change in a system (Miller *et al.* 2010). Both are difficult to measure because they depend on so many variables. The status of many variables has been used as indicators of vulnerability or resilience – a fact we consider further in Section 3.4. In other words, what makes individuals, groups and systems vulnerable varies a lot with context. For example, in remote disadvantaged communities (typical of forest and farm producers) the provision of welfare support to ensure short-term resilience can lock people into dependency that undermines longer-term resilience based on strong social capital, diversified economic livelihoods and dispersed and shifting use of the environment (Maru *et al.* 2014). For useful risk assessment, detailed contextual understanding over time is vital.

1.6.2 Resilience responses

It can be helpful to think of resilience responses like activities on a beach as the tide comes in: first, building a sandcastle with defensive walls (to persist), but also abandoning that strategy in favour of a moat around the sandcastle to accommodate the tide (to adapt) and finally looking for another game to play on the beach (to transform). For a time, each may serve. In the event of a tsunami, none will. In the context of forest and farm producers, resilience responses are processes that allow:

- **Persistence** – of producers, crops, product lines and farm homesteads to climate stresses
- **Adaptation** – of communities, crop and livestock populations, businesses and infrastructure to climate stresses
- **Transformation** – of the wider socio-political system, ecosystem, market system or public infrastructure.

Much of the emphasis in the climate-resilience literature is on the first line of defence: persistence – often of an individual. But the recent expansion in social groups to improve recovery and push for broader system change is now well recognised (Pretty *et al.* 2020). And it is here in the work of FFPOs that there has emerged a profusion of options to help forest and farm producers be resilient to climate change (see Tables 4 to 7 for examples). Some of these resilience response options focus primarily on more resilient ways of marshalling ecological resistance. But many different terms are used: agroecological approaches, agroforestry (AF), conservation agriculture (CA), climate-smart agriculture (CSA), community-based adaptation (CbA), forest landscape restoration (FLR), integrated agricultural systems (IAS), integrated landscape approach (ILA), integrated natural resource management (INRM), nature-based solutions (NbS), organic agriculture (OA), sustainable agriculture (SA) and sustainable intensification (SI). More practical reports analyse possible motivations and areas of action in pursuing resilience to develop simple menus of options for forest and farm producers (Mayers 2019).

More important for resilience than understanding such new terminology is understanding the underlying practical resilience response options (Tables 4 to 7). Such options are common to all these many terms. Knowledge about such options comes from various sources and for that reason, in Chapter 4 we return to the importance of co-production of knowledge which has rightly been promoted as a key element in resilience thinking (Norström *et al.* 2020). We also return to the subject of reorganisation of the wider systems – through advocacy by FFPOs.

Members of a community producer organization in Togo © Duncan Macqueen

2 Why FFPOs are central to climate resilience

Having introduced climate resilience, this chapter highlights the importance of engaging the power (numbers, scale, relevance) of FFPOs in climate-resilience action, and provides evidence of how FFPOs themselves are increasingly prioritising climate-resilience action.

2.1 The pursuit of prosperity and links to climate resilience

FFPOs and their technical support partners may not understand their own central relevance to climate resilience, and indeed to many others of the Sustainable Development Goals (SDGs). But they certainly have both the membership and landscape reach to drive progress in climate action, for example in SDG 13 on climate action (see Figure 5).

Figure 5. The SDGs for which FFPOs provide agency – and the consequent centrality of their resilience

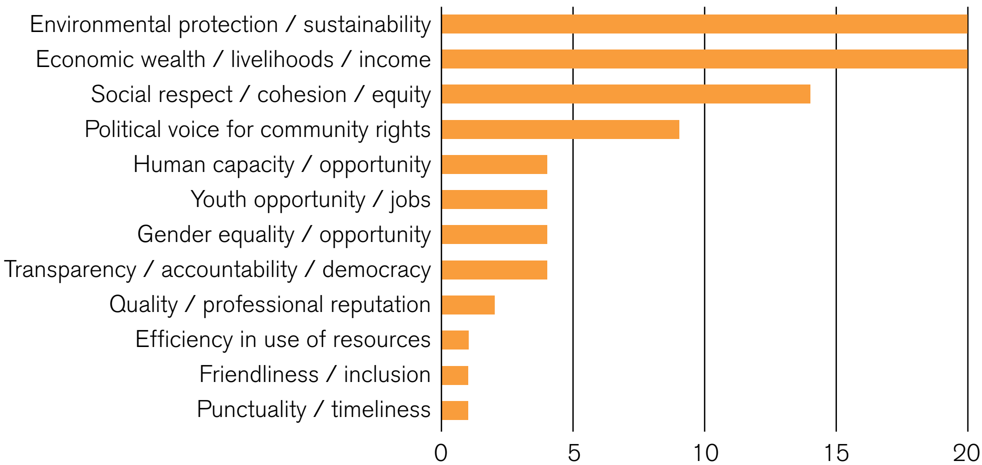
Source: FFF (2021)

Forest landscapes are increasingly affected by climate change. And we noted in Chapter 1 that forests and trees are necessary not only to help adapt to climate change, but also to reduce it: to mitigate climate change. In those landscapes, almost 1.3 billion people live (Chao 2012) who exhibit a range of different forms of forest dependence (Mayers *et al.* 2016). By this we mean human populations that gain some form of direct benefit from forests although the precise nature of such benefits always requires further definition (Newton *et al.* 2016). Most of these forest-dependent people are producers of some sort. Sometimes this 'production' consists of subsistence hunting, gathering and cultivation systems typical of the world's 500 million Indigenous Peoples (Chao 2012). Sometimes it involves more commercial contexts of the 800 million people living out their lives in community forestry settings, smallholder forest and farm mosaics or in peri-urban forest product-processing centres (Macqueen and Mayers 2020). Many of these people belong to some sort of FFPO which are taken to include organisations of private smallholders, communities and Indigenous Peoples. FFPOs form in search of shared information and contacts, shared equipment and costs, and shared power to negotiate with traders and political decision-makers (Macqueen *et al.* 2006).

What smallholders, communities and Indigenous Peoples want and how they pursue their vision of prosperity is likely to be decisive for the resilience of both forests and their own livelihoods. FFPOs are the key actors in defining what happens in multifunctional landscapes (Hart *et al.* 2016). There is good evidence that they innovate in a wide range of ways that bring prosperity to their members (Macqueen *et al.* 2020). Nevertheless, while FFPO impacts are often positive, they are constrained by many factors including the quality of the biophysical resource they control, de facto tenure rights, enabling or disabling policies, user-group characteristics and intervention processes (Hajjar *et al.* 2021). Power is often marshalled against FFPOs in ways that impede their capacity to deliver prosperity for their members. Strengthening cultural ties of trust that underpin FFPO collective action is one preliminary step that can help build resilience in the face of such situations (Venable-Thomas 2021).

In 2019, demand surveys were carried out of the knowledge needs of 41 FFPOs from six FFF countries (Ecuador, Ghana, Kenya, Nepal, Vietnam and Zambia). The surveys were led by the author of this report but funded by the FFF – a partnership of FAO, the International Union for Conservation of Nature (IUCN), IIED and AgriCord and backed by a multi-donor trust fund that aims to strengthen FFPOs for climate-resilient landscapes and improved livelihoods. The surveys included an early question about 'what values the producer organisation had set out to pursue'. Figure 6 shows the number of times a value was mentioned by the 41 FFPOs when asked which values those organisations were pursuing. The results in Figure 6 demonstrate quite clearly that these organisations' pursuit of prosperity involves much more than financial value.

Figure 6. Number of mentions of values being pursued in a survey of 41 FFPOs in six countries



Cultural and territorial elements of prosperity are often given pe-eminence by many Indigenous Peoples – rather than financial transaction values (eg Bunten 2010). Social prestige often lies in generosity and reciprocity rather than competition and accumulation (Fenelon and Hall 2008). Indigenous spirituality often infers that people do not own land but must care for the land as part of their sacred stewardship within the purpose and direction of the cosmic order (Champagne 2005). It should also be noted that prioritising values other than finance has also been prized by many other non-indigenous champions of limits to economic growth over past decades (Meadows *et al.* 1972, Hickel and Kallis 2019). But what seems clear is that visions of prosperity among many forest-dependent people differ substantially from conventional Western visions. And it is these differences that have proved so effective at conserving forest areas. Ecological, economic, socio-cultural, and physical and technological dimensions of resilience in the systems managed by these groups are clearly important planetarily.

2.2 Climate resilience from an FFPO perspective

In Chapter 1, four dimensions of climate resilience were introduced and their origins explained. Here, we revisit those four dimensions – but this time, looking at why each matters to local producers and to the global public at large.

2.2.1 Why socio-cultural resilience matters to FFPOs

Socio-cultural resilience matters to FFPOs because, in remote forest landscapes, self-help through organisation is often the only way forward (Pretty *et al.* 2020). Groups form to overcome social isolation (from each other, markets, service providers and decision-makers) while strengthening common goals. Groups are usually the best entry point towards better livelihood outcomes in remote areas (Macqueen and DeMarsh 2016). But they also matter to the global public because they provide a political voice that can speak knowledgeably about the forest and farm landscape – and the threats to it. They form a formidable political force when federated at national level in apex-level FFPOs.

There are many advantages to collective action (see Macqueen *et al*. 2006), but also costs and risks, such as the ever-present risk of corruption and elite capture (Persha and Andersson 2014). Despite such risks, as FFPOs pursue prosperity, they often establish bonds of trust between their members (ie social capital) that can provide a springboard into successful enterprise (Macqueen *et al.* 2015). They often create social networks that are necessary for ongoing business incubation and support (Macqueen and Bolin 2018). They may also begin to provide a range of broader social and cultural services to their members (Bolin and Macqueen 2019). Organisational innovations that help them deliver prosperity to their members can also make them a crucial implementation mechanism for the SDGs (see Macqueen *et al.* 2020). And there are useful ways in which women's organisation – either within an FFPO or established as separate FFPOs – can act to improve women's empowerment (Bolin 2020a). FFPOs provide a collective view on the impacts of climate change across their membership and a mechanism through which to trigger a collective response to those impacts (Agrawal 2008).

2.2.2 Why ecological resilience matters to FFPOs

Ecological resilience matters to FFPOs as they generally depend on the continuing integrity of forest and farm ecosystems both for their subsistence and livelihoods. But these same ecological systems also matter to the global public because the forests and on-farm trees on which these people depend – if protected, managed sustainably, restored and expanded – could contribute 4–20% of global emission-reduction targets required to meet the +2°C limit of the Paris Agreement (Forsell *et al*. 2016). Currently, this looks unlikely not least because forest ecosystems are increasingly being damaged by the frequency and intensity of fires, pests and diseases, extreme events (flooding and storms) and changing precipitation regimes associated with climate change itself (Louman *et al.* 2019). But there is good evidence that devolving control over forest tenure to local forest-dependent people enhances the quality of forest condition (through sustainable forest management or SFM). This is because the pursuit of prosperity by their FFPOs includes strong environmental dimensions. Particularly positive outcomes have been cited from countries with a long history of secure community forest tenure and other enabling conditions, such as Mexico, Nepal and Tanzania (Seymour *et al.* 2014, Oldekop *et al.* 2019) or for Indigenous Peoples' land titling in Peru and the Amazon more generally (Blackman *et al.* 2017, Schleicher 2018, Walker *et al.* 2020). External government support and secure property rights are two of five success factors for community forestry advanced by Baynes *et al*. (2015). While exceptions are to be expected across the very wide range of community forest contexts and types, in general, community forest tenure has been shown to be at least as effective as state-enforced protected areas in protecting forests (Porter-Bolland *et al.* 2012) and generally has positive effects on the condition of the forest (Bowler *et al.* 2010; Fa *et al.* 2020).

2.2.3 Why economic resilience matters to FFPOs

Economic resilience matters to FFPOs because they depend on their forest and farm businesses to generate income. But they also matter to the global public because the combined gross annual value of forest and farm smallholder's food, fuel, timber and non-timber forest products (NTFPs) is between US$881 trillion and US$1.505 trillion (Verdone 2018). This makes them collectively by far the world's largest private-sector player. Smallholders are a big deal in the global economy. Yet, these forest-dependent people and the broader cohort of the world's 1.5 billion smallholder farmers are among the most economically vulnerable to climate change (FAO 2012). And this is critical, because their smallholdings, despite using less (often much less) than 25% of the world's total input resources – including land, water, fossil fuels – supply anything between 34% (Ricciardi *et al.* 2018) and 70% (ETC Group 2017) of the world's food. In other words, the pursuit of prosperity by FFPOs representing smallholder groups is far more resource efficient economically than alternative approaches – and it is based in the sectors that are most central to the well-being of the global community (ie food). So, their vulnerability matters much more than other industrial sectors, including the industrial food producers who use at least 75% of the world's agricultural resources – a major source of global GHG emissions, to meet the needs of a much smaller segment of the world's population – often excluding the poor.

2.2.4 Why physical and technological resilience matters to FFPOs

Physical and technological resilience matters to FFPOs because they must often extend physical infrastructure to brings services into remote rural areas (and FFPOs often help to install roads and generator power even before centralised provision). But they also matter to the global public because it is this expansion of infrastructure into remote areas that expands market opportunity but also often precedes the loss of forests and biodiversity.

The emergence of FFPOs and the infrastructure that serves them typically expands fastest in areas with certain biophysical characteristics (eg low slopes, low elevation, soil suitability, distance to water). Some biophysical and infrastructure characteristics are clearly more prone to climate hazards than others (eg roads on steep slopes, grid electricity in remote areas). Certain combinations also introduce ecological risks. For example, deforestation is consistently higher in proximity to roads, urban areas, high population densities, fertile soils, flat lands, lower elevations and existing agriculture

(Busch and Ferretti-Gallon 2017). Continuing road expansion in Africa, for example, could irreparably diminish the most biodiverse forests and wildlife populations (Laurance *et al.* 2017).

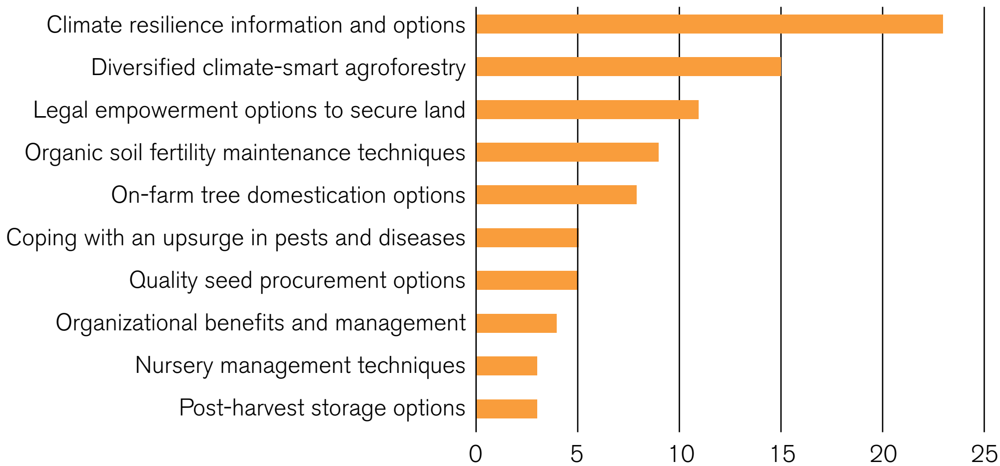
But while some infrastructure might exacerbate ecological threats to natural resources, it is also an important building block for rural resilience. Migration studies frequently cite the lack of rural infrastructure (with its high cost-benefit ratio) as a driver for outmigration (Sumberg *et al.* 2019) – and this also applies to infrastructure necessary for digital connectivity (Salemink *et al.* 2017). Conversely, investment in rural development seems to stem outmigration (Gamso and Yuldashev 2018). Being membership based, FFPOs are ideally placed to pursue prosperity in such a way that they take account of long-term consequences of short-term infrastructure decisions in regular meetings of their members. This allows them to navigate the trade-offs between infrastructure as a means of resilience and infrastructure as a driver of ecological vulnerability.

The argument for investing in FFPOs prosperity and climate resilience is very strong. But before we look in more detail about how that might be done, it is worth asking: 'Do FFPOs themselves prioritise investments in climate resilience in pursuit of prosperity – or are there other priorities?'.

2.3 Increasing prioritisation of climate resilience

What do FFPOs themselves prioritise in terms of land and natural resources? The answer emerged in the same demand surveys of the knowledge needs of the 41 FFPOs from six FFF countries described earlier. Representatives of these FFPOs were asked about the main challenges and knowledge needs which they faced in six main areas: land and resources, business and finance organisational relationships and communication, policy advocacy and security, youth and education, and gender and culture. In the responses on land and natural resources, out of many possible challenges that might have been articulated, the demand for new knowledge on climate change was overwhelmingly the priority (see Figure 7).

Figure 7. Knowledge needs relating to land and natural resources from 41 FFPOs in six countries



It is apparent from such results that in their pursuit of prosperity for their members, FFPOs are indeed very concerned about climate-change resilience.

The role of groups (ie FFPOs) is particularly important because climate resilience involves socio-cultural, ecological, economic, and physical and technological options for elements of: persistence, adaptation, and transformation involving the three levels of individual producers, groups or FFPOs, and socio-political systems (ie local and national governance). The FFPOs play a particularly important role in resilience. On the one hand, they help spread understanding to their member individuals of how best to persist in the face of climate change. On the other, they can use their strength in numbers to shape better transformations of socio-political systems for the future (see Agrawal 2008).

Finally, across the more generic principles for resilience that emerged from academic literature and the Global Resilience Partnership (GRP), FFPOs clearly seem suited as a delivery mechanism (see Table 2)

Table 2 Widely agreed resilience principles and their high degree of fit with FFPOs

Resilience principles	Characteristics of FFPOs that make them suited to delivery
1. Embrace the complexity of managing diversity and redundancy	FFPOs and their members are grounded in the complexity of diverse rural landscapes that span multiple systems and multiple challenges
2. Recognise constant change in complex adaptive systems	FFPOs often emerge precisely to represent their members' interests in the face of constant challenges from climate change, markets, politics, pests and diseases
3. Enable inclusive decision-making and broaden participation	FFPOs are member-based and often have highly inclusive decision-making, often with deliberate outreach to excluded groups
4. Enhance system integrity and manage connectivity	FFPOs typically represent multiple smallholders with ecologically diverse land uses and baskets of products and manage internal and external connectivity
5. Promote flexible experimentation and learning	FFPOs typically hold regular meetings at which thematic learning on a whole range of topics is advanced, piloting agreed and experiences shared
6. Promote various centres of governance to leverage innovation	FFPOs are often sources of organisational innovation to meet member's needs and their strength in numbers improves linkages to external sources of innovation

Source: Adapted from Biggs *et al.* (2012a, 2015) and GRP (2019)

There is clearly a close fit between the resilience principles developed in broad resilience partnerships and the characteristic of FFPOs. For this reason, programmes to strengthen climate resilience would do well to make FFPOs a central element of partnerships that span different systems, levels and dimensions of resilience.

A women farmer in the rainforests of Southern Cameroon © Duncan Macqueen

3 A climate-resilience framework for FFPOs

Presenting a climate-resilience framework for forest and farm producer organisations is the objective of this chapter. What follows presents FFPOs and their technical support partners with a structure to help them implement climate-resilience activities. It lays out the scope of the framework, how to manage risk assessment, how to plan resilience responses and how to monitor progress.

3.1 Scope of this framework

From the preceding chapters, FFPOs have the agency (including the motivation) to help build climate resilience. They offer the scale that underpins many of the successful examples of resilience worldwide (see GRP 2019). Building from the observations above, a practical framework for climate resilience led by FFPOs can be built around four main components which correlate with other recent resilience assessment frameworks such as the Wayfinder (see Figure 8):

(1) Definition of scope – agree boundaries of people and place for the focal human system where resilience is to be built (which could be the members and landscape of an FFPO).

(2) Risk assessment – investigate the nature of climate hazards and the exposure and vulnerability of that focal human system.

(3) Resilience responses – designing appropriate responses for individuals, groups and broader systems.

(4) Monitoring progress – agreeing and using indicators to measure progress in resilience.

Definition of scope is simply the process of deciding what particular people, systems and place are the subject of climate-resilience interventions. The process answers the question: 'Resilience of what?' (see Carpenter *et al.* 2014). There is a real risk that if the focus is on resilience of ecological systems, some people may benefit, while the resilience of others may suffer (Leach *et al.* 2010). So, it is good to map the scope around the resilience of sets of people. Resilience is a fluid concept which depends deeply on people, their sense of belonging, and their subjective perceptions of resilience (see Beauchamp *et al.* 2019).

An obvious starting point, given this report's focus on the proposed agency and motivation of FFPOs, would be to align the 'people, systems and place' of proposed climate resilience to the actual 'people, systems and place' covered by the membership of an FFPO. This might work especially well for certain types of FFPO. For example, the FFPOs of Indigenous Peoples often have extensive and clearly demarked territories and clearly differentiated community membership (if rarely referred to in such terms by those people). This could form the scope of climate-resilience work. For example, in the 2016 provisions for community forestry in the Democratic Republic of the Congo (DRC) Indigenous Peoples can assert rights to up to 50,000 hectares of forest and by 2019, 64 local community forestry concessions (LCFCs) had been registered for a total area of 1,157,327 hectares in seven provinces (Ewango *et al.* 2019). In many community forest contexts, such spatial landscape areas could easily be defined as the scope of climate-resilience work. Tying resilience to a specific landscape in some form of spatial resilience that sees people and nature as a single integrated reality is a useful way of looking at resilience (see Cumming 2011).

In the more commercial FFPO settings of smallholder forest and farm mosaics or in peri-urban forest product-processing centres – where members may not have contiguous geographical areas of land – the scope of climate resilience might have to circumscribe landscapes not entirely controlled by the FFPO. So, they need partnerships with other actors and authorities in achieving climate resilience. But the emphasis on FFPOs as the main agency for delivering climate resilience would still hold. This is not easy to achieve. As noted in Chapter 1, the exercise of power and politics in broader landscapes often confounds logical resilience actions that might be taken (Crona and Hubacek 2010) – and governance of resilience becomes a much more important issue (Boonstra 2016, Folke *et al.* 2019).

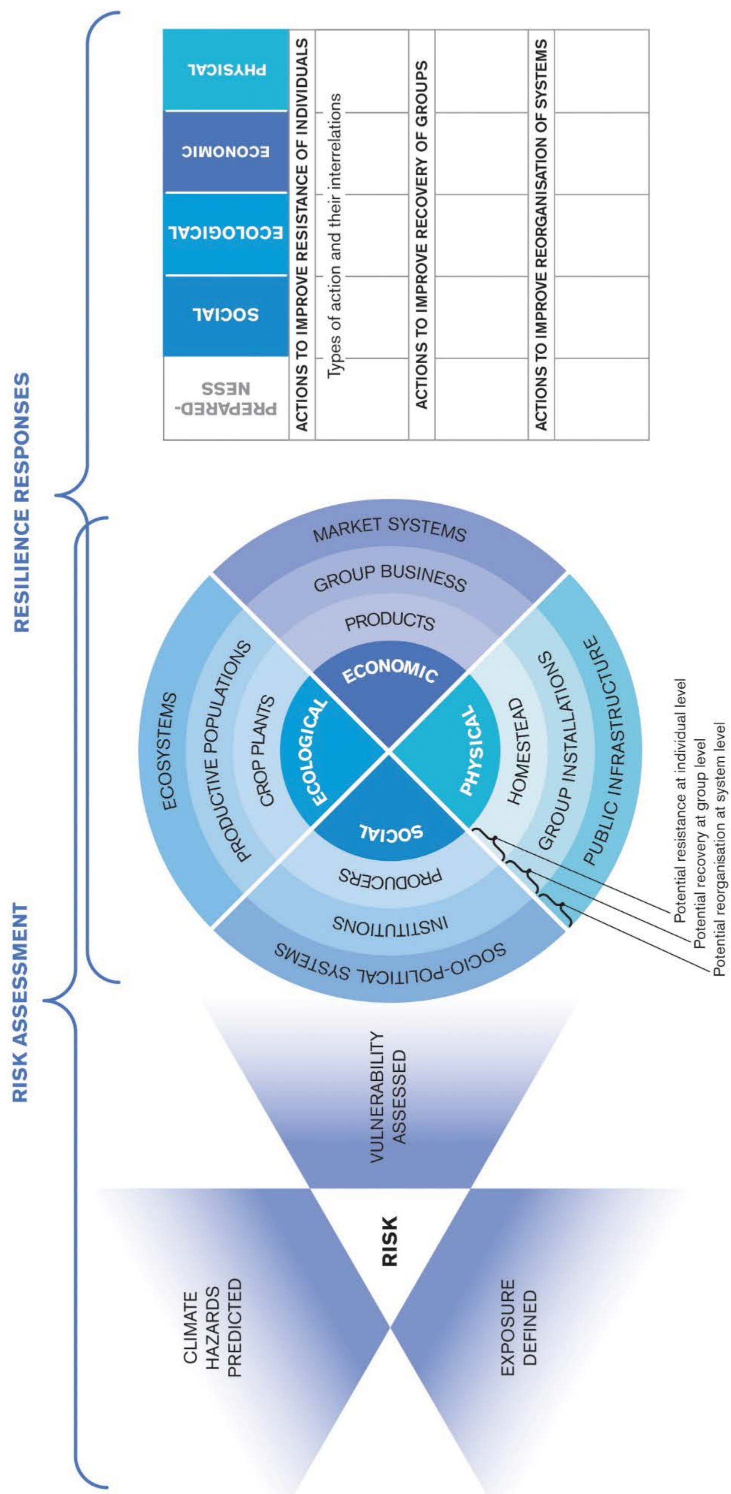
One unfortunate truth is that the scale of human impacts beyond the chosen scope of resilience may outrun FFPO's capacity to be resilient. Combined stresses may simply spill over from one socio-ecological system to the next in a global crisis. For example, dramatically increasing scales of human economic activity; rapidly rising density, capacity and transmission speeds of the connections in materials, energy and information; and the increasing homogeneity of human cultures, institutions, practices and technologies may simply overwhelm the planetary system (Homer-Dixon *et al.* 2015). FFPOs certainly need to engage and shape broader international resilience processes to ensure their relevance and impact at local levels. Tailoring resilience to contexts is all important and only representatives of local FFPOs can truly understand these specificities – even though they also need representation within higher-level international processes.

Figure 8 shows a framework for thinking about and acting on climate resilience for FFPOs and their technical support partners. The left-hand side points to the three main elements of risk assessment that FFPOs might undertake: predicting the nature of any climate hazards, defining the exposure of forest and farm producers to those hazards, and assessing the vulnerability of those producers. Good household-level survey tools such as SHARP (self-evaluation and holistic assessment of climate resilience of farmers and pastoralists) can help with those latter steps (see Choptiany *et al.* 2015).

The central target shape within the diagram points to the four areas of resilience that FFPOs and their technical support partners might want to think through – including the levels at which different actions might be designed.

The right-hand side points to a table of options that FFPOs might wish to develop to become more climate resilient. But it is important to note that not all the squares are equally important or need to be filled in. While it is important to analyse widely, it is equally important to act specifically. If only one resilience response is needed, it is quite appropriate to develop only one of the squares in that table. A list of 30 possible resilience response options is developed later in this report in Chapter 5.

Figure 8. Resilience framework for forest and farm producer organisations (FFPOs)



3.2 Risk assessment

An important initial point is that risk assessment should ideally be broad, so as not to miss all the other types of risks and unpredictable shocks that will hit the system (Pereira *et al.* 2021) and the interactions between them (Keys *et al.* 2019). Broad risk assessment toolkits for FFPOs such as *Securing Forest Business* (Bolin *et al.* 2016) cover a spread of possible risk areas including financial risks, production risks (including climate risks to that production), business relationship risks, legality risks, staff capability risks and reputational risks. When looking in detail at climate risks, however, the risk assessment process needs to cover three main elements that have been described above (and see Miola *et al.* 2015):

- **Hazard prediction** (eg early warning of how FFPO members might be affected by weather-related events and probability mapping for other major hazards such as fires, floods, pest and disease outbreaks).
- **Exposure mapping** of people and place (eg assessment of FFPO members' forest and farm assets and the extent to which each of these might be threatened by hazards).
- **Vulnerability assessment** of their integrated human systems (eg vulnerability in ecological, economic, socio-cultural, and physical and technological dimensions at individual, group and systems levels).

3.2.1 Hazard prediction

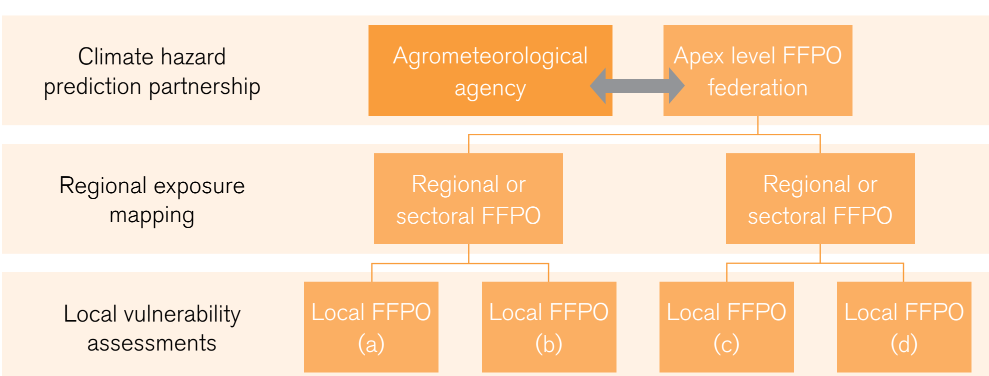
The main climate-resilience hazards are listed in Table 1 of this report. These hazards are often referred to as 'natural disasters' in the field of DRR. The impact of natural disasters on people and places are especially important in poorer places. For example, floods may be roughly equivalent in different places, but in poorer regions people have a very different experience of the risk from a flood, because risk is socially constructed and depends on the social support structures available in that place. In poorer places, mortality is often disproportionately high and material losses can have a catastrophic impact on economies. An international roadmap to reduce these impacts is laid out in the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework).
But predicting hazards or natural disasters is not just about extreme events, but the more regular variabilities that climate change introduces. Such predications most often fall to remote-sensing specialists and agrometeorological exerts (ie weather forecasters).

Agrometeorology caters to the increasingly pressing need for more accurate weather forecasting for forest and farm producers. Local producers use weather data to plan planting, irrigation and harvest timing, selection of crop type and/or crop varieties, and make decisions related to crop storage and purchase of crop insurance (Frisvold and

Murugesan 2012). Mechanisms through which regular weather information and natural disaster predication and early warning systems reach forest and farm producers are often deficient. Yet improvements have been made to weather forecasting information online – and indeed the accuracy and crop-specific impacts of weather forecasting have improved greatly over time (Klemm and McPherson 2017). And when weather forecasting does predict natural disasters there are improving prospects for involving the other actors in emergency decision-making that deal with the effective control of hazards in the event of disasters. These include monitoring, early warning and emergency planning, collection of information for emergency transferring, dispatching and rescuing, and disaster recovery after the occurrences of natural disasters (Zhou *et al.* 2018).

In terms of natural disaster, the Sendai Framework has spawned many efforts to improve actionable information in early warning systems and to ensure that this information reaches the right people (Lorenzo-Alonso *et al.* 2019). This is especially true in regions such as the Caribbean with regular exposure to extreme events such as hurricanes. But most weather forecasting still does not adequately predict the agricultural impacts of more regular patterns of changed weather and weather variability. There is a strong call for better partnerships between agrometeorological agencies (whose job it is to supply actionable information) and apex-level FFPO federations (whose job is to defend the interests of their members – namely the forest and farm productivity that is threatened by climate change) (Shannon and Motha 2015). A key challenge is to integrate the top-down information from agrometeorological agencies with the bottom-up knowledge of local forest and farm producers – and this integration is rarely done well (Ton *et al.* 2016). Much also needs to be done to involve different tiers of member-based FFPOs in making such information actionable – by passing down weather forecasting and information from early warning systems via ICTs mediated by third-tier apex-level FFPO federations, but reaching second-tier regional-level FFPOs, and their local FPPO members (see Figure 9). The different tiers of FFPOs have different roles to play in climate risk assessments.

Figure 9. Useful partnerships between FFPOs and agrometeorological agencies



3.2.2 Exposure mapping

The key to useful exposure mapping is to ensure that the local FFPOs most likely to face climate change hazards are identified and targeted with useful information and support. The responsibility for such mapping would ideally lie with either the apex-level FFPOs or regional/sectoral FFPOs who have oversight of their members and the conditions in which they operate.

An example is perhaps the best way to illustrate how this might work. In Kenya, volatile agricultural performance is largely attributed to extreme weather events, which are increasing in frequency and intensity with climate change. An apex-level FFPO federation such as the Kenya National Farmers' Federation (KENAFF) has 36 sectoral FFPO members mostly representing farmers of commodities, such as:

- Kenya Coffee Producers Association (KCPA)
- Cereal Growers Association (CGA)
- National Alliance of Community Forest Associations (NACFA), and
- Farm Forestry Smallholder Producers Association of Kenya (FF-SPAK).

Each of these commodity associations, such as FF-SPAK, is made up of multiple regional FFPOs (given with the acronyms by which they are usually called). These represent different geographical areas such as:

- Western Tree Planters Association (WTPA) – western-based in Webuye
- Meru Farm Forestry Producers Association (MEFFPA) – upper-eastern-based in Meru
- Kisii Tree Planters Association (KTPA) – Nyanza-based in Kisii
- South Coast Forest Owners Association (SCOFOA) – based on the south coast
- Central Highlands Tree Growers Association (CHTGA) – central, based in Thika
- Community Food and Environment Group (COFEG) – Rift Valley-based in Molo
- Nakuru Smallholder Timber Association (NASTA) – Rift Valley-based in Nakuru
- North Coast Farm Forestry Association (NCFFA) – based on the north coast

Through partnerships with agrometeorological agencies such as the Kenya Meteorological Department (KMD), and the National Drought Management Authority (NDMA), KENAFF can feed weather-forecasting information to relevant commodity associations (ie FF-SPAK) – who can also assess exposure to hazards for their regional member FFPOs. Indeed, improved agroecological forecasting has been written as a US$55 million component of an ongoing US$250 million World Bank Kenya Climate-Smart Agriculture Project. But the extent to which the FFPOs listed above have been involved to define what information farmers need to assess exposure to possible hazards is not readily discernible – but KENAFF is certainly listed as a beneficiary.

3.2.3 Vulnerability assessment

The key to useful climate change vulnerability assessment is to factor climate hazards into the regular process of risk assessment that may (or may not) be carried out by local FFPOs. Forest and farm decisions may be steered by climate hazards based on weather forecasting, but other factors play an important role too, such as resource access risks, market or revenue flow risks, business relationship risks and so on (Klockow *et al.* 2010). Previous work with FFPOs has highlighted the utility of conducting regular risk self-assessments to develop strategic plans for the year ahead (Bolin and Macqueen 2016). Toolkits exist that help FFPOs to prioritise risk management tasks based on: (i) the scale of consequences of that risk and (ii) the probability of its occurrence (Bolin *et al.* 2016). Within such toolkits, risks associated with natural resources are often where climate change hazards are assessed – alongside risks to do with financial revenue flows, business relationships, security of the operating environment, operational capabilities of staff, and organisational reputation.

For vulnerability assessments to have any practical application, it is essential that local FFPOs or their businesses regularly assess their vulnerability to different risks – including those associated with climate change. It is no use conducting climate vulnerability assessments in a way that is isolated from other risks which FFPO members face, since there may be more member-critical issues than climate change to deal with which require priority attention. For example, market volatility or health hazards during a pandemic might be much more pressing than longer-term climate risks. But it might be useful to complement those broader risk assessment processes with a more detailed assessment of climate change risks. To do that, it is essential that a flow of useful weather forecasting and natural disaster early warning information is fed down from apex-level FFPO federations to equip local FFPOs with accurate data on the climate change hazards and their likely forest and farm impacts.

Good systematic guidance exists to help perform vulnerability assessments where resources permit a more involved approach. For example, Thiault *et al.* (2020) offer 12 interlinked steps in a series of phases that include:

A. Scope: (1) Setting objectives for specific beneficiaries, (2) System exploration to establish what is considered relevant, (3) Reviewing any previous assessments.

B. Design: (4) Modelling the structure from dimensions to indicators, (5) Indicator selection.

C. Operationalisation: (6) Data collection for each indicator, (7) Standardisation so that data from different indicators can be compared, (8) Integration into a single assessment, (9) Specifying uncertainties.

D. Implementation: (10) Interpretation of the analysis, (11) Communication of the results, (12) Learning process.

Using those useful steps, a range of different vulnerability assessments could be designed tailored to the needs of particular FFPOs. This moves resilience away from a static risk-management framework towards something more dynamic in line with recent literature (see Slijper *et al*. 2020).

3.3 Resilience responses

Once vulnerabilities are assessed, resilience responses can be chosen that help to persist in the face of climate hazards, adapt to them, or transform the system to be less vulnerable in the future. These responses span what individual producers can do, what FFPOs can do and what the broader national political system can do. Reponses can be divided broadly into (i) enabling conditions for general resilience and (ii) specific responses in anticipation of specific hazards.

Many specific response options are possible in each dimension of climate resilience: socio-cultural responses, ecological responses, economic responses, and responses to do with physical and technological infrastructure. In Chapter 5, we outline some of the more commonly cited resilience response options from the literature. Then in Chapter 6, we analyse some real-life case studies of FFPO responses to climate change to build resilience for their members (the case studies are each summarised in Annex 1). Here it is worth introducing some of the enabling conditions for general resilience shown below in Table 3, as these might provide FFPOs with some questions about institutional traits they need to cultivate (Carpenter *et al.* 2012):

There are no climate resilience silver bullets – so working through a list of enabling conditions for general climate resilience can be a good place to start building resilience. At the scale of climate change envisaged under even the most optimistic scenarios, it may be impossible to retain agricultural productivity in some locations. So, while it may be possible for a time to resist climate change through planting better-adapted varieties or species, there may come a point at which such resistance is overrun. Faced with such true uncertainty, resilience is a bit like steering a vessel in turbulent waters (Olsson *et al*. 2006).

Table 3. Enabling conditions for general resilience: starting to ask the right questions

Enabling condition for general resilience	Explanation	Questions to consider
Trust	Development of social cohesion between heterogenous members of a group through collective actions over time without excluding sub-groups	Can people within a group collaborate effectively when faced with climate-related uncertainties?
Leadership	Individuals who can frame the risks, opportunities, alliances and trade-offs necessary to build resilience	Can leaders frame the problem and potential solutions to galvanise effective climate action?
Awareness	Regular and transparent monitoring and sharing on climate-hazard and climate-response variables	Do group members know enough about climate variables affecting their lives to respond appropriately?
Diversity	Variability within social (cultural), ecological (species), economic (value chains) and physical (infrastructure) systems	Can multiple elements of the system perform similar functions if one element is knocked out by a climate hazard?
Independence	Independent groups (or individuals) each with problem-solving capacities	Are groups insulated from each other (in responses to climate hazards) so that failure in one does not necessarily mean failure in all?
Inclusiveness	Groups that represent the full range of individuals within the community	Do existing groups adequately represent potentially marginalised groups such as women or ethnic minorities?
Connectedness	Strength of connection between one socio-ecological system and the next	Are groups sufficiently connected to allow replication of useful responses to climate hazards?
Reserves	Capacity to remobilise the system after a climate hazard (eg seed to replace lost crops or money to buy it)	Are groups endowed with sufficient savings to regenerate the system after a climate hazard?
Incentives	Incentives to restore (or further degrade) the socio-ecological system	Are individuals suitably encouraged to invest in restoring (not further degrading) the system?
Integration	Governance at different levels	Can the decision-making bodies at different levels cooperate to address the climate hazard at the right scale?

Source: Adapted from Carpenter *et al.* (2012) and Rodin (2013).

One danger is that by trying too hard to maintain a particular strategy (eg production within a particular context) an FFPO may risk tying its members into a dead end or poverty trap from which it is difficult to escape (Sterner *et al.* 2006, Cummings *et al.* 2014). At that point, FFPOs may need to consider how to help members break out of the trap (Carpenter and Brock 2008) with more radical options for adapting and transforming – including ideas such as innovations in infrastructure (Enfors 2013) or complete regime shifts that might even include potential outmigration (Biggs *et al.* 2012b, Rocha *et al.* 2015). In thinking through resilience options, therefore, it is worth weighing up the merits of small incremental fixes against the potential need for deeper transformations – the need to create a fundamentally new system when the socio-cultural, ecological, economic, physical and technological dimensions of the current systems are deemed untenable (Folke *et al.* 2010, Feola 2015)

3.4 Monitoring progress

Monitoring progress towards resilience is not an easy task. There are at least four complex adaptive dimensions of human systems. What metrics should be used to measure progress? The risk is that things that are easy to measure might not be the best indicators of real resilience (Carpenter *et al.* 2009). Also, metrics that link FFPO system properties to resilience may focus efforts unduly on one thing and reduce the flexibility FFPOs need for real resilience (Quinlan *et al.* 2015). When trying to measure the converse of resilience (ie vulnerability) the science of predicting critical thresholds is improving – for example, using indicators that track the time for small perturbations to return to normal (Scheffer *et al.* 2012). But it is still not possible to use indicators to reliably predict imminent system failures. Indeed, it is rarely possible to agree what a 'system failure' is. There is some discussion as to whether tipping points are the rule rather than the exception (see Rocha *et al.* 2018) or more the exception than the rule – with more evidence required to show anything other than positive physical feedbacks that can cause quite rapid change (eg deforestation leading to drying of the Amazon which increases the risk of fire and leads to further deforestation – see Pimm *et al.* 2019).

With the widespread adoption of 'resilience' as a concept in donor agencies and civil society organisations, there has a been a corresponding upsurge in the measurement of resilience (Winderl 2014, Schipper and Langston 2015). A major problem that continues to plague measurement of resilience is that it is multidimensional – and with multiple feedbacks (eg what happens to the economy affects what happens on the farm). But understanding of resilience is often built up indicator by single indicator (not the interactions between them). So, our understanding of resilience often fails to be multidimensional (Donohue *et al.* 2016) and consequently we have a poor understanding of the impacts on resilience of many of the most important elements of climate change. Given this tendency (and to avoid using a single indicator), new resilience assessment toolkits such as SHARP use the Cabell and Oelofse (2012) indicator framework in which 13 properties are considered essential to represent resilience in a holistic way – and only when all 13 are taken into consideration is an assessment viewed as adequate.

With so many potential objective indicators of resilience that could be used, Schipper and Langston (2015) group together indicators as to whether they are to do with:

- Learning (eg group membership, involvement in decision-making, access to climate information, information-sharing processes, education and training and so on)
- Options (eg access to seed, diversity in livestock, access to emergency services, training options, finance to invest in new things and so on), and
- Flexibility (eg the enabling conditions for general resilience such as social cohesion, accountable leadership, awareness and so on).

But this grouping is made necessary, as they acknowledge, by the diversity of contexts and dimensions of the resilience frameworks whose indicators they are assessing – rather than because those categories are necessarily the best to use in a single resilience framework.

Clearly, the nature of the indicators (what is measured) will reflect the dimensions of resilience that are included in the resilience framework. This is true whether resilience is seen through the conventional three-fold lens (social, ecological, economic) or the five-fold lens of capital assets in the sustainable livelihood framework (human, social, natural, physical and financial) or any other framework. The nature of the indicators will also depend on the scale of observation. For example, Miola *et al* (2015) used 32 indicators at a national level to create a national climate-resilient development index (showing what countries are climate resilient). But while their list of indicators works at a national level, it might be too macro-scale and generic to help individual FFPOs. It includes only broad measures of historic climate hazards (eg drought events in the last 20 years), exposure (eg population density), vulnerability (eg Gini index and dependence on agriculture), adaptive and mitigating capacities (eg manufacturing added value as % GDP, hospital beds per unit population etc) and development indicators (eg life expectancy and literacy rates etc). To gauge the resilience of an FFPO, much more detailed indicators are needed.

In summary, there is no right answer as to what objective indicators are used – except to say that indicators must be logically valid, easy to understand and readily available over time. So, for example, measuring fertiliser inputs would only work as an indicator of resilience if in that context more fertiliser was known to be good (or bad) for resilience, farmers understood what was or was not classed as fertiliser, and such data could be collected over time. Obvious problems are that it is often not known how different factors link to resilience at the outset, not all factors are readily measurable and it is difficult to combine multiple objective indicators into a single measure of 'resilience' (Béné *et al.* 2016b).

In moving from broad national or regional assessments of resilience towards particular people and places, there is even less ground for a 'one-size-fits-all' approach to monitoring resilience. Different communities will have different data sources and will want to measure different things. Communities and in this case local-level FFPOs are the experts on the matter. Community buy-in to any resilience approach, and the co-production of indicators, is fundamental to its uptake and utility. So, it may be difficult at the outset to know what to measure or indeed where to invest to have most impact (NASEM 2019).

Because of the doubts over which objective metrics best describe resilience, subjective metrics have also been proposed as an important and valid way to study resilience, based on the perceptions, opinions and preferences of individuals involved (Maxwell *et al.* 2015. Jones 2018. Jones and D'Errico 2019). Subjective metrics are useful in three ways, helping to:

- Improve understanding of the drivers of resilience (especially among those seeking resilience)
- Reduce the questionnaire burden for objective indicators, and
- Provide more cross-culturally valid comparisons (Clare *et al.* 2017).

The latter can be achieved by describing an event (eg heavy flooding) and an outcome prediction (eg full recovery within six months) and then a subjective scale to assess opinion (eg on a scale from 1 to 10, how strongly do you agree with the outcome prediction?).

The use of any form of metric without careful consideration (and indeed experience) can introduce biases that can drive perverse outcomes that are not efficient, context specific, fair, transformational, comprehensive, robust, or do not solve difficult cases (Hallegatte and Engle 2019). Easily accessible objective metrics on infrastructure and finance may displace unavailable metrics on governance, voice and empowerment in ways that quickly undermine real progress. Hallegatte and Engle (2019) recommend that instead of the search for single aggregated resilience metrics, metrics should be processed to ensure that:

- Climate risks and other uncertainties are factored into interventions and are flexible enough in their implementation and monitoring to be able to adjust as climate risks ensue, and
- Resilience-building outcomes are pursued in each community, ecosystem or country.

The following chapters on options for FFPO climate-resilience action hint at possible indicators without becoming too prescriptive.

Members of the FEDECOVERA Cooperative in Guatemala © Duncan Macqueen

4 FFPO climate resilience – organisational foundations

How organisational innovations within and between FFPOs can help climate resilience is the subject of this chapter. Organisational innovation can help improve both preparedness (risk assessment) and useful action (resilience responses) integrated across four main dimensions (socio-cultural, ecological, economic, and physical and technological dimensions). The evidence from supporting FFPOs suggests that power to build resilience can come from collective action marshalled within the right organisational structures.

4.1 Risk assessments within FFPO organisational structures

In the area of preparedness and risk assessment, a key role of FFPOs can be to improve knowledge about the risks members are likely to face. Within recent studies of organisational resilience, the period between detection of a risk and activation of a response is critical, i.e. the less time the better (see Burnard and Bhamra 2011). So, it is important first to give attention to how members of FFPOs generate and share information. These information flows happen within their organisation structures – both within their own FFPO and in the broader FFPO associations or federations to which their FFPO may belong. Shared knowledge attracts members to FFPOs (Cherukuri and Reddy 2014, Nugusse, *et al.* 2013) and better predictive capacity about likely future risks would certainly be advantageous to FFPOs. Academic reviews note the lack of information on how individual small and medium enterprises (SMEs) can achieve degrees of resilience (Bhamra *et al.* 2011). The following observations about how FFPOs support their members' information needs helps to tackle this issue.

To improve information flows, there are benefits to be had from FFPO linkages to one another in tiers of organisation (Macqueen *et al.* 2020). This does not mean that upper tiers are somehow superior to lower tiers – merely that upper tiers group together members of lower tiers. Each tier has vital, different and useful knowledge-generation and sharing functions. For example:

- Local first-tier FFPOs perform functions relating to production and aggregation of product – and so need to generate and share information on agroecological risks affecting smallholder homesteads.
- Regional second-tier FFPOs process and market products and provide business and financial services to their members – and so need to generate and share information about market exposure to risk.
- National third-tier organisations (eg federations and unions) are typically set up to advocate for rights and enabling policy reform – but can also generate and share information about broader political and legal risks (alongside meteorological prediction) – especially as they affect physical infrastructure and social networks.

At each different level, FFPOs can work to increase the preparedness of their members, using existing tools. For example, at the local level, there are tools to guide FFPOs through business start-ups such as market analysis and development (MA&D). Using that methodology, prospective entrepreneurs can assess challenges in five main areas of potential risk (Lecup 2011). They assemble the necessary information to prepare them for all possible eventualities in the areas of cultural and legal institutional arrangements (socio-cultural), natural resources (ecological), economy and finance (economic), and technological product research and development (physical and technological). It can immediately be seen that these areas of preparation for sustainable business map very closely onto the dimensions of resilience.

For more established businesses at either the first-tier local level or regional second-tier level, there are tools which encourage self-assessment of risk as an annual planning process – regularly taking stock of, prioritising and then managing risks of different sorts, including climate risk (see Figure 10). Encouraging FFPOs to take a proactive approach to risk self-assessment is an important first step in building resilience – which of course includes climate resilience.

Figure 10. Annual cycle of risk self-assessment and management

Source: Bolin *et al.* (2016)

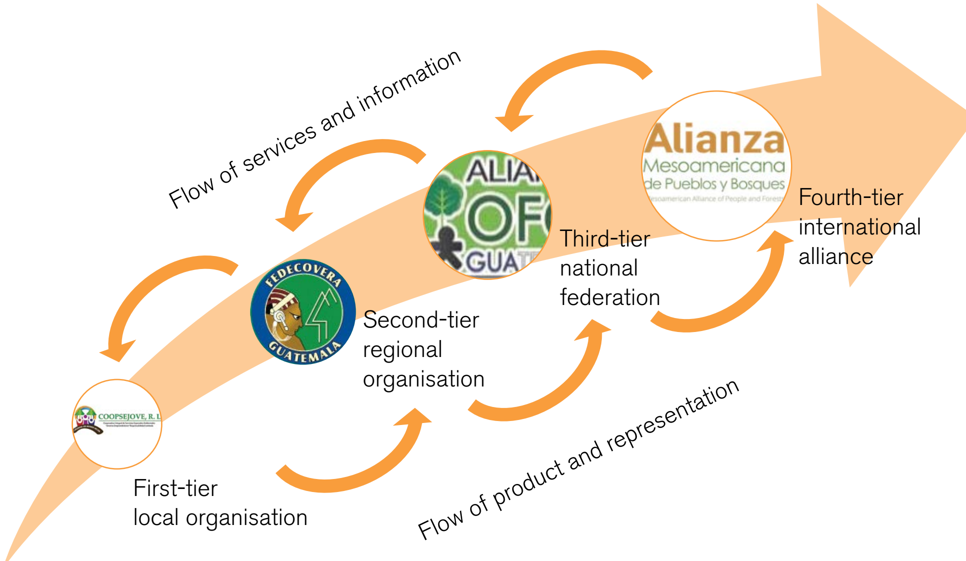
But there are two major sources of organisational innovation that can help in making such assessments. First, there is a vertical dimension, within which it is useful to build intentionally a process of co-learning up and down the tiered FFPO membership structures. Second, there is a horizontal dimension, within which it is useful to establish co-production partnerships with a range of different knowledge partners suited to the task.

4.2 Vertical innovations in organisation: benefits of tiered knowledge networks

Organisation of forest and farm producers is not only important in terms of scale (strength in numbers within markets and political processes). It is also important because it creates tiered knowledge networks that can serve them. Each tier of organisation generates vital, different and useful knowledge which can be fed upwards or downwards through the duly elected representatives of each tier of organisation (for example, requests for knowledge about the likely patterns of climate-related change directed towards often centrally placed meteorological services). Equally important is that there is a useful counterflow of services and information downwards (for example, meteorological predictions, guidance on market trends and risks, and specific agronomic advice on what to plant in view of those risks).

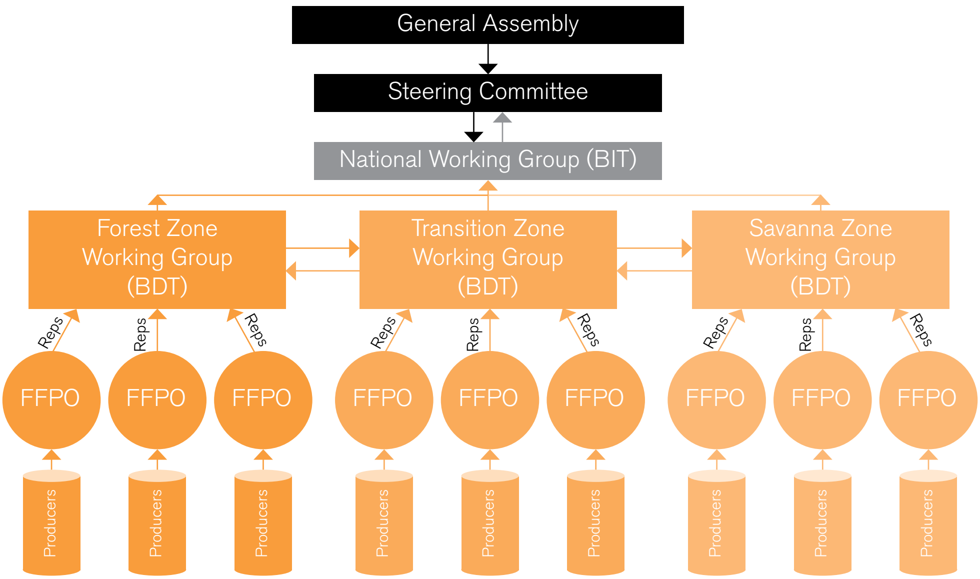
Figure 11 displays innovative tiered knowledge networks in Guatemala where local producer cooperatives such as the first-tier Cooperativa Integral de Servicios Especiales Ambientales 'Jovenes Emprendedores' Responsibilidade Limitada (COOPSEJOVE) request support for and receive services from the second-tier cooperative federation of Baja and Alta Verapaz, the Federación de Cooperativas de Las Verapaces Responsabilidad Limitada (FEDECOVERA) on issues pertaining to business and finance. FEDECOVERA in turn requests support for and receives services from the national alliance of community forestry organisations of Guatemala (Nacional de Organizaciones Forestales Comunitarias de Guatemala Alianza or ANOFCG) on issues pertaining to national policy which in turn requests advocacy support and receives services from the Mesoamerican Alliance of Peoples and Forests (AMPB).

Figure 11. Guatemala: vertical organisational innovations to help FFPOs assess risk and develop resilience responses



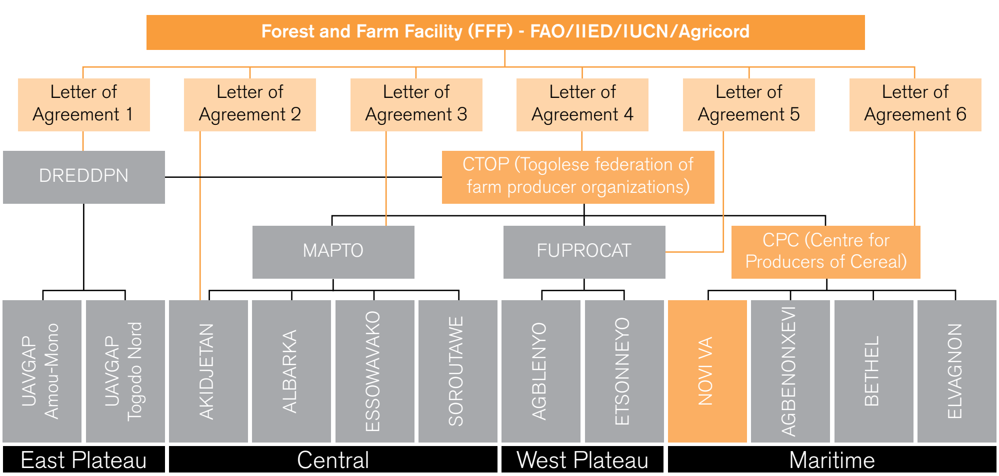
The sorts of knowledge that are necessary to cope with climate risks are often most keenly felt in FFPO businesses as crops and markets fail in the face of unpredictable weather. Tiered organisational structures can often provide knowledge services for member-based organisations that would not be viable for each individual FFPO alone. So, for example in Ghana, the various regional producer organisations in forest, transition and savannah zones that belong to the Peasant Farmers Association of Ghana (PFAG) have worked together with other similar national commodity associations to form the Ghana Federation of Forest and Farm Producers (GhaFFaP). Under the general assembly of this national umbrella organisation is housed a secretariat serviced by PFAG that provides a business incubation team (BIT). The BIT provides services downwards to its multiple member organisations. Among those services are the development of climate-resilient business models – for example, support to the Kassena-Nankana Baobab Cooperative Union (KANBAOCU) that has helped them find nature-based solutions (NbS) that give climate resilience in Northern Ghana (see the KANBAOCU case study in Annex 1). Figure 12 illustrates the organisational innovation that allows for such knowledge services to support local FFPOs in Ghana, using as an example of how the Business Incubation Team (BIT) under GhaFFaP is improving resilience for its members in various climate contexts.

Figure 12. Improving member resilience: GhaFFaP's business incubation team (BIT) in Ghana



Similar vertical tiers of knowledge-sharing organisation can be seen in many other countries where the FFF supports FFPOs – such as in Togo (Figure 13) where the first-tier NOVI VA cassava producers association has been supported with market development and packaging by the second-tier Centre for Producers of Cereals (CPC) which has in turn received climate-resilient business incubation and finance support from the Togolese Coordination of Peasant Organisations and Agricultural Producers (CTOP).

Figure 13. Tiered knowledge-delivery structures to support climate-resilient businesses in Togo



Not every country will have the same degree of organisation between producers, either locally or in such hierarchical tiers. Nevertheless, it is apparent how much of an advantage in terms of knowledge on climate risk and appropriate resilience responses is such vertical nesting of producers, where producers belong to a local group that belongs to a regional group that belongs to a national group etc.

4.3 Horizontal innovations between organisations: benefits of co-produced knowledge

Knowledge is essential for resilience to local and global uncertainties. Knowledge allows people to adapt – whether this is to changes in the economy (Murphy 2012), social migration (Proctor and Lucchesi 2012, Macqueen and Campbell 2020) or climate and the environment (Morton 2007, Call *et al.* 2019). For remote FFPOs, where resilience options are fewer, changes can often happen fast (Markelova and Mwangi 2010). Responding to these changes is challenging as they are often unannounced and can be beyond the scope of traditional knowledge and strategies. FFPOs must therefore build their resilience through new knowledge about the threats being faced and appropriate responses to them across economic, political, ecological and social systems (Ribot 2014, AgriCord 2016, 2020).

FFPOs have internal knowledge on how to adapt to risks based on the collective knowledge and experiences of FFPO members (Dolinska and d'Aquino 2016, Val *et al*. 2019). The availability, suitability to context, and sense of local ownership are big advantages to internal knowledge (Šūmane *et al*. 2018). But low educational endowments limit the breadth of utility of local knowledge (Shiferaw *et al.* 2011) and knowledge often resides with elites who can guard it jealously to the detriment of women, youth and Indigenous Peoples (Agarwal 2001). Power relations within FFPOs are a vital issue in developing resilience – and building strong democratic accountability within FFPOs from the outset is a crucial part of ensuring resilience. Part of that work necessarily involves tackling gender inequalities, through efforts to include the number of women members and their voice in decision-making (Bolin 2020a).

In contrast, external knowledge is available to FFPOs through partnerships with external organisations, such as government extension services, non-governmental organisations (NGOs), private-sector actors etc. They can bring in technical knowledge from a range of different contexts (Dolinska and d'Aquino 2016). Yet such external knowledge may come at cost or be unsuitable for the local context or fail to gain traction locally (Cleaver 2012, Banks *et al.* 2015, Dolinska and d'Aquino 2016) and the risk of elite capture still applies (Platteau 2004). Lack of trust between knowledge bringers and FFPO implementers can become a major issue (Campbell *et al.* 2016). By focusing only on the technical elements, the political nature of problems can be obscured (Li 2011). Resilience always has a political dimension so apolitical solutions rarely get to the root of the issues – including the root causes of gender inequalities. Indeed, if these political and gender issues are not tackled, these issues can result in external knowledge being 'left on the shelf' (Cash *et al.* 2006). Knowledge that is produced but unused (ie redundant) is widespread and greatly reduces the efficiency of development work (Clark *et al.* 2016, West *et al.* 2019). Once again, power relations between the FFPO and the external partner are key to resilience outcomes.

Blending internal and external knowledge in an FFPO-led effort to improve resilience is an obvious and worthy ambition. Systematic literature reviews show how co-production of knowledge can reduce the lag between understanding options for resilience and putting them into practice (van Ewijk and Ros-Tonen 2021). Co-creating knowledge requires acceptance that there are plural types of knowledge with political strings attached (Pohl *et al.* 2010, Norström *et al.* 2020). Co-production knowledge partnerships hold out the promise of more useable knowledge (Lemos *et al.* 2012, Dilling and Lemos 2011, Norström *et al.* 2020) especially if FFPOs or other local actors can lead the process (Jupp *et al.* 2010). For this reason, there has been a proliferation of co-productive methods over the last few decades (Turnhout *et al.* 2020). With greater ownership over the knowledge comes sensitivity to the political aspects of knowledge generation and use (Wall *et al.* 2017, Salomaa 2018). FFPOs are likely to benefit from such an approach for four reasons (Covey *et al.* forthcoming):

- Greater local relevance will make it easier for FFPOs to implement under uncertainty (Djenontin and Meadow 2018, Weichselgartner and Kasperson 2010).
- Greater partnerships between FFPOs and other agencies involved in knowledge creation can help overcome parallel governance challenges (Bowen *et al.* 2017).
- Greater leadership on the part of FFPOs can strengthen their capacity to broker solutions between their members and outsiders (Lemos *et al.* 2018).
- Greater participation by FFPO members can elevate internal knowledge levels to be better equipped for future risks (Djenontin and Meadow 2018, Jupp *et al.* 2010, Norström *et al.* 2020).

Partnerships that co-produce knowledge need to overcome challenges such as addressing unequal power relations between parties (Muñoz-Erickson 2014, Pohl *et al.* 2010, Turnhout *et al.* 2020), working with often conflicting timeframes, standards and reward systems for knowledge generation (Irwin *et al.* 2018) and different accountabilities (Banks *et al.* 2015). Research conducted under the FFF programme has attempted to develop such co-production partnerships and ensure inclusion so that knowledge generation meets the needs of the FFPO (see guidance in Djenontin and Meadow 2018). This has involved making uncertainty in new knowledge explicit (Scoones 2009). Such processes always have limitations in funding, staff and time limitations (currently exacerbated by COVID-19) so rarely live up to a perfect ideal – but the aspiration for knowledge co-production partnerships is a worthy one. The following sections of this report present the co-production of knowledge on diversification as a central notion in the pursuit of climate resilience.

Diverse home garden agroforestry system in Indonesia © Duncan Macqueen

5

FFPO climate resilience – options for diversification

This chapter introduces the various ways in which FFPOs can diversify what they do to have more options to face climate change risks. That broadening is referred to in this report as diversification. Many (but not all) of these options reinforce one another when integrated within a single forest and farm landscape.

5.1 Introducing diversification

Diversification looms large in resilience responses because it captures the idea of broadening options to address increasing climate risks. This report defines 'diversification' broadly (ie the whole suite of options in all the dimensions of resilience that are available to an FFPO) – rather than narrowly (ie the diversification of crops species as one part of ecological resilience – which is not always the best route towards resilience – see Cochrane and Cafer 2017). Having more resilience options is generally a good idea especially when these create durable livelihood benefits alongside biodiversity and climate benefits (Di Sacco *et al.* 2021) and even if sometimes the pace of change overwhelms those option (Pimm 1984, Naemm *et al.* 1994).

The previous chapter noted that co-production of knowledge is critical for FFPOs because climate-related changes are occurring so fast as to be outside the customary range of knowledge. The pace of change magnifies ignorance about what might work best in rapidly changing environment – so the more experience that can be brought to bear the better. And when faced with uncertainty, having a diverse range of socio-cultural, ecological, economic, and physical and technological alternatives to fall back on makes a great deal of sense. Hence the need for diversification. In the case studies in Annex 1 that highlight FFPO strategies for climate resilience, diversification is seen to be an almost ubiquitous response.

While there is abundant academic literature on different elements of diversification, recent overviews stress the need to have a more consistent framework to be able to assess impact. For example, it is useful to define:

- The problem (ie the threat to existing forest and farm systems and consequent need for diversification)
- The baseline situation to be diversified
- The scale and target area for that diversification
- The intended elements of diversification, and
- The expected impacts (see Hufnagel *et al.* 2020).

The problem with the academic literature is that most studies tend to look at only one element of diversification – such as diversification into climate-resilient crops (Acevedo *et al.* 2020). In a review of 3,563 records of sustainable agriculture for climate-resilience practice it was noted that most records researched a single practice (not a combination of socio-cultural, ecological, economic, and physical/technological diversification) (El Chami *et al.* 2020).

What is presented in the following sections are a series of options for diversification in socio-cultural, ecological, economic, and physical and technological dimensions. The intention is not to provide forensic detail on each option (each has a vast technical and academic literature). Rather, the intention is twofold: first, to provide the reader with a menu of options to explore as a practical start-point for improving resilience and second, to make the point that there are useful and maybe even necessary complementary advances in the socio-cultural, ecological, economic, and physical and technological dimensions. Advancing in more than one option area may deepen resilience, offering more in combination than the sum of the individual options. As noted earlier, resilience is all about connectivity and interlinked adaptive cycles. Emphasising this is important, because evidence from combinations of several agricultural diversification strategies is that they outperform any individual strategy (see the review of 3,700 experiments and 99 meta-analyses by Beillouin *et al.* 2019).

The complexity of making forest and farm systems resilient is such that there are still big knowledge gaps. While the links between ecological diversification and social network diversification are well studied (eg Martinez-Baron *et al.* 2018) less is known about how different approaches to business development may or may not enhance resilience (Kuhl 2018). And treatment of physical and technological diversification is often not linked to those other dimensions. The sections that follow review the literature to list some of the main options that FFPOs can take to enhance their resilience through a broad notion of diversification.

5.2 Socio-cultural diversification options

Humans are particularly good at working together to solve problems. Social organisation is the basis of our evolutionary advantage – and socio-cultural networks inevitably play a critical role in climate resilience. Social, information and physical networks are what allow us to share knowledge, trade, engineer solutions – and critically, adapt to change. The speed and effectiveness of adaptation and innovation are limited by those social networks (Henrich 2015). An increasing dependence on social networks for subsistence has enabled human societies to become complex, specialised and hierarchical (Chase-Dunn and Lerro 2013). Social networks comprise many different forms and functions, including knowledge networks, communities of practice, policy and advocacy networks and increasingly social communities of the web, connected via electronic mail, websites and web logs and networking applications such as Twitter, FaceBook, Whatsapp or LinkedIn (Serrat 2017).

The political economy of the Western world in the later 20th century and early 21st century prioritised individual action over the collective to the detriment of rural institutions. But since then, there has been an upsurge in social movements, network and federations. For example, in 55 countries studied, collaborative groups mushroomed from 0.5 million in 2000 to 8.5 million in 2020 in support of greater sustainability and equity (Pretty *et al.* 2020).

With the advent of widespread social media and the internet, expanding social networks offer fantastic potential to help local groups become more resilient to climate change (Fox *et al.* 2017) – equipping them to prepare for and respond to climate risks (Schmidt 2017). These social networks often start small with a local group working together to share information and costs or use their collective strength to get better deals from buyers or decision-makers (Macqueen and DeMarsh 2016). But as they become larger and more sophisticated, they can soon procure technical, business, financial and political support. Social networks are then able to shape a range of other factors of relevance to resilience as shown in Table 4.

Many studies focus on the outcome of social networks rather than the dynamics of how they evolve to deliver those outcomes in natural resource governance, technical innovation and socio-cultural support structures (Rockenbauch and Sakdapolrak 2017). Producers may be hesitant to try new resilience options because of their socio-economic context. To evolve towards greater resilience, producers often need socio-cultural inspiration and better information that can best come through improved social networks (Canevari-Luzardo 2019). FFPOs often provide sources of inspiration and information so that individual members have greater propensity to invest in resilience practices.

Socio-cultural inspiration and support to make necessary changes can come from inside FFPOs through sharing of collective experience and skills – sometimes market oriented, but often more political or territorial in outlook (see Hart *et al.* 2016). But in reviews of adoption of climate-resilient crops for example, external social networks also play a role – like education systems, extension services, distribution networks for farm inputs, government programmes and projects (Acevedo *et al.* 2020). Other enabling networks include finance and insurance networks and market networks in which buyers can play a pivotal role in encouraging adoption of new approaches (van Zonneveld *et al.* 2020).

Table 4 summarises some of the main options for diversification of social networks that are known to give greater resilience – each with an example or tool to illustrate how such socio-cultural elements of resilience work in practice.

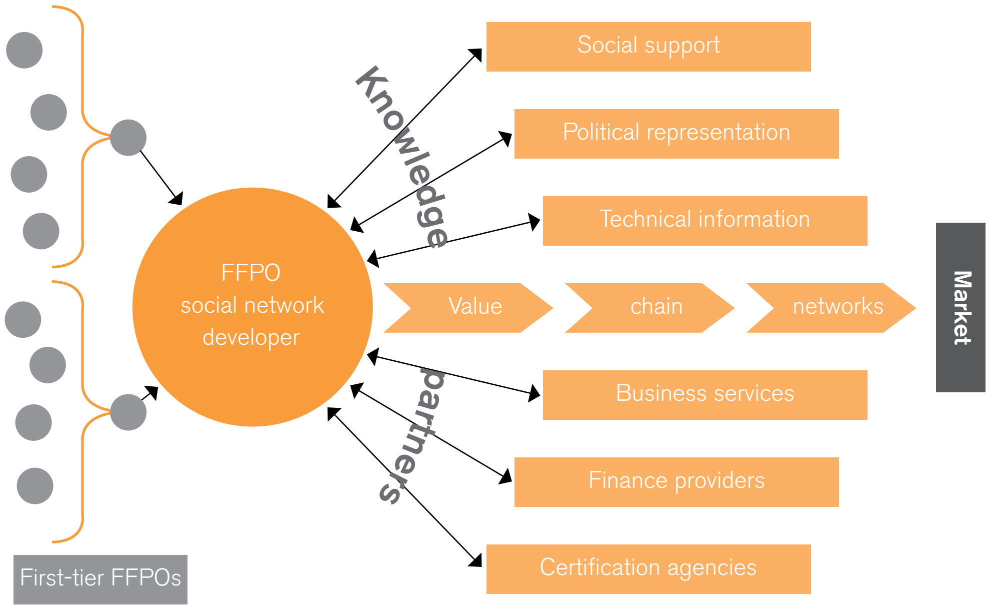
Ideally the social networks that an FFPO seeks to develop should be ones in which the FFPO acts as a broker between various knowledge holders. This type of arrangement has already received widespread endorsement in fields such as the provision of business incubation services. In business incubation, multiple risks and uncertainties require the business incubator to have multiple social links and knowledge partnerships that can serve its members – and it plays the leading brokering role. Figure 14 shows how FFPOs that group organisations together can help to develop useful social networks and knowledge partnerships for their members to enhance resilience.

Table 4. Options for FFPO socio-cultural diversification

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
1/30. Organisational systems	System installations that regularise a diverse membership and clarify leadership, decision-making, finance, recordkeeping, human resources and quality control and include gender equality in each element	Strong organisational systems underpin resilience and various approaches exist to improve FFPO organisational management – from simple checklists (like the organisational capacity self-assessment tool for producer organizations or OCSAT) to more engaged organisational risk self-assessments such as *Securing Forest Business* (Bolin *et al.* 2016)
2/30. Membership services	Social and cultural services that strengthen inclusion and trust across a diversity of members and protect the most vulnerable including women and youth	A diverse committed membership is the basis of resilience – and FFPOs have developed a wide range of services to improve inclusion, such as KANBAOCU in Ghana which represents 173 group enterprises with 12,376 female and 485 male members. It has improved women's inclusion by establishing a savings and loans association, home-care and school-care services (Bolin and Macqueen 2019)
3/30. Political representation	Structures of political representation that link diverse rural producers to authorities governing land tenure, agriculture and forestry, commerce and finance – including the gender balance in such representation	Shaping favourable policies can enhance resilience and the representatives of federations of FFPOs are powerful in that regard – such as FEDECOVERA in Guatemala shaping the forestry incentive law (known as PROBOSQUE), which assigns 1% of the annual national budget (around US$20 million) for the next 30 years to smallholders, cooperatives and indigenous communities (Campbell 2016)
4/30. Technical extension	Social networks that share information (on weather forecasting, crop varieties, seed sources, planting arrangements, weather forecasting) to a diverse and inclusive membership, both men and women	Technical proficiency improves resilience and FFPOs often improve access to knowledge networks to improve that proficiency, such as Northern Ghanaian FFPOs who linked to agricultural extension officers who trained them on demonstration farms in spacing, tilling and mulching and mixed cropping with drought-tolerant varieties (Dapilah *et al.* 2019)

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
5/30. Business incubation	Business incubation networks that link members to diverse customers, input suppliers, exporters, chambers of commerce, technology providers, authorities – and provide gender-differentiated support services	More profitable business builds capital reserves that can enhance resilience – and so FFPOs can develop business incubation services that link members to necessary support services, for example the Self Employed Women's Association (SEWA) (India's largest trade union) that established the SEWA Manager Ni School (a school for new managers) which provides access to research and technology experts within universities (Nanavaty *et al.* 2018)
6/30. Financial services	Financial savings and loans groups or credit unions that embrace a diverse membership and can provide or attract finance or insurance for FFPO investments across that membership	Financial investment and insurance products can improve profitability and resilience – especially if some money is mobilised internally. FFPOs often mobilise internal savings and loan funds whose financial track records help members access finance (Hodgdon and Loewenthal 2015). For example, the Bolivian Central de Cooperativas, El Ceibo RL, unites 47 base cooperatives with 1,200 members, and has developed an Alternative Financial Development (AFID) service. AFID grants efficient loans at competitive interest rates for members' cocoa production (FFF 2021)
7/30. Quality assurance	Certification schemes that verify the origin, quality, sustainability or benefit distribution of FFPO production and cover a broad membership base	Marketing can be enhanced through certification – and FFPOs have often developed the social networks to oversee compliance processes with third-party schemes (such as Forest Stewardship Council certification) or develop second-party participatory guarantee schemes (PGS) or geographical indications (GIs) such as the Tenun Ikat Sikka (GI) Protection Association representing 122 weavers' groups in Sikka Regency, Flores, Indonesia to guarantee and protect their hand-woven and tie-dyed textile known as Tenun Ikat, which has a rich biocultural heritage captured through intrinsic motifs and storytelling (Bolin 2020b)
8/30. Cooperative union	Links to higher tiers of organisation and representation including cooperative alliances that have a commitment to mutual support (including to women's unions and support networks)	Mutual support networks have a long history and many FFPOs often associate or federate for mutual advantage – often linked to the International Cooperative Alliance whose 3 million cooperative societies embrace 12% of the global population and whose sixth of seven founding principles is cooperation among cooperatives (ICA 2015)

Figure 14. Building FFPO resilience through group knowledge partnerships and social networks



Source: Macqueen *et al.* (2018)

5.3 Ecological diversification options

Over the last 10,000 years, the human conversion of biodiverse natural perennial ecosystems into annual crop monocultures for the provisioning of food has had some positive impacts on short-term food supply. But longer-term negative impacts are now increasingly felt (see Nyström *et al.* 2019). The once fully energetically-renewable services of soil formation, nutrient retention, organic matter storage, pest suppression and others have been converted into the disservices of soil erosion, nutrient contamination, loss of organic carbon, and reliance on energetically non-renewable and often-toxic agrochemicals (Crews *et al.* 2018). These problems are widely associated with the simplification of agriculture's ecological system (Rosati *et al.* 2020) These processes are well known to be accelerated by increasing economic consolidation in agricultural industries whose pursuit of economic efficiency has carried major consequences for both the natural environment and the social fabric of rural societies that outpace many proposed solutions (Foley *et al.* 2011).

Against that backdrop there have been many calls for approaches that restore something of the ecological diversity and sustainability of agricultural systems (El Chami *et al.* 2020). These approaches fit rather better with complex collective landscapes of smallholders – typical of the members of FFPOs – than with the large-scale agro-industrial landscapes of major agricultural corporations (Hou Jones and Macqueen 2019).

As noted earlier, these approaches are described under a bewildering array of 'frameworks' in a bewildering number of academic articles. The latest reviews suggest that while many approaches can show positive impacts on resilience under the right context, much still needs to be done, especially for the newer 'concepts' described below, to quantify what approach delivers what elements of resilience under what contexts (Duncan *et al.* 2021, Seddon *et al.* 2020). There are many (often the same) approaches for resilience that can be found in literature covering:

- Agroecological approaches (AA – Sinclair *et al.* 2019)
- Agroforestry (AF – Quandt *et al.* 2019)
- Conservation agriculture (CA – Michler *et al.* 2019)
- Climate-smart agriculture (CSA – Lipper *et al.* 2018)
- Community-based adaptation (CbA – Kirkby *et al.* 2017)
- Forest landscape restoration (FLR – Spathelf *et al.* 2018)
- Integrated agricultural systems (IAS – Gil *et al.* 2017)
- Integrated landscape approach (ILA – Duncan *et al.* 2021)
- Integrated natural resource management (INRM – van Noordwijk 2019)
- Nature-based solutions (NbS – IUCN 2021)
- Organic agriculture (OA – Mendoza *et al.* 2020)
- Sustainable agriculture (SA – Adhikari *et al.* 2018)
- Sustainable intensification (SI – Cassman and Grassini 2020)

Once the intellectual smoke has cleared, it appears that these frameworks cover a relatively limited number of forest and farm options. All are essentially trying to optimise the use of natural ecological processes (eg trees fixing nitrogen in agroforestry systems – Wilson and Lovell 2016) to enhance production and spread the risk of failure in the event of a climate shock. Many of these practices help both climate adaptation and mitigation by enabling more carbon to be stored per unit area of land (Matocha *et al.* 2012). Table 5 summarises some of the main options for diversification of ecological options that are known to give greater resilience – each with an example or tool to illustrate how such ecological elements of resilience work in practice.

Table 5. Options for FFPO ecological diversification

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
9/30. Climate-adapted stock	Procure better-adapted crops, trees or livestock varieties through botanic gardens or commercial suppliers, farmer-assisted natural regeneration/ breeding and seed stands/nurseries of diverse tree and agricultural crops	Identifying and procuring diverse seed stocks that are adapted to an evolving climate (and can outcompete potentially invasive alien species) is a critical way to improve climate resilience. Knowledge can be built in forest and farm organisations through existing training approaches that start with existing knowledge and expand to germplasm procurement, replication and distribution (Vernooy *et al.* 2019)
10/30. Biodiversity enhancement	Protect natural forest areas (and their biodiversity) alongside adding additional indigenous agricultural, tree-crop or livestock species or varieties into the production area (with attention to the gender differences in who has access to which resources)	Protecting some natural forest biodiversity first is vital for ecological functions such as pollination (see Di Sacco *et al.* 2021), but FFPOs can also diversify livestock, agricultural and tree crops on farm as part of forest landscape restoration that reduces climate risk and enhances resilience. It strengthens the ability of the agroecosystem to respond to climate stresses, reduces the risk of total crop failure, reduces the incidence of insect pests, diseases and weed problems and provides alternative means of generating income (Lakhran *et al.* 2017)
11/30. Spatial optimisation	Arrange the various crop, tree and livestock elements to maximise productivity, including the use of cover crops, fallows or *taungya* (planting of mixed agriculture and tree crops where agriculture provides early and trees later income streams) and potentially multistorey agroforestry systems	Spatial planting arrangements can allow crops, trees and livestock to optimise the use of light, water and nutrients, minimising competition and so enhance climate resilience – with experimentation based on mimicking natural ecosystems a good starting point for finding the best arrangements (Tzuk *et al.* 2020)

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
12/30. Tree-based productivity	Integrate diverse productivity-enhancing trees in support of crops or livestock such as nitrogen-fixing alley crops, protein-rich fodder fences, energy woodlots or wind breaks	While some trees are crops, sometimes trees can be used to enhance production of conventional crops – through nitrogen fixation for example, which can benefit crops, through leaf mulching or livestock, through leaf feeds (Bayala *et al.* 2018) or through energy woodlots that can provide energy for processing
13/30. Pest management	Use more varied sequential planting or rotation or separation or other integrated pest-management techniques to avoid build-up of soil-borne or surface pests and diseases	Repetitive planting – or planting in large contiguous blocks – can increase the risk of pests and diseases especially in climate-stressed crops – so diversifying, spatially separating, rotating, using minimum tillage or other integrated pest-management practices with crops over time can reduce outbreaks and increase climate resilience (Murrell 2017; Tariq *et al.* 2019; He *et al.* 2019)
14/30. Soil erosion control	Control erosion and reduce surface water runoff through minimum tillage, contour planting, fallow cycles or multistorey arrangement that offer diverse and therefore resilient soil cover	Reducing soil erosion and rapid water runoff can enhance fertility and climate resilience – so using plant cover to increase water infiltration and reduce soil loss through minimum tillage, grass rows, can complement other physical diversification strategies like terracing or irrigation (Ahmad *et al.* 2020)
15/30. Soil enrichment	Use leaf mulching organic composting and slurry production from a range of plant and animal options to enrich soil fertility and moisture retention	The use of organic matter or 'mulch' (including livestock excrement) to improve soil fertility and moisture content and to suppress weeds is widely accepted as good agricultural practice (Iqbal *et al.* 2020) and mulch production can be enhanced by integrating trees and livestock into the agroforestry system

5.4 Economic diversification options

Resilience can be enhanced by both enhancing and broadening the ways in which FFPOs make money: economic diversification. The more ways to make money there are, the more resilient an organisation will be. Money allows investment – and the redeployment of resources away from things threatened by climate change towards more robust options. Institutions with money, however, (such as banks) often face challenges in reaching out to remote smallholders. So, it often falls to local organisations to mobilise and upscale their own finances. But this too can prove challenging as the profitability of forest and farm enterprises in remote areas is often marginal. Both challenges limit the capability of FFPOs to deal with increasing climate risks (Oostendorp *et al.* 2019).

In economic terms, climate change affects both supply and demand – and the reliability of both. On the supply side, climate change alters the relative productivity of tree-based and agricultural crops, making each more or less favourable as, on average, the climate moves closer to (or further away from) the optimum conditions for cultivating that crop (see Prishchepov *et al.* 2013). On the demand side, climate change affects what consumers want – which may include increasing demand for tree crops such as biomass energy to reduce further carbon emissions (Daioglou *et al.* 2019). But climate change is not linear: it is often felt in the increasing variability of rainfall and temperature and in the impact of extreme events. There are still major knowledge gaps on how the timing, severity and interactions of different climatic stresses affect plant growth and development and how changes in climate variability and extreme events affect pest-weed-disease complexes for crop, forest and livestock systems (Thornton *et al.* 2014). What is clear is that studies that estimate only the mean changes in temperature or rainfall seriously underestimate how difficult it is for forest and farm businesses to know what to grow that will survive and be saleable in more volatile markets.

It should be noted that there are tensions between certain approaches to enterprise development which go for consolidation and scale (eg the market system development approach) and economic approaches that enhance climate resilience (Kuhl 2018). It is known that for major retailers, consolidation cuts costs, but may increase reliance on particular production regions, where any disruptions, such as extreme weather events, experienced in one location will have immediate impacts on the chain (Lim-Camacho *et al.* 2017). So too for producers, consolidation can enhance profitability. But consolidation also increases reliance on one value chain where disruptions, such as extreme weather events, can increase the chance of business failure. For example, a drought might kill all a particular cash crop. Diversification into several value chains can avoid that outcome, but only to the point at which the severity of the extreme event decimates productivity across all crops (Davis *et al.* 2021). There are alternative approaches to business development that encourage the screening and development of a basket of products (Lecup 2011) and which encourage active risk management – taking steps to guard against over-reliance on particular crops or business value chains (Bolin *et al.* 2016). In the light of increasing climate-related uncertainties, many FFPO businesses are diversifying what they produce, process, package and sell (as described in Annex 1 of this report).

Table 6 summarises some of the main options for diversification of economic options in business that are known to result in greater resilience – each with an example or tool to illustrate how such economic elements of resilience work in practice. In presenting these options, economic diversification is treated either as a change in product or a change in market. It builds on the original work of Ansoff (1957) that describes options that increase either the number of markets or the number of products.

Table 6. Options for FFPO economic diversification

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
16/30. Increase scale	Aggregate more product from an expanded and diverse membership to increase market-bargaining power – selling bigger volumes to a more diverse set of customers at better prices (with due consideration of women's membership and rights)	Increasing the volume of production by aggregating product from more members increases resilience by strengthening negotiation on selling prices without necessarily tying individual farmers into potentially less-resilient monoculture systems. Bigger volumes attract a larger range of larger buyers – for example, the Koperasi Wana Lestari Menoreh (KWLM) cooperative selling teak, mahogany and rosewood in Java improved prices for members through collective bargaining (Windratomo *et al.* 2015)
17/30. Stock information	Increase customer segments through better inventory of stock and grading – differentiating diverse quality categories to get premium prices for highest grades	Better stock information and product grading allows businesses to differentiate product into separate markets and gain higher prices that improve resilience – such as the Tree Growers Association of Nyandarua in Kenya (TGAN) inventorying and grading timber in Kenya (FAO 2020)
18/30. Processing and packaging	Processing and packaging to develop varied new products that are perceived to have more desirable characteristics for the consumer – and better employment prospects for both men and women	Processing can enhance the degree to which a product meets consumer needs – and so increase sales price, profits and resilience, for example the hygiene standards and elegant packaging of honey by the Cambodian Federation for Bee Conservation and Community Based Wild Honey Enterprises (CBHE) (Seat *et al.* 2015)

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
19/30. Vertical integration	Vertical integration – taking on more stages in the input supply or output processing to consolidate the value chain	When demand is strong, vertical integration can increase profitability by acquiring the more valuable value-chain segments – for example by 24 de Mayo taking on the processing and packaging of Guyausa tea in Ecuador (King 2020)
20/30. More distribution channels	Sell to a greater diversity of people by better placement or distribution of same product in same market	Diversifying where a product is sold, either through owned retail outlets or distribution channels can increase sales, profitability and resilience – as seen in the Himalayan Naturals which used 40 one-day demonstration kiosks in Kathmandu to build product awareness and negotiate retail arrangements (Subedi *et al.* 2015)
21/30. Better marketing	Promote diverse new market uses for different components of the same crop – or new uses for the same component	Diversifying the uses for which a product or its waste products can be sold can increase profits and build resilience – for example, the Union of Women Producers of Shea Products of Sissili and Ziro (UGPPK S/Z) in Burkina Faso using shea butter for body balms and lip salves (TFD 2011)
22/30. Horizontal diversification	Develop a diversity both of new products and for new markets through horizontal diversification	Diversifying into completely new products and new markets is challenging and can have negative impact in profitability in the short term – but builds resilience in the longer term – for example, the Viet Nam Cinnamon and Star Anise Cooperative diversifying into silk and medicinal plant production (Thoan *et al.* 2020)

5.5 Physical and technological diversification options

Diversifying physical infrastructure and technologies is often seen mainly as a feature of urban climate resilience (Meerow *et al.* 2016). It is true that in the built environment there is a close relationship between the physical and technological infrastructure and people's livelihoods and resilience to climate change. But in rural environments too, physical and technological infrastructure also plays a key role in resilience. To install physical infrastructure beyond business premises and information technology is often beyond FFPOs. But through political engagement with local authorities, it is often possible to influence the provision of new services such as roads or irrigation – especially where these will have substantial economic benefits (Thoan *et al.* 2020).

The physical reach of electronic ICTs into rural areas is one area of particular significance for resilience – as indicated by one recent review of 27 different systems (Haworth *et al.* 2018). These have proved vital in improving predictive capacity and knowledge around weather, geographical mapping of soils and crop tolerances, spread of pests and diseases and market prices.

Beyond ICT, however, there are other equally important types of physical and technological infrastructure that help improve resilience for forest and farm producers, such as terracing (Kumar *et al.* 2020), firebreaks (Scalingi 2020), business premises (Adekola and Clelland 2019), roads (van Steenbergen *et al.* 2018), water supply (MacAllister *et al.* 2020), electricity (To and Subedi 2020) and a range of other public facilities such as health (Li *et al.* 2021) and education (Feinstein and Mach 2020). The lack of infrastructure in rural areas can leave people overly reliant on local production in climate extremes (eg drought) – and this vulnerability can lead to rural-urban migrations (Javadinejad *et al.* 2020). This contrasts with recent urban market disruptions due to COVID-19 that led to a countervailing urban-rural migration (Malatksy *et al.* 2020).

What is clear is that FFPOs with a long history can develop considerable physical and technological infrastructure that can improve their resilience – not only to climate change, but also to a range of other shocks, as shown by the efficacy of the Nepalese Community Forest User Groups in disaster recovery work following the 2015 earthquake and the 2020 pandemic (Gentle *et al.* 2020). Building up such infrastructure can take time. For example, Sweden's four large forest cooperatives have taken almost a century to mature from local associations fighting for better timber prices, to international sawmilling, pulp, paper and bio-gasification electricity giants (KSLA 2009). Through structured learning, it may well be possible to greatly accelerate such transitions in the future.

Table 7 outlines various options for diversifying physical infrastructure to build climate resilience – each with an example or tool of how such physical options work in practice.

Table 7. Options for FFPO physical and technological infrastructure diversification

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
23/30. Maps and plans	Use geographical information systems (GIS) to create maps of the varied forest and land use to secure tenure and agree diverse land-use plans for both men and women	Guidance on good land-use planning as a means of optimising land use and thereby enhancing climate resilience have long been available (eg FAO 1993) and new methodologies help communities with mapping to secure rights for traditional land uses (RFUK 2015). For example, in the DRC, eight communities have developed land-use plans and six community concessions have been granted with four more in the pipeline in Équateur and North Kivu, benefitting 25,000 people who manage more than 100,000 hectares (RFUK 2015; 2019a; 2019b)
24/30. Inventory and remote sensing	Using inventory or satellite maps to demonstrate sustainable forest conditions across a patchwork of diverse land uses so as to enhance fundraising and marketing of products	Alongside tools that allow local communities to conduct Forest Integrity Assessments (HCV Resource Network 2018) there are now affordable ways to demonstrate forest cover using satellite data that can allow photographic verification of forest protection for fundraising and marketing purposes – with benefits for resilience – in platforms like Google Earth or Map X (see Lacroix *et al.* 2019)
25/30. Physical boundaries	Use of diverse physical and nature-based barriers such as firebreaks, windbreaks, mangrove tidal protection zones or animal fencing/scarecrows to protect forest and farm production sites	Physical boundaries not only strengthen territorial claims, but can also give resilience from natural threats such as fire (eg Goldammer 2017) or wildlife, although sometimes with negative effects on other wildlife species (Smith *et al.* 2020)
26/30. Terracing	Introduction of terracing or contour hedging onto steep slopes to protect from soil erosion and loss of fertility	Terracing can improve climate resilience as part of a range of soil management techniques (Hagdu *et al.* 2019). Terraces retain water and soil, allow machinery and ploughs to work in better conditions and facilitate irrigation – if well maintained (Taroli *et al.* 2014)

Focus	Action	Evidence and tools demonstrating the benefits of that type of action for FFPOs
27/30. Water management	Introduction of boreholes, irrigation, water harvesting, water saving or water reuse to diversify potential water sources as so improve dry-season animal or crop growth	Water management increases climate resilience by improving crop survival and yields through a range of possible irrigation interventions, from simple river buckets, wells and rainwater harvesting to more advanced drip irrigation or terraced water channels – albeit often beyond the reach of isolated smallholders in countries such as Zambia (see Ngoma *et al.* 2019)
28/30. Storage and transport	Develop a range of storage and transport option to allow value to be added and differentiated for different markets	In addition to processing facilities listed under economic diversification, post-harvest storage and transport technologies can increase resilience by holding stock until seasonal gluts are over and prices are better or through tapping into higher-price markets (Niles *et al.* 2018)
29/30. Electrification and technology	Installing electricity and various digital connections that allow technological diversification and better customer interactions and working environments	Electrification in rural areas – either through grid or off-grid solutions – can facilitate multiple technological advances that aid resilience such as product processing, night work and study, and better communication – and electrification also has the benefit of reducing reliance on biomass energy which can be sustainably sourced but often is not (see Tanner and Johnston 2017)
30/30. Information services	Acquiring various digital information systems for markets, weather, inputs and services can improve productivity and expand sales	Digital information and marketing can increase resilience by reducing reliance on physically accessible customers – for example, the eGranary mobile-based digital solution developed by the Eastern Africa Farmers Federation (EAFF) provides agricultural information, services and products via a mobile phone application to address challenges faced by smallholder farmers including a lack of access to markets, financial services, extension and advisory services, certified inputs and timely weather information (AgriCord and FAO 2021)

5.6 A consolidated list of 30 options for climate-resilience diversification

The previous sections surveyed some of the main options for enhancing the climate resilience of FFPOs in four dimensions. There may well be others. Part of the complexity of resilience is that options are ever changing with leaps in technology and understanding. And as noted in the preceding text, many of these options are closely integrated with one another in different dimensions of resilience. For example, ecological 'Option 6. Erosion control' and 'Option 8. Soil enrichment' can be complemented by physical 'Option 26. Terracing'. Similarly, economic 'Option 10. Processing and packaging' and 'Option 13. Marketing' can be readily complemented by socio-cultural 'Option 19 Business networks' and physical 'Option 28. Storage and transport'. It is unnecessary to try and draw tight boundaries around each option. Instead, the list of options should form a useful check list of possible ways of increasing climate resilience for an FFPO.

There is some sort of logical flow between the four dimensions of options. For example, improvements in an FFPO's social networks can pave the way to technical inputs that improve its ecological resilience. This in turn can improve the economic prospects for an FFPO's business. And profits from the latter can allow investment in physical or technological infrastructure. But the order is not rigid and many things can be put in place at once. Figure 1 from the summary and repeated here summarises the 30 options that FFPOs might wish to explore in designing resilience responses to climate risks.

Figure 1. Summary of 30 diversification options for FFPO climate resilience

Climate resilience options for FFPOs

SOCIO-CULTURAL

1. Organizational systems
2. Membership services
3. Political representation
4. Technical extension
5. Business incubation
6. Financial services
7. Quality assurance
8. Cooperative union

ECOLOGICAL

9. Climate adapted stock
10. Biodiversity enhancement
11. Spatial optimisation
12. Tree based productivity
13. Pest management
14. Soil erosion control
15. Soil enrichment

PHYSICAL

23. Maps and plans
24. Inventory / remote sensing
25. Physical boundaries
26. Terracing
27. Water management
28. Storage and transport
29. Electrification and connectivity
30. Information services

ECONOMIC

16. Increase scale
17. Stock information
18. Processing and packaging
19. Vertical integration
20. More distribution channels
21. Better marketing
22. Horizontal diversification

A women producer group from the forests of central Ghana © Duncan Macqueen

6

Analysis of climate-resilience options from 10 FFPO case studies

This analysis introduces a set of case studies that are summarised in Annex 1. It assesses the rather extraordinary extent to which even very localised FFPO groups are deploying many of the 30 climate-resilience options gleaned from the academic literature. It describes a series of examples of all 30 of the options listed in the previous chapter from those case studies.

6.1 Introducing the 10 international FFPO climate-resilience case studies

Annex 1 is a set of summaries of 10 case studies of FFPOs that are undertaking climate-resilience responses to specific climate risks in their country context. Each case study was written in 2020 by FFPOs or their technical support partners for the purpose of a peer-to-peer exchange on climate resilience that was to have taken place in Vietnam, prior to the COVID-19 crisis that led to the cancellation of the exchange event. Each summary provides a description of the producer organisation, the perceived nature of the increasing climate change risks, and the main climate-resilience responses organised by that organisation. Like previous studies of particular local responses to natural hazards (see Colding *et al.* 2002) the FFPOs here described often see hazards as normal and so devise strategies to cope with them, rather than trying to avoid the hazard altogether (eg through migration or alternative employment).

The case studies were selected from a portfolio of 99 FFPOs that had requested support from the FFF in 2020 to develop climate-resilience plans (see FFF 2021). A decision was made to select one case study from each of the 10 FFF partner countries where FFF was providing support including: Bolivia, Ecuador, Ghana, Kenya, Madagascar, Nepal, Tanzania, Togo, Vietnam and Zambia. In each country, the national facilitator, with the national FFF advisory group, assessed the merits of case study options against criteria which included: perceived strength of FFPO in climate awareness and preparedness, degree of climate threat to production system, strength of the climate-resilience response, duration over which the response had been active (longer being better), and logistical feasibility of documenting the case. A recommendation (along with a shortlist of possibilities) was proposed by the national facilitator to IIED and a final selection was made through discussions between those parties.

IIED then subcontracted either the FFPO or a knowledgeable technical support partner to document the case using a template. The template asked the authors to introduce the FFPO and its market context, describe the perceived climate change threats and then document any resilience responses that involved social, ecological and economic diversification.[1] No mention was made of the 30 options described in the preceding chapter (as these were not defined at the time the case studies were written). Each longer case was reviewed, edited (sometimes also translated) and then published online as part of FFF's commitment to co-production of knowledge. Preliminary findings have

1 The case studies were commissioned before the literature review so for the case studies reported against a threefold structure of: social, ecological and economic diversification. After the literature review we adopted a framework also involving a fourth dimension (physical and technological diversification).

been presented to other FFPOs in two different online webinars to encourage peer-to-peer learning. What is presented in this chapter is an analysis of those longer case studies (see Figure 15 and Table 8). Abbreviated summaries of the case studies are provided in Annex 1, all referenced to the original online publication.

There is a considerable range in the types of organisation that have been documented in these case studies. These range from local women-dominated producer groups in Kenya, Nepal, Togo and Zambia, an Indigenous People's group in Ecuador and four local supply cooperatives in Madagascar, to larger regional or even national associations or unions in Bolivia, Ghana, Tanzania and Vietnam. Similarly, there were a range of climate change risks documented – often focusing especially on the increasing climate variability and extreme weather events that undermine both predictability and productivity.

As noted earlier, the authors of the case studies were encouraged to describe any resilience responses that had occurred in three of the four dimensions of resilience described in this book (ie socio-cultural, ecological, economic) but unprompted by any pre-prepared list of 30 options – as that option list did not exist when those case studies were commissioned. In the concluding chapter, these case studies are used for an entirely different purpose. An attempt is made to assess how the theoretical options for climate resilience map onto actual field examples of FFPOs developing their own climate-resilience plans.

Figure 15. Map of the countries from which the case studies were selected

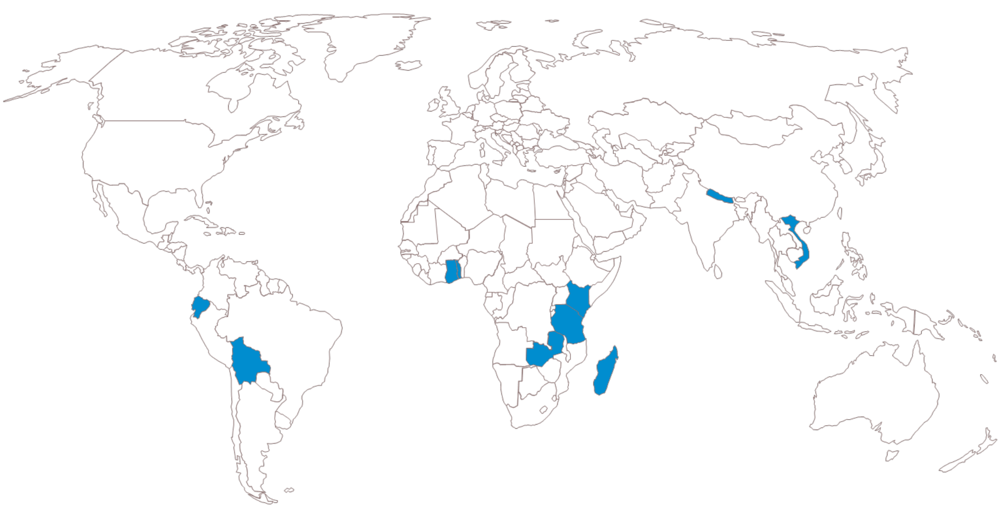


Table 8. Overview of the 10 FFF case studies on diversification for resilience

Country	Name	Production	Climate threat
Bolivia	Federation of Agroecological Producers and Collectors of Cocoa in Cochabamba (FEDPRACAO CBBA)	Cocoa and other crops based on mixed agroforestry	Heavier winter rains, summer droughts and fungal outbreaks
Ecuador	Artisanal Producers Association of Agricultural and Livestock Goods of Napo (Kallari)	Cocoa and other crops based on indigenous *chakra* agroforestry system	Alternate droughts and heavy rainfall events with increased pests and diseases
Ghana	Kassena-Nankana Baobab Cooperative Union (KANBAOCU)	Trading cooperative based on multiple tree crops, cash crops and vegetables	Unpredictable rains – with extreme events (droughts and floods) and pests and diseases outbreaks
Kenya	Lake Elementaita Tree Nurseries Self Help Group (LETNSHG)	Seedlings of tree crops and ornamental plants	Unpredictable rains – with drought (sometimes seasonal floods) and pest and disease outbreaks
Madagascar	Manarivo AB and its four supply cooperatives	Groundnut oil and other aromatic oil production	Late, more variable rains, dry season fires, occasional floods, increasing pests and diseases outbreaks
Nepal	Laliguras Herbal Women Group (LHWG)	Aromatic oil production in farm land and community forests	Unpredictable and increasingly extreme weather, plus more pests and diseases outbreaks
Tanzania	Tanzania Tree Growers Association Union (TTGAU)	Timber and fruit tree plantations	Shorter rainy season, high temperatures and pests and diseases outbreaks
Togo	NOVI VA, a Simplified Cooperative Society (SCoopS)	Cassava products from agroforestry systems	Unpredictable rainfall and droughts
Vietnam	Viet Nam Cinnamon and Star Anise Cooperative	Cinnamon and star anise from diverse farm smallholdings	Extreme weather events, increasing temperatures, pests and diseases outbreaks
Zambia	Tubeleke Women Club	Basket weaving and semi-arid livestock rearing	Diminishing and more erratic rainfall leading to severe droughts

6.2 Diversification options adopted in FFPO case studies involving FFF support

Table 9 presents a summary of the degree to which the different case-study FFPOs described in Annex 1 and indicated here by their country name abbreviation, have used specific diversification options as a means of improving climate resilience after requesting and receiving support from the FFF. The longer original case studies have been used to shade the various resilience options in this table.

In many cases there are explicit references to these resilience options shown in dark blue and scored as 1. But in fewer cases, there is only implicit mention of a particular resilience option. For example, in the Nepalese case of the Laliguras Herbal Women Group (LHWG) the training given to the women in aromatic oil distillation by the company Chaudhary Biosys Nepal Pvt Ltd (CBNPL) is strongly suggestive of a production quality-assurance process – but this is not explicitly stated. As noted earlier, case studies were written under the three broad dimensions of socio-cultural, ecological and economic resilience – but not armed with a set of predefined categories, to preserve the integrity of the cases. So, in cases where the option was relatively obvious, but not explicit, the option is shown in light blue and scored 0.5. In some instances, there is no mention of a resilience option and no grounds for believing that it has been put in place and these are left uncoloured and scored 0. Given the 10 case studies, the totals on the right column of Table 8 add up to a total of 10 – loosely indicative of the degree to which FFPOs are adopting particular resilience options.

FFPOs clearly apply a diverse range of climate-resilience options across multiple domains. They must, as their members' livelihoods are at stake. A striking fact is the degree to which FFPOs in very different contexts are doing multiple, sophisticated things to become climate resilient. Driven perhaps by their high degree of dependence on their socio-cultural, environmental, economic and physical and technological assets, FFPOs are not 'dabbling' with climate resilience. Even the most localised groups such as the Tubeleke Women Club in Zambia had adopted more than half of the full range of resilience options. All FFPO case studies are acting decisively on multiple fronts to put in place the means of their survival. Supporting them to do so – one of four outcomes of FFF – offers significant returns on investment.

Greater climate resilience often involves **climate change mitigation**, but the link is not straight forward. Some resilience options have a generally direct and positive impact on climate change mitigation (marked in red in Table 9). For example, Option 12 on increasing tree-based productivity is perhaps the most direct guarantee of greater above-ground and soil carbon storage. But Option 9 (improving climate-adapted stock) and Option 13 (pest management) will also tend to increase above and below-ground carbon storage to different extents depending on the crops in question, by reducing crop failure.

Similarly, Option 10 (enhancing biodiversity) will potentially increase carbon storage, especially if tree species are introduced. Option 11 (spatial optimisation of different crops) will also tend to increase the above and below-ground carbon storage. Option 14 (erosion control), Option 15 (soil mulching) and Option 26 (terracing) deal mainly with increased soil carbon storage. In no case are the relationships between the action and the carbon storage likely to be straight forward, however, and quantification would be needed to assert the magnitude of any link.

This is even more the case for indirect links marked in pink in Table 8. For example, business incubation might, if directed towards tree-based value chains, incentivise more tree planting and hence more carbon storage. But not all business incubation will achieve that end and the magnitude of the link will depend very much on circumstances. In general, we can assert that the effort to improve climate resilience in the case studies here represented has tended to increase climate change mitigation – but that is not necessarily always the case and the magnitude of the link has not been assessed.

Table 9. Extent to which case-study FFPOs from 10 countries deploy various resilience options

Option – diversification focus	CM	Bolivia	Ecuador	Ghana	Kenya	Madagascar	Nepal	Tanzania	Togo	Vietnam	Zambia	Total
SOCIO-CULTURAL												
1. Organisational systems												7
2. Membership services												7.5
3. Political representation												6
4. Technical extension												10
5. Business incubation												9.5
6. Financial services												6
7. Quality assurance												8.5
8. Cooperative union												7.5
ECOLOGICAL												
9. Climate-adapted stock												10
10. Biodiversity enhancement												8.5
11. Spatial optimisation												6

Option – diversification focus	CM	Bolivia	Ecuador	Ghana	Kenya	Madagascar	Nepal	Tanzania	Togo	Vietnam	Zambia	Total
12. Tree-based productivity	Red	Dark blue	Dark blue	Light blue	Dark blue				Dark blue			4.5
13. Pest management	Red	Dark blue	Light blue					Light blue		Light blue		2.5
14. Soil erosion control	Red	Light blue	Light blue	Dark blue		Dark blue						3
15. Soil enrichment	Red	Dark blue	Dark blue	Dark blue	Light blue	Dark blue			Dark blue	Dark blue	Dark blue	7.5
ECONOMIC												
16. Increase scale	Pink	Light blue		Dark blue	Light blue	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue		7
17. Stock information		Light blue	Dark blue	Light blue	Dark blue	Light blue	Light blue	Dark blue	Dark blue	Dark blue	Light blue	7.5
18. Processing and packaging		Dark blue	Dark blue	Light blue	Dark blue	Dark blue	Dark blue		Dark blue	Dark blue	Dark blue	8.5
19. Vertical integration		Light blue	Dark blue	Dark blue		Light blue	Dark blue	Dark blue		Dark blue		6
20. More distribution channels		Dark blue	Dark blue	Light blue	Dark blue	Dark blue		Dark blue	Dark blue	Dark blue		7.5
21. Better marketing	Pink	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue		Dark blue	Dark blue	Dark blue	Dark blue	9
22. Horizontal diversification	Pink		Dark blue	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue		Dark blue	Dark blue	8
PHYSICAL/TECHNOLOGICAL												
23. Maps and plans			Light blue				Light blue	Light blue				1.5
24. Inventory and remote sensing								Dark blue				1
25. Physical boundaries	Pink	Dark blue		Light blue	Light blue							2
26. Terracing	Red					Dark blue						1
27. Water management	Pink			Dark blue	Dark blue						Dark blue	3
28. Storage and transport		Dark blue	Light blue	Light blue	Dark blue	Dark blue	Light blue	Light blue	Dark blue	Dark blue		7
29. Electricity and connectivity		Light blue	Light blue	Light blue	Light blue	Light blue		Light blue		Dark blue		4
30. Information services		Light blue	Dark blue	Dark blue	Light blue	Light blue	Dark blue	Dark blue	Light blue	Dark blue	Dark blue	8

Key: Dark blue = confirmed action (1); Light blue = implicit or part of plan (0.5); White = not recorded (0); CM column = climate mitigation potential where: Red = direct climate mitigation potential; Pink = indirect climate mitigation potential.

Certain climate-resilience actions are almost ubiquitous, especially in the socio-cultural and ecological dimensions. For FFPOs choosing to prioritise climate resilience (as in these cases) adoption of the more common resilience options was almost universal. All FFPOs in very different contexts were providing their members with socio-cultural support through the provision of technical forest and farm advisory services (Option 4). All had identified and secured more ecologically resistant species or varieties (Option 9) and almost all had increased on-farm biodiversity (Option 10).

Building more profitable and sustainable business is also a key area of economic resilience action. Almost all had provided business incubation support (Option 5), with very frequent attention to diversifying and enhancing marketing (Options 21 and 22), improving information to their members (Option 30), enhancing processing and packaging (Option 18) and developing different types of quality assurance (Option 7).

By way of contrast, physical and technological options are more scattered and context specific. Options to do with installing physical infrastructure or technology are somewhat less frequently adopted than socio-cultural, ecological and economic options. This may be in part because some of the physical and technological options are more contextually specific. For example, not all FFPOs need to use mapping to secure their tenure right. Not all FFPOs are on steep land or require terracing. Not all are threatened by fire or wildlife or tidal surges or require physical space, fences or mangrove barriers to protect them. Physical and technological options can be more expensive, too, requiring more considered planning and investment. Furthermore, physical and technological options may require political support or external partnerships that complicate their development.

All resilience options are exemplified by at least one case study example. Given the small number of cases, this is rather extraordinary! Indeed, it would be easy from this small sample of 10 case studies to describe many good examples of any particular climate-resilience option. To illustrate this fact, the following sections describe, for each option, one good example of how limited FFF support channelled directly to an FFPO has improved climate resilience. An attempt is made to spread the examples across the 10 case studies. The examples are given in the order listed above of socio-cultural, ecological, economic, and physical and technological dimensions of resilience.

6.3 Case-study examples of socio-cultural options for climate resilience

The eight (out of 30) climate-resilience options within the social dimension are widely adopted in the 10 case studies. In Table 10, one example is given of each climate-resilience option from the case studies.

Table 10. Examples of socio-cultural climate-resilience response options adopted in the case studies

Socio-cultural option for climate resilience	One example of that option from the 10 FFF case studies
1. Organisational systems	Lake Elementaita Tree Nurseries Self Help Group (LETNSHG) in Kenya conducted a self-assessment of its governance structures. They then identified system gaps and responded in this case by developing collective marketing processes and joints savings and loans schemes, which helped reduce the risk of failure from climate threats (Wekesa 2020).
2. Membership services	The Artisanal Producers Association of Agricultural and Livestock Good of Napo (Kallari) in Ecuador improved commercial opportunities for women by tackling, in special dialogues, the ancestral patriarchy in the *chakra* production system. This has strengthened women's participation and income generation and resilience in the face of climate change (Poso 2020).
3. Political representation	The Bolivian Federation of Agroecological Producers and Collectors of Cocoa in Cochabamba (FEDPRACAO CBBA) helped to establish the national Confederation of Bolivian Producers and Collectors of Ecological Cacao (COPRACAO), which successfully lobbied for a US$21.7 million cocoa support programme over 5 years greatly enhancing the climate resilience of its members (Aro 2020).
4. Technical extension	FEDPRACAO CBBA also formed youth squads or '*esquadrillos*' to train other farmer trainers in grafting more climate-resilient cocoa varieties – one of many examples of FFPOs procuring and spreading technical knowledge on climate resilience (Aro 2020).
5. Business incubation	LHWG in Nepal used their business skills in aromatic oil production to establish other businesses in fish farming, tourism and renewable energy. This diversity gives their core business resilience to climate change risks (Adhikari *et al*. 2020).
6. Financial services	The Tubeleke Women Club in Zambia have established a village savings and loans association whose function has been to improve access to finance for members to invest in improvements to their commercial activities – but has also served as an emergency response fund in the severe drought that affected the group (Machona 2020).
7. Quality assurance	The Viet Nam Cinnamon and Star Anise Cooperative has developed full organic certification for 500 hectares of cinnamon and designed and attracted finance for a state-of-the-art 9,900m^2 processing factory in less than four years (Thoan *et al.* 2020).
8. Cooperative union	KANBAOCU in Ghana helped to establish the Ghana Federation of Forest and Farm Producers (GhaFFaP) to help advocate for member producer organisations. This already represents 1 million plus members and is helping to advocate for an enabling environment which will make easier FFPO activities for climate resilience (Awaregya and Amoah 2020).

6.4 Case-study examples of ecological options for climate resilience

The seven (out of 30) climate-resilience options within the ecological dimension are also widely adopted in the 10 case studies. In Table 11, one example is given of each climate-resilience option from the case studies.

Table 11. Examples of ecological climate-resilience response options adopted in the case studies

Ecological option for climate resilience	One example of that option from the 10 FFF case studies
9. Climate-adapted stock	Every single FFPO case study procured climate-adapted forest, farm or livestock components. One good example is that of KANBAOCU in Ghana, which introduced more drought-resilient varieties of the main crops such as millet and sorghum plus drought-resistant trees such as parkia and balanites (Awaregya and Amoah 2020).
10. Biodiversity enhancement	LHWG in Nepal diversified the numbers of aromatic oil species to ensure a steady supply of oil products and avoid the risk of failure in any one plant species due to climate stresses (Adhikari *et al.* 2020).
11. Spatial optimisation	Kallari in Ecuador expanded the planting of traditional fruits – choosing careful spatial locations to maximise productivity within cocoa agroforestry systems, diversifying flavours for Kallari chocolate and reducing the risk of climate-related failure in any single component (Poso 2020).
12. Tree-based productivity	NOVI VA cassava-processing cooperative in Togo supported members to plant *Leucaena leucocephala* as a nitrogen fixing tree to improve soil fertility for cassava production and reduce risks of climate-related reductions in yield (Gaglo 2020). The trees can also be harvested for wood energy that is used in cassava processing, thereby reducing pressure on adjacent forests.
13. Pest management	The FEDPRACAO CBBA in Bolivia has been working with farmers to cultivate elite pest-resistant cocoa varieties for grafting – which will help farmers to cope with the more frequent outbreaks of pests due to climate-stressed plants (Aro 2020).
14. Soil erosion control	KANBAOCU in Ghana has been training members in zero tillage cultivation techniques to avoid soil erosion (Awaregya and Amoah 2020). These techniques have helped to maintain fertility and thereby yields in the face of a more variable climate.
15. Soil enrichment	NOVI VA in Togo encouraged members towards mixed agroforestry using livestock (sheep and goats) as a source of manure within composting sites to support cassava production which improves the climate resilience of that main crop (Gaglo 2020).

6.5 Case-study examples of economic options for climate resilience

The seven (out of 30) economic options for climate resilience have been widely adopted by FFPOs in the case studies. In Table 12, one example is given of each climate-resilience option from the case studies.

Table 12. Examples of economic climate-resilience response options adopted in the case studies

Economic option for climate resilience	One example of that option from the 10 FFF case studies
16. Increase scale	The simple measure of expanding membership to increase production scale is one of several measures taken by LETNSHG in Kenya, whose tree nursery members developed collective marketing for their nurseries. This enabled them to sell to larger clients – for example, 100,000 seedlings to the Co-operative Bank of Kenya and new sales to the Green Belt Movement (Wekesa 2020). Increased profitability of such sales increases the resilience of members of the group.
17. Stock information	The Viet Nam Cinnamon and Star Anise Cooperative has sophisticated processes of processing, packaging and monitoring stock, for example for its 12 types of cinnamon product (Thoan *et al.* 2020). Increased sales and profits enhance the resilience of cooperative members.
18. Processing and packaging	NOVI VA in Togo has developed high-quality packaging and labelling to differentiate its four main cassava products (tapioca, gari, starch powder and cassava bread flour), with the aim of supplying local supermarkets to diversify its sales options and improve the resilience of members (Gaglo 2020),
19. Vertical integration	LHWG in Nepal took on the aromatic oil distillation process from the original trading company CBNPL which had helped to set up the distillation unit (Adhikari *et al.* 2020). Similarly, TTGAU in Tanzania helped local tree growers' associations (TGAs) to take on the agro-dealer role of collecting and transporting timber as a means of improving profitability and thereby resilience of their enterprises (Timbula 2020)
20. More distribution channels	The Ecuadorian cocoa and chocolate producer Kallari secured a new buyer, Max Felchlin, to broaden its sales outlets for its confectionary products (Poso 2020).

Economic option for climate resilience	One example of that option from the 10 FFF case studies
21. Better marketing	Manarivo AB in Madagascar sources from four supply cooperatives and has developed sophisticated marketing and advertising for its groundnut and aromatic cosmetic product lines under the Tresor & Sens brand – increasing farmer incomes by 10–12% per year which has increased their resilience in the face of climate-related risks (Noasilalaonomenjanahary and Ramaromisa 2020).
22. Horizontal diversification	The process of horizontal diversification – developing entirely new product lines – has been successfully achieved by several FFPOs, including Kallari in Ecuador which diversified into vanilla and guayusa teas from their original base in cocoa and chocolate (Poso 2020)

6.6 Case-study examples of physical/technological options for climate resilience

Relatively few of the FFPO case studies recorded developing or investing in the eight (out of 30) resilience options to do with physical infrastructure or technology. This may in part be because the authors of the case studies were not asked to document physical or technological resilience responses. Even so, one example of each resilience response options is given below in Table 13.

Table 13. Examples of physical or technological climate-resilience response options adopted in the case studies

Physical or technological option for climate resilience	One example of that option from the 10 FFF case studies
23. Maps and plans	Only one of 10 case studies had invested in mapping and even then, this was only part of the picture as Kallari in Ecuador developed a geographical labelling system for their traditional *chakra* agroforestry system to help secure territorial autonomy for their members (Poso 2020). TTGUA in Tanzania did not map the areas but did help women members to get Certificates of Customary Rights of Occupancy (CCROs) to allow them to formally control their tree-based enterprises – thereby increasing their resilience (Timbula 2020).

Physical or technological option for climate resilience	One example of that option from the 10 FFF case studies
24. Inventory and remote sensing	TTGAU in Tanzania trained its members in timber inventorying to improve stock information for its buyers with the aim of increasing orders and thereby the income and climate resilience of its members (Timbula 2020).
25. Physical boundaries	Few FFPOs felt threatened by fires or wildlife, but the threat certainly existed in Bolivia which had suffered from record-breaking Amazonian fires. The Bolivian FEDPRACAO CBBA made considerable progress in establishing border alleys for fire prevention and then a succession of annual and perennial crops culminating in mature cocoa groves under timber (Aro 2020).
26. Terracing	Manarivo AB in Madagascar have been working with four groundnut production groups to establish terracing on steep slopes to maintain fertility and try to offset yield reductions through climate change (Noasilalaonomenjanahary and Ramaromisa 2020).
27. Water management	The Tubeleke Women Club secured resources for a borehole to improve their climate resilience in the face of droughts in Zambia (Machona 2020). KANBAOCU in Ghana trained its members in dry-season rainwater harvesting for vegetable irrigation in the White Volta and Sissili Basins (Awaregya and Amoah 2020)
28. Storage and transport	NOVI VA in Togo developed a dedicated stock aggregation and processing facility for women cassava processors (Gaglo 2020) which increases efficiency, market scale and thereby resilience in the face of climate-related stresses.
29. Electrification and technology	The Viet Nam Cinnamon and Star Anise Cooperative has installed a fully connected factory, storage and office complex to improve their business operations (Thoan *et al.* 2020). This significantly improved incomes for cooperative members and their resilience to the impacts of climate change.
30. Information services	Manarivo AB in Madagascar worked with four supply cooperatives to raise awareness of market prospects for and climate-resistant planting materials of aromatic crops that can be grown and sold within their Trevor & Sens cosmetic line. This information service has led to diversified planting with greater resilience to climate change (Noasilalaonomenjanahary and Ramaromisa 2020).

A bamboo producer from the lowlands of Ecuador © Duncan Macqueen

7 Conclusions: how to scale up FFPO climate resilience

This final chapter introduces a set of five pathways to recognise and scale up climate resilience responses by FFPOs. It then provides a set of recommendations for Government decision-makers and donors, before drawing some final conclusions.

7.1 Five pathways to recognise and scale up climate-resilient responses by FFPOs

FFPOs are having to adapt to a changing climate and within their capabilities are doing so fast and effectively. But the challenge remains as to how best to support them to persist, adapt and transform as the impacts of climate change worsen. Proposed here are five clear pathways by which FFPOs and their resource partners might foster better recognition and scaling up of these FFPO-led climate-resilience responses.

Pathway 1. Improve documentation of the beneficial impacts of FFPO resilience action

An obvious place to start for FFPOs and their technical support partners would be to undertake two steps:

- First, documenting the adoption of climate-resilience options by FFPOs (ie the 30 options listed in this report), and
- Second, the impact of adopting those options (through existing toolkits such as SHARP – see Choptiany *et al.* 2015).

Examples from the case studies show clear **social empowerment** benefits – effective organisations that are shaping more enabling policies – including many examples of women's empowerment. They also show **livelihood benefits** that come from business diversification and deliver gains in income, savings and investment funds that reduce poverty. The case studies demonstrate widespread **biodiversity enhancement** alongside the integration of tree components and improvements in soil organic matter – both of which increase **climate change mitigation**. Finally, in many cases the work of FFPOs has led to real advances in physical infrastructure or adoption of new technology leaving a **legacy of physical and technological infrastructure** to improve options for the future. Better monitoring and learning systems are needed to track these impacts of FFPO resilience actions.

Pathway 2. Strengthen multiple levels of organisation so knowledge and practice can spread

FFPOs and their technical support partners can catalyse discussions about how better to work together. As noted in Chapter 4, local FFPOs often group together to form second-tier regional aggregation and processing associations, who in turn often group into third-tier, apex-level national federations. Apex-level organisations of this sort, such as the Viet Nam Farmers' Union (VNFU) represent millions of producers whose climate action covers millions of hectares. Such organisation can greatly improve the spread of knowledge upward, downward and horizontally – and thereby help to upscale the best climate-resilience actions. Organisation also brings power and voice: a strength in numbers that can help shift policies at both national and international levels to unlock finance and enabling policies or resilience practices. Organisation also facilitates efficiency in project implementation, when those organisations are connected to national or international climate programmes.

Pathway 3. Build capacity for risk assessment and resilience responses in FFPOs

FFPOs and their technical support partners can scale up peer-to-peer exchanges around climate resilience. Ecological impacts of climate change are only one of many types of risk faced routinely by FFPOs. Disease outbreaks such as COVID-19 add to an existing spectrum of market shocks that are themselves magnified by frequent socio-political turmoil. FFPOs routinely must help members recover from such stresses – and they are normally good at it. Mainstreaming periodic and broad risk-self assessments using toolkits such as *Securing Forest Business* (Bolin *et al.* 2016) helps to put climate risks in context – and avoids finding climate solutions only to encounter, say, market failure. Encouraging consideration of different resilience response options (eg the 30 listed here) can then help equip FFPOs with confidence to act. No two contexts are alike and the best options for climate resilience will inevitably vary from place to place. For example, in very remote locations with limited market options the focus may be on socio-cultural and ecological options to cope with largely subsistence survival where there are only a few cash crops. Nearer to urban centres the priority may be to diversify business options into a range of local and even export markets to spread risk of failure across a spectrum of different economic options. As FFPOs grow in size and capability, investing in the physical and technological infrastructure may make increasing sense. Allowing FFPOs to learn from one another is an efficient form of technical extension and uptake (Franzel *et al.* 2019). Building learning events mediated by apex-level FFPOs such as farmer federations that allow first-tier forest and farm organisations to learn from one another is critical investment in this space.

Pathway 4. Improve FFPO representation in conferences of parties to Multilateral Environmental Agreements

FFPOs and their technical support partners need to work together to improve representation. Building a climate-resilient future is an ongoing priority for Multilateral Environmental Agreements (MEAs) such as the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD) and the Convention on Biological Diversity (CBD) – not to mention the Non-Legally Binding Instrument on All Types of Forests (Forest Instrument) of the United Nations Forum on Forests (UNFF). Each of the main MEAs has a Conference of the

Parties (CoP) which serves as the governing body of the convention and advances implementation of the convention through the decisions it takes at its periodic meetings. Getting voices and agency of locally accountable FFPOs heard and understood at these meeting is vital if real climate solutions are to be found that involve these organisation in implementing climate-resilience action at scale. At present these spaces are dominated by agencies who have no member-based accountability to forest and farm producers. One practical mechanism to improve FFPOs' voice in these international spaces might be to link their initiatives in some way to the Race to Resilience campaign.[2]

Pathway 5. Attract more climate finance for FFPOs by linking to mainstream climate programmes

FFPOs and their technical support partners need to engage better with climate finance. Financing for a climate-resilient future is ramping up through dedicated funds that serve the main MEAs, of which by far the largest are the Green Climate Fund (GCF), the Global Environment Facility (GEF), the Adaptation Fund (AF) and Least Developed Countries Fund (LDCF). Each fund channels finance to serve those conventions through a small number of accredited agencies – such as the World Bank, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), and FAO – that then distribute money mainly to government agencies but also civil society partners. At present very little funding flows to FFPOs of the sort described in the case studies. For example, as little as 10% is believed to reach anything that might be called 'the local level' (Soanes *et al.* 2017) and as little as 1.7% may reach smallholders and their organisations (Chiriac *et al.* 2020).

Given the effectiveness of FFPOs at solving climate problems, the larger global environmental funds need to radically rethink their approach – and turn government agencies towards facilitative governance while ensuring much more funding reaches the landscape-scale implementing agency of FFPOs. COVID-19 has forced FFPOs to take on several resilience measures to help members survive the health and economic shocks of the pandemic (Covey and Bolin 2021). As resources are made available for COVID recovery, a useful strategy would be to use those resources to build smallholders' long-term resilience by bridging COVID-19 support into longer-term support for adaptation, mitigation and restoration initiatives that recognise livelihoods and poverty eradication.

2 See https://racetozero.unfccc.int/first-round-of-initiatives-join-the-race-to-resilience

7.2 Implementing the pathways: recommendations to donors and governments

Putting into place these five pathways for better recognising and upscaling FFPOs climate-resilience impacts would also benefit from the support of donors and government decision-makers. The following recommendations are directed to that secondary audience:

- In official development assistance (ODA) or national funds for climate action, insist on improved indicators that track and quantify the benefits of local organisations' climate-resilience action.
- Increase direct enabling investment that strengthens FFPOs and the links between them, as a critical foundation for climate action.
- Support capacity development for climate resilience through increased investment in peer-to-peer learning to take advantage of the widespread capabilities within FFPOs.
- Makes space for representatives of FFPOs in the conferences of parties of the Multilateral Environment Agreements – both as advisors and accredited implementation agencies for climate action.
- Increase the small-grants components of the main climate funds and channel much more funding directly to democratically accountable FFPOs.

7.3 Conclusions

The 30 climate-resilience options and the simple framework surrounding them offer a pragmatic way forward for FFPOs and their technical support partners. **Innovation is to be found less in what to do, but in how to organise to get it done**. It is here that myriad member-based FFPOs provide vital inspiration. As forest and farm producers organise, often with their very survival in view, they start to build resilience. As noted in many excellent recent case studies (AgriCord and FAO 2021), FFPO approaches to resilience are highly pragmatic and solution oriented with an aim to secure the viability of forest and farm livelihoods for current and future generations.

Climate resilience and climate change mitigation often involve complementary pathways. But for FFPOs, climate action is one part of a larger integrated development pathway that involves putting in place the structures that will help them cope with constant change – political upheavals, economic shocks, health pandemics such as COVID-19, youth out-migration and so on. Again, as noted in AgriCord and FAO (2021) forest and farm producers' livelihoods are threatened by a complex risk context, where environmental change is undoubtedly accelerating, but as one part of a broader set of chronic and episodic stressors and disturbances outside of the range of experience. Assessing, prioritising and responding to those broader risks, rather than making everything about climate change, is a vital starting point.

Risk assessment and resilience responses work together and should always be done in close collaboration with FFPOs or local communities. Improving both the risk assessment capabilities of forest and farm producers (through better information and links to environmental and economic forecasting) and broadening their understanding of resilience response options has multiple benefits. It helps those local producers survive. It restores and diversifies forest and farm production systems. It does so in ways that can mitigate climate change. It is an investment worth making.

The groups, associations and federations that comprise FFPOs offer realistic pathways to scale for climate-resilience action. FFPO networks can offer to vital ingredients: first, they enable effective local innovations in climate resilience to spread upwards and outwards through organised structures that share information. Second, they offer a route to channel climate finance downward – an efficient delivery mechanism for the rapid spread of resilience and climate mitigation.

There is much new thinking on how to build back better from COVID-19 to enhance resilience in food systems (see Béné 2020, van Zanten and van Tulder 2020, Blay-Palmer *et al.* 2021, Huss *et al.* 2021). If we are to build back better from COVID-19, FFPOs are already highly operational in terms of resilience action, as demonstrated by this report and the complementary work of AgriCord and FAO (2021). That latter publication summarises a global FFPO survey conducted in 2020 demonstrating that of the 111 respondent FFPOs, 90% had implemented actions to adapt to COVID-19 (eg awareness-raising, hygiene campaigns, market strategies, collaboration with governments) and that 85% had also engaged in climate action (eg strategies and advisory services on climate adaptation and mitigation). In other words, FFPOs are on it. They are not passive recipients of ODA. They are often highly proactive innovators for both COVID-19 recovery and climate resilience.

National and multilateral agencies would do well to learn from FFPOs and position them as central agents of climate resilience in the future. At present, FFPO inclusion in formal funding channels is often impeded by prejudice and rules of due diligence, accreditation and bureaucracy. This must change.

Ways must be found to de-risk for climate finance agencies the practice of channelling funding directly to FFPOs. It is not acceptable that only 1.7% of climate finance goes directly to smallholders in developing countries despite their disproportionate vulnerability to the impacts of climate change and the pre-eminence of their organisations in adapting to it (Chiriac *et al.* 2020). Climate finance must increasingly be channelled through the agency provided by these FFPOs. They offer both the capacity and pathway to scale to get the job done.

Annex 1. 10 case studies of international FFPO climate resilience

Case study 1. Bolivia: Federation of Agroecological Producers and Collectors of Cocoa in Cochabamba (FEDPRACAO CBBA)

This case study is a summary of a more detailed analysis of FEDPRACAO CBBA (Aro 2020).

1.1 Introduction to the producer organisation

Bolivia has more than 50 million hectares of forest, mostly in the Amazon region, which covers 43% of Bolivia's territory. Deforestation and uncontrolled fires (which destroyed more than 3.6 million hectares of forest in 2019) are responsible for about 90% of national CO_2 emissions. Cochabamba is one of the regions most affected by deforestation and land-use change, reporting 85% loss of forest cover. In this context, agroforestry systems with shade tolerant cocoa offer a way restore tree cover – especially when mixed with diverse short, medium and long-term crops. Cocoa production in the low-lying region of Cochabamba (200–240m above sea level) has been promoted since 2004.

Since 2016, Cochabamba producers have been organised under FEDPRACAO CBBA. More than 560 families belong to its five member-based associations, including its two commercial arms – Chocolate Tropical (collecting raw hybrid cocoa from planted stands) and Arcasy (collecting wild cocoa from Indigenous Peoples). FEDPRACAO CBBA is itself one of five departmental cocoa producer organisations federated under the Confederation of Bolivian Producers and Collectors of Ecological Cacao (COPRACAO) with support from the FFF in 2019. FEDPRACAO CBBA is a relatively small player compared with FEDPRACAO La Paz, in which the central cooperative El Ceibo produces 70% of the countries production (1,420MT/yr).

FEDPRACAO CBBA has been developing the quality of its products since 2016 and was recognised for its 'fine and aromatic cocoa' in the first Bolivian Cocoa and Chocolate Salon in 2019 – with samples also sent to the Paris Chocolate Salon. Cocoa is currently sold to national companies such as Chocolates La Paz and Incona SRL. It fetches prices of US$3,500/MT for hybrid and US$5,000/MT – well above the average New York Stock Exchange cocoa price of US$2,337/MT in 2020.

1.2 Main perceptions of climate change risks

Cocoa producers in Cochabamba talk of a two-fold threat from climate change. On the one hand, January to March periods have seen heavy rainfall events and unusually cold temperatures. The rains bring flooding especially in the Yuracaré region where the indigenous wild coca is produced. In 2019, 356 families had to be evacuated from their homes. Cocoa plants were destroyed and damaged by a proliferation of fungal diseases: black pod (*Phytophthora sp.*) and moniliasis (*Moniliophthora roreri*). Additionally, cold temperatures below 15°C paralyse vegetative development of cocoa and other crops such as cassava, bananas, pineapples and pacay. Under these conditions, the physiological ripening time lasts for more than five months, when the usual time is between four and five months. In 2010 for example, low temperatures caused the loss of 80% of cocoa production.

Perversely, during the August to October period, there have been intense dry seasons. Water in the communities producing cocoa has even dried up. In the devastating 2019 fires, 7,538 families were affected and 5,438 hectares of planted crops lost. This followed a voracious forest fire in 2014 that swept away more than 500 hectares of forest, cocoa, citrus, coca, pineapple and grassland in the municipality of Chimoré. Water deficits in dry areas have caused physiological problems with flowering and fruit development resulting in loss of leaves, reduced production, blackening of the fruits and the entry of fungal diseases. Such events – both floods and droughts – have serious impacts on business, both on cocoa production, but also many of the alternative livelihood options such as agricultural crops or timber extraction.

1.3 Main climate-resilience responses

The climate-resilience responses of FEDPRACAO CBBA have been built around the considerable agroecological diversity of their cocoa systems. Under its new Climate Resilience Plan developed in 2020, members have already established 30 hectares of a planned total of 300 hectares of new cocoa agroforestry. Methods involve diversifying annual, medium and longer-term crops either through:

- Controlled burning in which trees are felled and crop land burnt, leaving border alleys to prevent future fires and then a gradual succession of annual and perennial crops, culminating in mature cocoa groves under valuable timber species, or

- Land rehabilitation without burning, which is the preferred method (in which 5–7-year-old secondary forests are thinned to leave more valuable shade trees, giving 50% shade for cocoa plantation alongside other shade tolerant crops).

Progress has also been made to rehabilitate more than 25 hectares of a planned 300 hectares of unproductive plots. An organisational innovation has been used to achieve this, through the formation of youth cocoa squads (*escuadrillos*) to train trainers in grafting. The results have included a five-fold increase in annual yields for 33 producer families helped so far (from 138 to 690Kg/ha).

In addition to the crop diversification in cocoa land rehabilitation areas and the increased productivity (that offsets climate-related production losses), resilience has also been built through FEDPRACAO CBBA training and exchange of experience events – in partnerships with Chocolate Tropical and El Ceibo. In 2019, these involved 96 producer families and covering agroecological issues such as the nature of climate change, soil enrichment and management, cocoa clones to withstand climate change, the importance of grafting for production, pruning to reduce disease, and the dynamics off cocoa agroforestry.

Growing agroecological resilience has been accompanied by work to improve economic resilience. FEDPRACAO CBBA co-financed the project with the FFF to establish 30 hectares and rehabilitate a further 25 hectares of cocoa production. It has also started work to select 15 elite cocoa plants that are coping with climatic conditions and pests/diseases to further improve production. Among the five training workshops and exchange of experience events were courses on organisational strengthening, marketing, the values and principles of co-operative business, chocolate making and confectionary, and the value chain from cocoa harvest to the chocolate bar.

Resilience through ecological and economic advances has also been accompanied by socio-cultural resilience through a strengthening of organisational networks and partnerships. In addition to the partnerships with FAO and El Ceibo to deliver training and upskill producers, new links have been built with chocolate buyers and service providers such as Breick Chocolate, Sauce TIPNIS, UMSA Experimental Station and the Sara-Ana Experimental Station of FIBL-ECOTOP. The new federation COPRACAO to which FEDPRACAO belongs has formulated a National Programme of Support for the Production and Collection of Cocoa, which will invest US$21.7 million over five years in the establishment of 8,593ha of cocoa, benefiting 7,500 families. New national cocoa and chocolate salons, and support for participation in business roundtables (eg in Colombia in 2019) have increased prices by 10% so that families can reinvest more in production. Further resilience will come from expanding production in Cochabamba to be able to meet larger and more lucrative orders – while preserving the diverse agroforestry systems and organisation trust on which resilience rests.

Case study 2. Ecuador: Artisanal Producers Association of Agricultural and Livestock Goods of Napo (Kallari)

This case study is a summary of a more detailed analysis of Kallari by Poso (2020).

2.1 Introduction to the producer organisation

The Napo region of the Ecuadorian Amazon is home to the Kichwa people settled in the provinces of Napo, Orellana and Sucumbíos. Their native language is Runa Shimi. The Kichwa people pay particular attention to their ancestral living and agricultural practices known as '*chakra*'. The chakra involves both a living space (managed mainly by women of the *chakra*) and a productive space located within the farm – both of which are characterised by agroforestry systems that have high agrobiodiversity that is rotated and combined in complex ways – and both are also habitat to a wide range of birds, insects, mammals, amphibians and small reptiles. The chakra is also an important source of ecosystem services – all of which are managed through ancestral knowledge to guarantee food security and income generation for their families. These ancestral production practices retain what is known the local values of *sumak kawsay* (which means 'good living' or 'well living').

The Kallari association was legally constituted as a cooperative on 10 December 2010 in the city of Tena. It is made up of 850 families (5,000 individuals) spread across 21 communities and involving 95% Kichwa members and 5% *mestizo* or settler members. It is founded on the strong belief that local people can generate their own income to provide a more equitable and sustainable model than the modern corporate production systems involving monocultures. It was set up to raise product qualities and prices, increase production volumes, certify what is produced (including as organic), internationalise markets and do all the above in a framework that preserves biocultural heritage.

Kallari started its commercial activities built around cocoa. By 2005, they had cut out the middlemen to deal directly with a Swiss buyer with a trial order of one 12.5-tonne container. Initial quality issues led to the establishment of a common collection and processing centre (El Salinerito) organised to meet the quality standards of the buyer. By 2007, through facilitated contact with the Wholefood Organic store they piloted the production of their first order of chocolate. This proved successful and they received a 50,000-bar order per month, negotiated down to an initial 15,000 to allow them to upscale gradually. Kallari chocolates were launched in 2008. Early experiments combined chocolate flavours with dried fruit. By 2011, orders from England, Germany, Japan, Sweden and Switzerland allowed them to open a factory. International awards followed for the unique taste. By 2013, the cooperative was diversifying chocolate with many flavours of dried fruits supplied by the same *chakra* farms – ginger, pineapple, banana, lemon grass, cinnamon, vanilla, chilli, orange and so on. Despite a downturn in 2014–2015, the cooperative rebounded and by 2019 was making major inroads into new markets for vanilla and guayusa and crafts produced from the *chakra* using natural fibres, seeds and dyes.

2.2 Main perceptions of climate change risks

Each *chakra* system is based on a history of domestication of Amazonian plants – combining subsistence agricultural crops such as rice, beans, groundnuts, yucca, plantain, corn, Chinese potato and various tubers, fruit such as papaya, chonta, mountain grape, guava and sugarcane plus medicinal plants and herbs – with commercial crops such as cocoa, vanilla, guayusa tea and fruit. Climate change is having significant impacts on some of those crops. More extreme droughts are causing crops water stress. Some can become more susceptible to pests and diseases as a result. And when the rains come, they are often intense, causing floods that sweep away croplands.

Climate change affects their main commercial crop, cocoa. The changing patterns affect both flowering and fruit maturation processes. The perceived risk by Kallari is that farmers will replace traditional varieties with their strong signature tastes and smells with high productivity, climate-resilient varieties such as CCN-51 which have much lower taste profiles. This will erode the unique genetic base upon which their *chakra* system and Kallari branding is based.

Despite these threats, the climate change impacts on the Kallari business model have been relatively minor as yet because of the strong resilience inherent to the diverse agroforestry systems themselves. Multi-strata agroforestry systems improve rain infiltration and retain soil moisture while preventing erosion and loss of fertility. Diverse subsistence and commercial crops provide a buffer against failures in any crops. And there is a constant process of family education about how best to manage the *chakra* to deal with change, led by the women of the communities.

2.3 Main climate-resilience responses

The main role of the cooperative Kallari has been to protect and indeed strengthen the ancestral diverse patterns of production which have served the Kichwa people so well over time. In part it has achieved this by gradually broadening the membership base of the cooperative organisation. But it has also worked to overcome the ancestral patriarchy of the *chakra* system and improve gender equality by enhancing how the vital role of women in the system is perceived and to improve commercial opportunities for women. Maintaining the agrobiodiversity of the *chakra* system itself continues to be central to preserving the ancestral patterns.

Perhaps most innovation has been the gradual process of product diversification – from original sales of cocoa and then chocolate, to multiple fruit flavours – all of which are sourced from the diverse agroforestry systems. Further diversification into vanilla and guayusa tea value chains have added further revenue streams – and each represents to the Kichwa people a triumph of perseverance, protection of cultural identity and conservation of natural resources. The same perseverance has led them to conquer not only domestic markets but also a wide range of international markets. And the addition of local craft products from diverse fibres, seeds and dyes adds yet further income-generating opportunities. All these economic opportunities incentivise the diverse agroforestry systems that supply them – and which provide resilience to climate change.

Though social networks and partnerships, Kallari has also jointly developed training services for its members in various topics such as good agricultural practice, the rescue of particular genetic materials in danger of extinction, the renewal of old plantations through grafting, and the spread of disease- and climate-resilient varieties that have been found from within the native stock of cultivated cocoa, vanilla and guayusa. Kallari also provides training in both gender and generational issues – ensuring that women and youth have equal access to training in business management and will so be able to perpetuate their cooperative model into the future. Partnership have also been secured with companies such a Max Felchlin, donors such as the German Society for International Cooperation (GIZ), and most recently the FFF programme co-managed by FAO, IIED, IUCN and AgriCord to improve production facilities and market contacts for their many emerging value chains.

The economic dimension of sustainability that Kallari provides is seen as integral to *sumak kawsay* or 'good living' that both complements and serves to reinforce their ecological diversity and cultural integrity. Indeed, members see Kallari as a resistance movement, in which excluded Kichwa families lead processes of social inclusion and business revolution as symbols of freedom and territorial autonomy that respect their cosmovision.

Case study 3. Ghana: Kassena-Nankana Baobab Cooperative Union (KANBAOCU)

This case study is a summary of a more detailed analysis of KANBAOCU by Awaregya and Amoah (2020).

3.1 Introduction to the producer organisation

The Kassena-Nankana Baobab Cooperative Union (KANBAOCU) operates in seven districts of the Upper East Region of Ghana. These inhabit the semi-arid Guinea Savanna-Sahel agroecological zone. Local communities survive off subsistence crops such as legumes (groundnuts, beans and cowpeas) and vegetables (peppers, okra, kenaf, amaranths and others) as well as cash crops (sorghum, millet, yam, maize and rice) and livestock. There are also NTFPs from native trees such as baobab (*Adansonia digitata*), shea (*Vitelleria paradoxa*), locust bean (*Parkia biglobosa*), balanite (*Balanites aegyptiaca*), plus exotic trees such as neem (*Azadirachta indica*), moringa (*Moringa oleifera*) and mango (*Mangifera indica*). These are now processed to make baobab powder and oil, shea butter, locust bean powder and seeds, balanite nuts and oil, neem leaf pesticides for crop protection and for ethno-veterinary uses, moringa powdered human and livestock nutrition, and mango seed powders and oil emoluments for cosmetic purposes.

KANBAOCU was established as a cooperative union in 2010. The union includes 45 registered cooperative societies, working with 175 group enterprises composed of 12,376 women and 485 men. KANBAOCU has a longstanding support partner in the Organization for Indigenous Initiatives and Sustainability (ORGIIS), an NGO in Ghana. KANBAOCU grew out of a long history of pioneering work of the Kassena Women's Association (KWA) which was founded in 1938 in the Northern Territories, focusing initially on mobilising women's village savings and loans associations (VSLAs), but gradually broadening its operations as the Kassena-Nankana Women's Association (KNWA). KNWA aimed to mobilise and help women's groups from two main ethnic tribal groupings: the Kassena ethnic group along the Ghana–Burkina Faso boundary and the Nankana ethnic group involving Frafra ethnic tribes to the east and the Builsa tribes to the west.

Building on the earlier focus on savings and loans, KANBAOCU's early commercial activities involved investments into the baobab and shea value chains. VSLA finance was used to aggregate and stockpile raw materials at the level of the union. Because the production of such NTFPs fluctuated annually, the union diversified its activities to include other NTFPs such as tamarind, parkia bean and neem to ensure more regular cash flows. More recently this has diversified yet further into four baskets of products: NTFPs as above, food crops (including indigenous millet, sorghum, beans, maize, okra, pepper and leafy vegetables, brewer's sorghum, maize, sesame and fonio (*Digitaria exilis*), wood-based tree products (including poles, rafters, firewood and twine plus softwood and hardwood seedlings) and livestock. The union serves as a processor and trader of these products.

3.2 Main perceptions of climate change risks

Concerns over climate change include increasing variability of rainfall patterns (eg the early onset of rains or the abrupt close of the rainy season) and extremes of alternating rains and floods or heatwaves and droughts. Invasions of migrating birds and other pests and diseases are becoming more pronounced. For example, widespread flooding in 2015, 2017 and 2018 caused catastrophic damage to crop and farms. The impacts were felt most heavily by women and girls, as well as young people. For example, in the flood events it was women and young people who suffered the most, from hunger and unsafe water consumption, from malaria and insect-bites, from diarrhoea and other water-borne diseases.

These extreme events have also been accompanied by more gradual declines in yields by as much as 30% – and these have especially affected conventional high-input, high-yielding crop varieties of maize, sorghum and rice (which had been displacing more drought-resilient traditional varieties in 2010–2020). For example, in 2015, more than 80 metric tonnes of maize and sorghum were produced by KANBAOCU for its main buyer Savannah Agri Chains Limited which then sold them to Guinness Ghana Breweries Limited to meet its orders. By 2017, with unreliable production caused by climate change, KANBAOCU and its buyer could meet less than 70% of orders from Guinness Ghana Breweries. Similarly, climate change impacts on NTFP value chains have resulted in undeterminable yields resulting in unstable production volumes and reliability of supply volumes. Livestock, including chicken, guineafowls, ducks and turkeys, as well as small ruminants, have not been spared as lack of fodder has resulted in over-browsing of vegetation and pastures in fallows and parkland, destroying economic trees and vegetation.

3.3 Main climate-resilience responses

A new climate-resilience approach within KANBAOCU (known as DUBE – doable-urgent-bold-equitable) has been helping members cope at household, cooperative and district levels. The approach is built around diversification – including not only increased use of indigenous trees for NTFPs (from baobab and shea to parkia, balanites, tamarind, moringa, neem and mango) but also a diversification of staple crops (from cowpeas, millet and beans to maize, sorghum, soybean, sesame and fonio) and the use of traditional, more drought-resistant crop varieties. Livestock have also been diversified from chicken and guinea fowl to include pigs, ducks, turkeys, small ruminants and cattle. But it is not just horizontal diversification that KANBOACU has been encouraging, but also vertical diversification in each value chain through value-added processing. For example, trade in raw shea nuts and baobab fruit has been replaced by processed butters, oils, powders and juices.

Alongside this diversification into a basket of products that improves agroecological and economic resilience, KANBAOCU more recently provided other technical interventions that have helped its members. It has encouraged restoring vegetation along the fringes of the White Volta and Sissili basins and the Tono, Vea and Bongo watersheds to improve rainfall and moisture regimes. It has improved water-harvesting techniques for dry season vegetable production by its women farmers' cooperatives and groups. KANBAOCU has also linked members to training in soil fertility by use of land-management practices such as short duration fallows of two to three years, zero tillage and organic composting along the catchment areas of the White Volta River, the Tono River and the Sissili river.

Additionally, KANBAOCU has worked to improve institutional resilience by strengthening business capabilities. For example, it has improved savings and loans capabilities at the level of its member cooperatives. During its apex meetings and general assembly meetings, KANBAOCU supports its members to share their knowledge so that they learn from one another how to use shared savings to invest in new production systems to diversify their value chains and improve access to markets. At the level of the union, KANBAOCU has also already established a VSLA for which there is planned progression into a larger recognisable body such as a regional/provincial cooperative credit union, under the supervision of Ghana's national body of credit unions called the Ghana Co-operative Credit Unions Association (CUA).

Many of these advances in resilience have come about through KANBAOCU's strong social networks with support partners such as ORGIIS, the Ghana National Sesame Business Farmers Association (GNSBFA), PFAG, and the newly formed Ghana Federation of Forest and Farm Producers (GhaFFaP). Additionally, it has worked hard to develop strong business partnerships with Savannah Agri Chains Limited, Savannah Fruits Company and Aduna UK Ptd.

Case study 4. Kenya: Lake Elementaita Tree Nurseries Self Help Group (LETNSHG)

This case study is a summary of a more detailed analysis of LETNSHG by Wekesa (2020).

4.1 Introduction to the producer organisation

Lake Elementaita Tree Nurseries Self Help Group (LETNSHG) is a tree nursery association found in Gilgil sub-county, Nakuru county, Kenya that sells 3 million seedlings per year with a turnover of 20 million Kenya shillings. Its members come from the Elementaita region, which comprises smallholder farmers who had purchased their land from the Gikuyu, Embu, Meru and Akamba Association (GEMA) in 1984. The founders of Lake Elementaita Tree Nurseries Self Help Group were six women farmers of the Geta Nyakinyua Women Self-Help Group. In 2003, the founder member started a profitable tree nursery and over time the group has expanded and now includes 62 members (45 females and 17 males). Forty-eight of those members have already established commercial tree nurseries along the Nairobi–Nakuru Highway. The group is a member of a Gilgil sub-county community-based organisations (CBO) affiliated to the larger Nakuru County Tree Nurseries Association (NCTNA). NCTNA also includes eight other CBOs with a total of 800 members in Nakuru county. NCTNA is itself a member of Community Tree Nurseries Growers Association of Kenya (CTNGAK) that operates nationally and represents nursery owners with government.

The 48 commercial nurseries propagate seedlings of different species of tree, shrub, flower and vegetables. The seedlings comprise 90% indigenous species and about 10 % exotics (the latter including traditional agroforestry species used in Kenya such as *Leucaena, Gliricidia* and *Calliandra*). The nurseries offer higher-value grafted seedlings of fruit trees such as avocado, pawpaw, mangoes and macadamia, alongside regular sales of timber trees, indigenous ornamental trees and agroforestry trees, plus flowers, vegetable seedlings, herbs and medicinal plants.

Indigenous trees, herbs, bamboos and flowers are collected locally from domesticated trees around the farms. But members also buy in crucial inputs such as certified seeds of higher-value trees, polythene tubes, forest soil, compost manure and water. Seeds and scions are purchased from certified sources such as Kenya Forestry Research Institute (KEFRI). Where necessary they hire casual labour to produce the seedlings in the right season. Trained group members provide advisory services to other farmers and other members of the community who make up some of their customers. These advisory services help to maintain their existing customers and attract new ones. Customers include local farmers, travellers and nearby institutions such as schools, churches, banks, colleges, hotels and NGOs, plus government institutions such as the Kenya Forest Service

(KFS), Water Resources Management Authority (WRMA) and National Environment Management Authority (NEMA).

4.2 Main perceptions of climate change risks

LETNSHG operates in a rainfall-depressed region with high impacts from climate change. The main perceived threats include rising temperatures, unpredictable rains, extreme weather events (including both prolonged dry spells and droughts but also heavy occasional rainfall and flooding), plus more frequent outbreaks of pests and diseases. These threats impact the group's businesses both positively and negatively. Prolonged rains mean customers purchase seedlings continuously. On the other hand, prolonged dry spells increase water scarcity that reduces farm productivity and depresses demand for seedlings. Inadequate water supplies also lead to loss of seedlings.

Delayed selling or transplanting of the seedlings increases the costs of purchasing water and maintaining labour prior to the eventual sales. Occasionally, seedlings became overgrown or require tubes to be changed or additional manure to be added, thus increasing costs of seedling production. Conversely, some unseasonably heavy rainfall events have damaged nursery structures, buildings and infrastructure. Women are particularly affected as they play particularly active roles in providing water during droughts and maintaining labour in the nurseries in addition to other domestic chores such as child and animal care. To bridge the financial gap related to climate impacts, some have resorted to selling household assets or over-borrowing to sustain the business. Such threats affect their livelihoods and income sources.

4.3 Main climate-resilience responses

LETNSHG have developed a six-step inclusive business resilience model that included diversification in six areas: agroecology, economic value chains, social organisation, partnerships, customers and marketing activities. Firstly, agroecological diversification was promoted. It included using advisory services with farmers to increase intercropping, agroforestry, conservation agriculture and organic farming. In the nurseries themselves, they collected and sold more tree species, installed rainwater harvesting and storage, improved water-use efficiency by trialling periodic watering regimes and shading, and mixing compost manure and forest soil to improve water retention. Secondly, economic diversification complimented these strategies. The group worked with local farmers and members homesteads to introduced poultry and other agricultural sales of beans, sugarcane and fruit such as bananas in an integrated manner as additional income sources.

Social organisations were the focus of the third step. Capacity was developed through self-assessment towards improving governance structures, with progress in collective marketing (everyone owning a nursery but selling together) and financial services. Group members were trained on marketing, financial services and gender inclusion. For example, 62 members were trained on VSLAs as a social financial model where 28 members started cycles of savings and loans schemes. Trainers of Trainees (ToTs) were engaged in training a total of 3,127 farmers in the area.

Fourthly, new partnerships involved linking to the FAO and We Effect, Farm Forestry Smallholder Producers Association of Kenya (FF-SPAK), Nakuru Tree Nurseries Association of Kenya (NTNAK) and Community Tree Nurseries Growers Association of Kenya (CTNGAK). These partnerships provided financial support, capacity building and tree nursery technology development and marketing. They also explored collaborations with the Elementaita Ecotourism organisation to market fresh organic products and tree seedlings and with the Green Belt Movement for technical support for tree planting. Fifthly, in terms of customers, the LETNSHG diversified sales to private institutions such as schools, hotels, banks and NGOs – for example, arranging sales to the Co-operative Bank of Kenya of over 100,000 seedlings and new sales to the Green Belt Movement, KFS and NEMA.

The final step of climate-resilient business development was the LETNSHG revised marketing strategy. The group invested in product development, price stabilisation and promotions. In terms of product development, the group invested in production of high-quality seedlings throughout the year to maintain market supply – with value addition improved through grafting, improved seedling grading and varying the container sizes to boost sales. Price stabilisation was introduced across the seasons to maintain customers' trust. In terms of promotion, seedlings were strategically placed along the busy highway for ease of access by customers. All these different elements, put in place in part through FFF financing, helped to improve climate resilience by maintaining stable incomes from diversified sources – both within the nursery group and the local farming population.

Case study 5. Madagascar: Manarivo Organic Agriculture (AB) Company and its four supply cooperatives

This case study is a summary of a more detailed analysis of Manarivo AB by Noasilalaonomenjanahary and Ramaromisa (2020)

5.1 Introduction to the producer organisation

The Manarivo Organic Agriculture (AB) Company of the Analamanga and Bongolava regions has developed an economic model for climate resilience in Madagascar. The owner of Manarivo AB is the secretary general of the National Platform for Women, Sustainable Development and Food Security (PNFDDSA) who has linked support from the FFF to the company's four supply cooperatives. Manarivo AB buys groundnuts from four groundnut producer cooperatives in the Bongolava region (Santatra, Vondrona, Tsikivy and KF2VS). The four cooperatives have a collective membership of 80 farmers (47 of whom are women) and 100 hectares of land. These four FFPOs have been developed in partnership with the Support Programme for Rural Microenterprise Poles and Regional Economies (PROSPERER) of Bongolava. The members of these FFPOs are responsible for planting groundnuts and processing raw groundnut oil.

Manarivo AB is a for-profit company that aims to make sustainable development effective in Madagascar, promote organic agriculture, improve the availability of quality foodstuffs, and meet the challenges of self-sufficiency. The main business of Manarivo AB is to buy the crude groundnut oil from its four supplier FFPOs, clean it and produce a high-quality organic oil. The company is responsible for packaging and marketing the oil.

Manarivo AB also produces well-packaged essential oils, coffee, rice, vegetables, fruits and jams etc. These products were formerly sourced from the owner of Manarivo AB's family plantations but are now increasingly supplied by the four cooperatives who plant agricultural resources and offer certified organic products such as red and white rice, groundnuts, pink bay, pineapple, guava, passion fruit, arabica coffee, aloe, pok or physalis, ravintsara, eucalyptus, lemongrass, geranium and so on. The company processes products under the label Tresor & Sens. Products include jams, dried fruit, fruit juices such as pineapple, guava, passion fruit, aloe, pok or physalis, extra-refined groundnut oil, cosmetic products such as vegetable soap, massage and bodycare oils, mosquito repellents, natural hydroalcoholic cleansing gel and essential oils of ravintsara, eucalyptus, lemongrass and geranium.

Following the development of its partnerships with the four FFPOs, Manarivo AB has committed to the following activities:

- Expanding local market-gardening land and maintaining biological corridors to protect natural ecosystems and wildlife in the area
- Multiplying aromatic and medicinal plants cultivation by FFPOs
- Intensifying the production of organic compost, biofertilisers and biopesticides, and
- Diversifying production, including by developing short-cycle livestock farms, which will help to produce more organic compost.

5.2 Main perceptions of climate change risks

Climate change is perceived as a significant threat in terms of late and variable rains, dry season fires, increasing outbreaks of plant pests and diseases, and occasional flooding. Rain delays and variability have delayed the cropping calendar, reduced yields and led to stressed crops which have become more prone to outbreaks of pests and diseases. The decline in groundnut production is a major threat to producers. During the dry season, an increase in fires has burnt forest and agricultural crops, leading to soil degradation. Whole crop cycles have been lost to fire. Conversely, flooding during the rainy season has greatly damaged productivity.

The impacts of these threats on the production of crude groundnut oil show (which has been the main product from the four FFPO cooperatives) demonstrates an average loss over three cropping cycles, even though the processing production of organic refined oil has been able to break even during those cycles. This realisation has led to the conclusion that the sale of unrefined oil alone is not profitable for FFPOs and that there is a need to consolidate the processing capacity of partnerships such as Manarivo AB while diversifying into other crops that are more lucrative. While many crops are affected by the changing climate, having a more diverse portfolio of crops is clearly advantageous in maintaining profitability.

5.3 Main climate-resilience responses

With support from the FFF through the PNFDDSA, Manarivo AB has worked with members of the four producer cooperatives on several options to overcome climate threats and build resilience. An important initial step has been to diversify planted crops beyond groundnuts to reduce reliance on any single product. Initial prioritisation was red and white rice, pink bay, pineapple, guava, passion fruit, arabica coffee, aloe, pok or physalis, ravintsara, eucalyptus, lemongrass and geranium – marketing the products through the Manarivo Tresor & Sens line of products.

Other agroecological measures towards resilience have been to improve soil moisture content and fertility by producing organic fertilisers from plant residues. This has been complemented by the building of erosion-control terraces on steeper land to avoid soil loss and the integration of indigenous fruit trees between cropping areas. Additionally, Manarivo AB has secured the use of different and improved seeds that are more adapted to climate change (especially drought). Farmers have been encouraged to keep back 50% of the production of these new varieties to build up seedstock for the next planting seasons. The Manarivo AB company has also set up seed orchards to produce seeds for the next planting season.

Improving social and economic support networks has also been a key feature of the early work of Manarivo AB. For example, since its inception, the company has built partnerships with a wide range of organisations which now include:

- PNFDDSA
- The Scaling Up Nutrition (SUN) movement (in particular, the Private Sector Platform and the Researchers' Platform)
- The National Alliance for Food Fortification (NAFA) in Madagascar
- The Malagasy Union of Organic Agriculture (SYMABIO)
- The Madagascar Industries Union (SIM)
- The Chamber of Commerce and Industry of Antananarivo (CCIA) in Madagascar, and
- FAO and its FFF programme co-managed by FAO, IUCN, IIED and AgriCord.

The latter programme has already introduced training and capacity building on finance, the development of community savings and loans facilities, risk management, and business planning and management, so that the cooperatives can expand the possibilities and opportunities for service delivery. Manarivo AB, through its productive partnership with four FFPOs, has so far increased the income of its farmer workers by 10–12% per year. By committing together to practice organic and climate-smart agriculture and to join together to sell everything as a group, to save as a group and to invest as a group, the farmers in the region have strengthened their resilience in the face of climate change.

Case study 6. Nepal: Laliguras Herbal Women Group (LHWG)

This case study is a summary of a more detailed analysis of LHWG by Adhikari *et al.* (2020).

6.1 Introduction to the producer organisation

The Laliguras Herbal Women Group (LHWG) have been contributing to climate resilience by running a small-scale enterprise for processing herbal plants and extraction of essential oil called Chisapani Community Herbal Processing Industry (CCHPI). The 16 women members of the group belong to the Chisapani community forest users' group (CFUG) located in Bardaghat Municipality of Nepal. The total area of the Chisapani community forest is 495.76ha but contains many underutilised lands. This LHWG business model targets dual goals of economic benefits for marginalised women and more sustainable management of underutilised forest land. The Chisapani community forest was established in 1997 but was only formally registered and handed over to the CFUG in 2009. It is comprised of 3,350 households with the total population of 18,550 including 9,421 males and 9,129 females. Ethnic groups include mainly Adibasi (Tharu), Janajati (Gurungs, Magars, Newars), Dalits (disadvantaged and socially excluded) and Terai (Basi), all represented by the executive committee of the CFUG.

In 2013, a private company named Chaudhary Biosys Nepal Pvt Ltd (CBNPL) offered to support the CFUG with a training investment in micro-enterprise development for essential oil extraction, initially patchouli oil (*Pogostemom cablin*). CBNPL leased 10ha of land and started producing patchouli oil, engaging poor and marginalised women to work as daily wage labour in the production process. The company then helped the women to form a nine-member socially inclusive women's business group. It provided training in business management including cultivation, harvesting, processing, packaging, marketing of the product, and networking with national and international traders. Almost US$18,000 of distillation units with vessels, condensers, boilers and receivers were also installed and handed over to CFUG by CBNPL for patchouli processing (1,200kg of raw material per year). Later, the women's group (now called the Laliguras Herbal Women Group – LHWG) was expanded to include 16 members. LHWG expanded plantation of herbs to 40ha for which no further lease had to be paid because it fell within the CFUG of which they were members. Initially, CBNPL assured the group with a buy-back guarantee for their products.

Although CBNPL left the area in 2016, it left behind a strong group, who since 2017 engaged other buyers, primarily Himalayan Bio Trade Pvt Ltd (HBTPL) but also Everest Aroma Pvt Ltd (EAPL). LHWG received further support from the Livelihoods and Forestry Programme (LFP) and the International Development Enterprises (iDE) Nepal to expand distillation units. By 2020, 85ha of unused and barren forest land within the Chisapani community forest was planted with different herb species (palmarosa, patchouli, lemongrass, citronella, wild turmeric) and different grass species such as stylo, napier annd broom by the women's group. The CFUG runs the distillation plants and rents processing capacity to seven neighbouring CFUGs. But the profits generated from the CCHPI business enterprise are distributed among the LHWG group members after deducting the salary costs for the CFUG distillation plant.

6.2 Main perceptions of climate change risks

Climate change has begun to affect the livelihoods of farmers in communities such as Chisapani, bringing more variable rainfall, extreme weather events (storms, floods and droughts) and related crop failures, pests and diseases. The community of the Chisapani community forest area perceive several climate-related threats:

- Increased number of extreme weather events
- Landslides in the upstream area and floods in the lower plains
- Strong wind and storms,
- Heatwaves, drought and subsequent forest fires
- Thunderstorms that bring hailstones
- Untimely, irregular, heavy and intense rain, and
- Changes in the monsoon pattern (sometimes earlier, sometime later).

The irregular patterns make timing agricultural planting difficult. The extreme events damage crops leading to food shortages. Because of low purchasing capacity and lack of skills to earn income from other activities except agriculture, farming families face food insecurity. Loss of infrastructure from landslides impedes market access. Droughts harden soils and increase costs of cultivation as well as lowering the groundwater table with less recharging of aquifers – reducing springs that allow irrigation and a depletion of wetland and fish habitats. Droughts also increase the chance of forest fires. Invasive species such as crofton weed, siam weed and broadleaf button weed in forest land and blue billygoat weed, Bermuda grass, kane jhar and mothe in farmland have expanded in these degraded conditions. Under this scenario, producing essential oils in forests and farmland during fallow periods increases the diversity of income generation, helping to build livelihood resilience.

6.3 Main climate-resilience responses

LHWG have helped to improve climate resilience in the ecological resource base, by expanding from their original location in what was technically forest land, to include also farmland, and then farming land of different agroecological types. This has helped to ensure production of diversified herb and oil plants suited to different ecological sites.

The enterprise increases production options by incorporating alternative species, which started from patchouli cultivation and later expanded to citronella, chamomile, lemongrass, mentha, palmarosa and wild turmeric. There is less chance of failure across such diverse crops.

Economically, climate resilience has been strengthened by diversifying the business model. The enterprise initially ran with only one distillation plant. But they greatly diversified their distillation products and markets to increase income. Later, they added two additional distillation plants. The expansion provided additional income to the CFUG as neighbouring CFUGs hired the facilities for a utilisation fee. At the broader level of the CFUG, the successful enterprise model has also been copied with the formation of other enterprise groups which enhance climate-resilient livelihoods by incorporating other climate-resilient practices in their community forest. Among the broader memberships of the CFUG there are now groups pursuing sustainable tourism, fish farming, renewable energy and scientific forest management.

Climate resilience has also been enhanced by more diversified social networks. They facilitated linkages between expanded producers and vendors and buyers, thereby also increasing their network and capacity to negotiate. Their reaching out to neighbouring communities increased their financial return by making more efficient use of their distillation plants. The LHWG and hosting CFUG also extended advisory and capacity-building services in peer-to-peer learning activities, sharing their learning and experiences in essential oil production and its potential resilient business options in the region, often in collaboration with divisional forest authorities. As a result of these diversification strategies supported through FFF funding, the LHWG enterprise provides resilient livelihood options to the most vulnerable groups among community forest members, demonstrating a climate-resilient sustainable business model.

Case study 7. Tanzania: Tanzania Tree Growers Associations Union (TTGAU)

This case study is a summary of a more detailed analysis of TTGAU by Timbula (2020).

7.1 Introduction to the producer organisation

The Tanzania Tree Growers Associations Union (TTGAU) was established in 2017 to promote the social and economic interests of smallholder tree growers in Tanzania. TTGAU groups together 146 regional tree grower associations (TGAs) who pay membership fees and who have a total membership of 10,106 of whom 3,224 are women and 6,802 are men. Member TGAs are found in different villages. Within Tanzania, forest plantations cover a total of 325,000 hectares: 100,000ha owned by the state, 54,000ha under five larger industrial plantation companies, and 174,000ha belonging to small-scale tree growers – most of whom are affiliated with TTGAU. It is this latter crucial and expanding smallholder tree growers' market that TTGAU serves. Tree growing involves both timbers and other tree crops such as avocado.

The majority of TTGAU members are subsistence farmers growing various crops like maize, beans, wheat, potatoes and horticultural crops to earn their living. But these subsistence farmers have also begun to see timber production as a promising market opportunity. TTGAU was established to strengthen the collective voice of small-scale tree growers, improving income from woodlots through collective marketing, and support for the use of improved tree seeds, alongside providing access to forestry technical advice to increase the asset value of the woodlots.

TTGAU offers four main services to its members:

- Support for advocacy and lobbying – acting to broker discussions with private-sector buyers and government decision-makers
- Facilitating members' access to improved planting materials through bulk buying and forestry technical advice – including on nursery establishment for improved genetic material through a partnership with Tanzania Forest Services Agency (TFS) and the bilateral Participatory Plantation Forestry Programme (PFP2)
- Representing women and youth with local government to improve access to idle land so they can take part in local TGAs
- Enhancing smallholder tree growers' market access and integration within the value chains through helping them to overcome perceptions of poor quality, and
- Increasing members' income by aggregating volumes and improving the quality of products such as sawn timber and also by supporting processing of trees instead of selling standing trees.

7.2 Main perceptions of climate change risks

Climate change affects not only tree planting, but also farming activities which are the backbone of rural life. The main impacts of climate change have included a combination of a shorter rain season and increased temperatures. These changing conditions have stressed crops and led to new outbreaks of pests and diseases which in many areas were not common in the past. The conditions have also led to a decreased performance of some of agricultural crops and change of farming calendars. Prolonged dry seasons associated with high temperatures poses risk of fires which affect both forests and crops.

TTGAU members see forestry and farming as one integrated reality. Change in rainfall patterns, increased temperatures and occurrence of pests and diseases threaten the performance of both forestry and agricultural sectors and hence the livelihoods of the rural population. For example, in Makete District, traditional varieties of potato are no longer performing well due to uneven distribution of rains. This is problematic as potatoes are a main cash and staple food crop. To survive, farmers have had no choice other than to change their planning practices, either to new varieties which can withstand climate change or planting new crops altogether. Seeds of more tolerant varieties are very expensive and difficult to obtain in rural areas.

Recently, fusarium and bacterial wilts, plus early and late blights have spread. For example, tomato pests like *Tuta absoluta* are now widespread, such that some farmers are giving up because they cannot afford to control infestations. To ensure production, farmers must use a lot of agrochemicals to ensure adequate marketable quality. New agrochemicals are entering the market every day. The chemicals are expensive. Many farmers cannot afford them and these chemicals may also pose a hazard to health.

7.3 Main climate-resilience responses

In the context of uncertain agriculture, diversification into tree planting is one way in which farmers can make sure that at least some components of their farming system provides returns in the face of pests and diseases. Strong national markets for tree products mean that there is more resilience for those who can sell both agricultural and forest products.

TTGAU wants to ensure that this resilience is inclusive. Consequently, engaging women in farming and forestry is crucial. TTGAU is working with local government authorities (LGAs) and families to facilitate women and young people access to land and to help them through the process of issuance of Certificates of Customary Rights of Occupancy (CCROs). These newly secured tenure arrangements give women confidence to actively engage in tree planting and crop production. The newfound confidence in diversified agriculture and tree planting is improving household incomes and food security.

Another way in which TTGAU is supporting TGAs to improve their resilience is by helping them to take on the agro-dealer role, so that farm and forest inputs such as seed, fertiliser, pesticides, tools and so on are available in their vicinity, in a timely manner and at lower cost. Taking on this role also helps to diversify income streams and build resilience.

Linked to the above, TTGAU has been both introducing new species of pine and eucalyptus and promoting the establishment of seed orchards to provide improved tree seeds and nurseries to grow on the plants. Good quality tree seed is not locally available at a fair price. So, establishing seed orchards and seedling nurseries is one of the endeavours that both supports diversification into tree planting and provides a further income stream itself. TTGAU is working with the TFS and PFP2 to help realise this ambition of self-production of climate-resistant varieties. For example, new species (*Pinus maximinoii* and *Pinus tecunmanii*) have now been introduced to smallholders in some parts of the country to replace *Pinus patula*.

As well as diversification of timber species and varieties, TTGAU is also supporting tree growers to diversify income through commercial beekeeping and avocado farming. These are frequently practiced for subsistence purposes, but TTGAU has been introducing better and more standardised quality standards and finding market links to foster commercial production. Additionally, women are also being encouraged to establish their own economic groups producing simple but valuable products such as soap and batik.

TTGAU aims to enable members to improve production and quality as well as equip them with the means of both adapting to and mitigating climate change. The combination of food and cash crops (including trees) enables members to diversify sources of income and ensure availability of food during hard times. New FFF support to Tanzania will help develop these options.

Case study 8. Togo: NOVI VA, a Simplified Cooperative Society (SCoopS)

This case study is a summary of a more detailed analysis of the NOVI VA cooperative by Gaglo (2020).

8.1 Introduction to the producer organisation

The NOVI VA cooperative was registered as a Simplified Cooperative Society (SCoopS) on 14 April 1992. It was established as a women's collective agricultural enterprise involved in the procurement and processing of cassava (*Manihot esculenta*). It is based in southern Togo in Topko in the commune of Anfoin (Lacs Prefecture). Its membership is made up of 30 members including 29 women. The background history is lengthy. In the 1950s, Topko was equipped with a Ganavé cassava processing plant, but this closed in 1980 due to a devastating white fly pandemic (carrying the cassava mosaic virus disease). Subsequent food crises of the 1990s aggravated the precarious living conditions of the local communities. But with the control of the cassava mosaic virus thanks to regional treatment of the area, the resumption of large-scale cassava production was possible but without any processing capacity. This led the women of Tokpo to found NOVI VA which originally produced gari, tapioca and starch powder which it sold on the local market.

Sadly, following a scam by its microfinance partner in 2016, NOVI VA had to cease its activities. This led to a rapid deterioration in the socio-economic situation of its members. Despite being in this situation, the associative link between the members remained such that, in 2019, this cooperative was identified as a beneficiary in the pilot phase of the implementation of the FFF as it started operations in Togo.

Since 2019, financial support and a series of trainings have improved the management and governance capacities within the cooperative and led to a revitalisation of activities. The NOVI VA cooperative undertakes the artisanal processing of cassava into four main products: gari (granulated cassava flour), tapioca (granulated cassava starch), starch powder and cassava bread flour (used in baking). Gari and tapioca are packaged in 500g or 1kg packs, while starch powder and bread flour are packaged in 1kg packs. In addition to these four products, NOVI VA also makes tapioca latté to order. It should be noted that NOVI VA also sells gari by the bowl in local markets until more customers are found for its packaged products.

Tokpo farmers, for their subsistence, grow food crops (maize as a staple), legumes (beans and groundnuts) and vegetables (tomatoes, chilli, ademe, gboma). Irregular rainfall affects all these crops. As a result, there is an increasing reliance on the production of cassava, a crop that is more resilient to climate change. And that elevates concerns over the resilience of NOVI VA.

8.2 Main perceptions of climate change risks

For the NOVI VA production system, cassava and fuelwood energy (used for processing) are the essential elements. But, alongside other staple agricultural food crops, these raw materials are also affected by the effects of climate change. The main impacts come from the more irregular rainfall and these irregularities also have an impact on the duration and intensity of the droughts that threaten soil fertility and food security. Land degradation is widespread due to overexploitation of the soil by local communities exacerbated by the effects of demographic pressures. Reduced soil fertility and deforestation (driven in part by declining yields that require a search for more cultivable land) have led to a decrease in cassava yields and a lack of fuelwood, making the NOVI VA business model less secure.

Lower yields and shortages of fuelwood have increased the costs of production and reduced profits. The increase in the duration and intensity of the dry period leads to a reduction in the cassava processing period in the year. During the dry season, cassava harvesting is very difficult and painful. The cooperative's productivity drops simply because of the additional labour costs. To meet the cooperative's production objectives, NOVI VA often must hire in external labour for cassava tuber harvesting and some production work. No actor in the cassava chain is spared the negative effects of climate change. For example, in the case of the young men who are employed in the cassava harvest, their remuneration is linked to the size of the field or the quantity of cassava harvested, which is evaluated in six-tonne trucks. For a truckload of harvested cassava, the effort required becomes greater and greater and varies according to the density of the cassava plants, their productivity, the fertility of the soil and the abundance of rainfall. Dry hard soils and low yields decrease their income. Due to the increasing cost of cassava production and processing, the NOVI VA cooperative society is opting for climate-resilient options.

8.3 Main climate-resilience responses

The main climate-resilience responses are based on the collective efforts of the organised cooperative. The advances described here have become possible through the social networks that NOVI VA has established through its membership of the Centre for Producers of Cereals (CPC) and to the overarching Togolese Coordination of Farmers' and Agricultural Producers' Organisations (CTOP). Both organisations have helped NOVI VA identify useful contacts and bring in project support – including through the FFF, a programme that directly finances FFPOs.

In terms of agroecology, the NOVI VA members have been promoting the use of agroforestry systems (with nitrogen-fixing trees such as *Leucaena leucocephala* to improve soil fertility). They have been practicing soil conservation and the use of *Mucuna* *pruriens* fallows. To improve the fertility of cultivable soils, sensitisation and training has been undertaken in how to improve the physical and chemical quality of soils, using integrated and biological soil fertility-management techniques that have been organised with the support of the FFF and has proved its worth in other localities in Togo. It includes the establishment of composting sites and a traditional system of grazing sheep and goats in cassava fields for specific soil-improvement purposes.

More resistant varieties of cassava are being planted to maintain yields in the face of changing climate patterns. Moreover, dedicated woodlots have been established using *Eucalyptus spp* to provide the fuelwood needed to process cassava products. In the meantime, while these woodlots and agroforestry systems mature, the cooperative is making use of coconut shells and agricultural residues.

Alongside these agronomic developments, the NOVI VA cooperative has been diversifying economically its product range which now includes gari, tapioca, cassava starch powder and bread flour. New packaging and labelling have been introduced to enable the cooperative to sell products into supermarket chains. While still under development, these ambitions will improve economic resilience and increase sales prices to compensate for any downturns in productivity.

Today, the NOVI VA cooperative model provides income to its (mostly women) members as well as temporary employment to young men and women in the Tokpo locality and is steadily building demand for the quality of its processing products in national and international markets. All these advances will help with the resilience of farmers around Topko in Togo.

Case study 9. Vietnam: Viet Nam Cinnamon and Star Anise Cooperative

This case study is a summary of a more detailed analysis of the Viet Nam Cinnamon and Star Anise Cooperative by Thoan *et al.* (2020).

9.1 Introduction to the producer organisation

The Viet Nam Cinnamon and Star Anise Cooperative operates out of Dao Thinh commune, Tran Yen District, in Yen Bai Province in the North of Vietnam. Cinnamon growing had started in Dao Thinh in 1993 and by 2015, with facilitation from the Viet Nam Farmers' Union (VNFU) and the FFF, local cinnamon growers saw the merit in forming four collective farmer groups as a means of sharing market information, aggregating supply and negotiating better prices. By 2016, these four groups had decided to associate as an inter-collective group with 39 members, having a total of 135ha of cinnamon. After FFF-supported MA&D training, the inter-collective group worked out a business plan, conducted a market research study, looked for potential buyers and introduced their cinnamon products in agriculture fairs to look for markets. Facilitated policy roundtables with local authorities led to an organic cinnamon development strategy within the local socio-economic development plan (and public investment in 2km of cement forest roads to reduce transportation costs).

By sharing information with cinnamon exporters, the inter-collective group began to understand in 2016 that to go further, they had to expand their cooperation and formalise it by forming a cooperative and reaching an agreement with local authorities on the lease of land for a processing plant. Household members of the inter-collective group agreed to put their own money into a joint business for organic cinnamon processing – while also evolving production rapidly towards a sustainable organic agroforestry production system. In April 2017, with facilitation from FFF, the Viet Nam Cinnamon and Star Anise Cooperative was established with 23 members and with co-investment from the Vietnamese Vina Samex exporting company, a private investor which later became a member of the cooperative.

Farmers in Dao Thinh commune soon expanded organic cinnamon production to more than 500ha and the local authority allowed a lease of 9900m^2 land for factory building that commenced in 2018 and was completed in 2019. The vision of the cooperative is:

> *In the next five years […] to continue to maintain and expand the organic production model, consolidating its leading position in the export cinnamon industry, raising Vietnam's cinnamon industry in the world market, leading to it becoming a leader in spice production in Vietnam.*

By 2020, the cooperative was producing 80–100 tonnes/month of 12 kinds of organic cinnamon product. The factory has created jobs for 70–100 people, with the majority being women. More than 600 forest farmers have been trained and now apply organic farming in cinnamon production, alongside organic production of other crops and trees.

9.2 Main perceptions of climate change risks

Vietnam is still an agricultural country with 75% of the population being farmers and 70% of the land area being rural, where people's incomes depend mainly on natural resources, alongside subsistence farming. In Yen Bai Province, the average annual temperature has increased over recent years, while the average annual rainfall has decreased. Extreme events have included landslides, droughts, floods, cold spells and hailstorms that have increased crop damage, increased the incidence of disease and reduced yields, as well as causing significant human and property losses. Extreme weather events combined with the sloping terrain of Yen Bai have made the damage even more severe.

In terms of cinnamon and impacts to other crops, increasing average annual temperature causes changing crop growth and development, leading to sudden crop production or growth rate changes. Pests hatch earlier, grow stronger and spread in ways that can cause major damage. For example, turn rot on cinnamon trees has not had a specific fungicide developed to combat it yet. The leaf roll worm epidemic is expanding on both the bodhi and cinnamon trees, which has greatly affected crop yield. There have been years when the leaf roll worm broke out into an epidemic (2009, 2011 and 2014), causing hundreds of hectares of forest losses each year.

9.3 Main climate-resilience responses

The cooperative's priorities are to become the main purchaser for cinnamon bark products in the region, to expand members' organic cinnamon to 2000ha, to support each other in maintaining organic farming practices, and to promote cooperative products. But the cooperative has also prioritised specific climate-resilience options – such as developing a diversified business model through establishing an additional handicraft cooperative group, a mulberry planting cooperative group, medicinal plant cultivation and beekeeping cooperative groups – alongside exploring ecotourism. Agronomic diversification reduces dependence on any one crop/service. And the economic diversification spreads risk across different markets as well. Broader networks of support agencies (including links to research institutes studying pests and diseases) have been built.

Increasing profitability itself helps foster resilience. For example, every year, the cooperatives set aside a budget to train organic farmers, giving priority to female and young labourers who are most vulnerable in the face of climate change, as well as giving gifts to poor households on the Vietnamese Tet holiday. The VNFU's Farmers' Support Fund and the Viet Nam Bank for Social Policies (VBSP) have also lent money to 30 poor households in the commune. In this way, the cooperative has started to provide social and cultural services that will enhance its social resilience over time.

The approach to resilience within the Viet Nam Cinnamon and Star Anise Cooperative is now understood to be built through a series of seven interrelated actions that include:

- Step 1: Recognising benefits of cooperation in the face of increasing external risks.
- Step 2: Member needs assessment, collaboration and trust building to identify shared goals – including developing sustainable businesses in the face of a more variable climate.
- Step 3: Organisational strengthening: visioning and strengths, weaknesses, opportunities, threats (SWOT) analysis leading to the formation of producer groups, inter-collective groups and then a commercial cooperative. The cooperative now conducts MA&D across five areas of enterprise development (markets, natural resource management, socio-cultural engagement, institutional and legal issues, technology) together with regular risk management for threats in those five areas (including climate change).
- Step 4: Business incubation to build staff capability within business organisations – by drawing in experts for practical solutions to technical problems, coaching and following up.
- Step 5: Production and business planning in core value chains – consolidating sustainable production models and organic farming and exploring external and internal investment to upgrade processes.
- Step 6: Diversification into new value chains and markets – developing business and production plans integrated with sustainable resource management and climate change response plans.
- Step 7: Implementation of further production pilots, lesson learning and replication.

These steps have radically improved the climate resilience of members of the cooperative through a complete upgrade of business capability and diversification of value chains.

Case study 10. Zambia: the Tubeleke Women Club

This case study is a summary of a more detailed analysis of the Tubeleke Women Club by Machona (2020).

10.1 Introduction to the producer organisation

The Tubeleke Women Club is a producer organisation founded in 2002 and made up 26 people comprising 20 females (4 youth) and 6 males. It is in the south of Choma District in the southwest of the Southern Province of Zambia. It is a women and youth-based organisation that aims to generate income through producing and selling baskets made from bamboo fibre and through animal farming.

The group was formed under the Zambia National Farmers Union (ZNFU) by a group of women mainly for obtaining fertiliser from the government under the Farmer Input Support Program (FISP) for maize growing (which was the major income earner for the members at that time). However, over the years, membership of the group declined and the group only really became active when it was maize growing time and members needed fertiliser. Additionally, maize growing became less lucrative as the soils in the fields became overused and produced less. This was compounded by frequent droughts caused in part by climate change.

In 2016, the group was revived through support from the FAO-hosted FFF which trained one of the members in MA&D. Since then, the group reoriented towards business development, starting with woven baskets and brooms. There is a longstanding presence of bamboo clumps in Siachitema that were planted some time ago and the grass used to make brooms grows naturally and is available as a raw material throughout the year. A few individuals exploit these bamboos for storage barns and mat making. The Tubeleke Women Club is the only entity that is currently producing baskets for commercial purpose in the local area and surrounding communities of Siachitema in Choma.

It is the group's mission to attract investment in basket making for sustainable socio-economic development to transform the living standards of the local people in the Siachitema area of Choma District. This is already happening as the group has been given a borehole to enable them to carry out other activities like gardening and planting new stock of bamboo.

The Tubeleke Women Club has also developed a savings and loans fund to provide small loans or investment funds to its members. Through that fund the group has grown and improved its production in recent years. The goal of the group is to empower the members of the club through exploiting natural forest products such as locally grown bamboo and other sustainable farm products.

10.2 Main perceptions of climate change risks

Zambia is divided into three main agroecological zones based on soils, climatic factors, rainfall patterns and common agricultural activities. Zone 1 constitutes about 12% of the country and covers the Luangwa and Zambezi river valleys. It is low altitude and has low erratic rainfall with a short growing season. Although it is hot and humid with poor soils in some places, it is suited for growing drought-resistant crops. Goat rearing and fishing potential are high as is cattle rearing. Choma District falls in this zone, which has an average annual rainfall of 800mm, growing season ranges from 80 to 120 days per year and temperatures between 20 and 25 degrees centigrade.

However, in the past decade or two, rainfall has become erratic and does not reach 800mm. The growing season has reduced to less than 80 days. This has negatively affected crop yields. These impacts have severely affected the members of the Tubeleke Women Club. Rains have become increasingly erratic and prolonged droughts have had major impacts on subsistence crop production. The droughts have resulted in severe hunger and a radical drop in incomes.

In 2019, the group planted bamboo suckers to increase the raw material for baskets, but all the stock planted dried up due to drought. Individual maize fields for members also dried up and affected household food security. The groups shared funds within their savings and loans fund had to be used to buy food to stave off starvation – rather than be reinvested to expand their business as had been planned. The group will try again, but these setbacks are a typical occurrence in this semi-arid part of Zambia.

10.3 Main climate-resilience responses

The Tubeleke Women Club has been thinking about how to become more climate resilient in the face of this growing threat. The group's business has evolved over the past three years, from basket and broom making to a more integrated model including animal rearing. From an initial capital of K180 (US$10), the group has raised funds up to K44,480 (US$2,471). Subsistence farming has been diversified into a cash-generating business through their basket weaving and it is anticipated that the group will grow and alleviate poverty through producing and selling bamboo baskets and other farm products.

To diversify still further, the group has saved profits from the basket sales in its savings and loan fund. Rather than redistributing all profits to members at the end of the year, they agreed to reinvest some of the capital into further diversification: pig and sheep rearing. Neither of those two activities depend on seasonal water. The group are expanding the piggery project to individual members. This is not only meant to increase animal production but also ownership of the project. It was expected that by the end of 2020, 10 selected members will have piggery houses and the number will increase to over 50 animals (with more than 200 piglets). Revenue is expected to increase annually to over K90,000 (US$5,000). The funds realised will help support members in drought periods when they are most vulnerable.

Once the livestock project was in place, the group also started a biogas plant using animal droppings, which now provides cooking fuel (reducing the need for fuelwood). The process also provides a regular supply of slurry to fertilise crops for the members of the club. Additionally, the group has attempted to establish a bamboo plantation to ensure the future sustainability of its bamboo basket production. While setbacks due to the drought hampered this ambition, the group has survived using their savings and are able to try again.

The increasing confidence of the group in business activities and their strong collective action has cemented new partnerships with the FAO and Forestry Department and with the newly established Zambia National Forest Commodities Association (ZNFCA) – which it is hoped will help market their products. The strong social bonds that have been built are an additional source of climate resilience as they have been able to attract external support – including for the installation of a borehole to improve water supply. They will soon be able to grow their own animal feed (reducing external expenditure) and can contemplate new cropping options such as the production of vegetables in more resilient agroforestry systems.

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Research report

June 2021

Knowledge Products

Forests

Keywords:
forestry, climate change, climate resilience, forest and farm producer organisations

Global climate resilience is a matter of life and death. In forest landscapes, 1.3 billion smallholder farmers, communities and indigenous peoples must organise for climate resilience to survive. With joint responsibility for managing much of the world's remaining forests and securing food for many of the world's poor, their resilience is also essential for global climate solutions.

This report is written for representatives of forest and farm producer organisations (FFPOs) and their technical support partners. It explains why climate resilience matters and what it is. It introduces a climate framework and how to build it – including 30 practical climate-resilience options. It includes new analysis of 10 international climate-resilience case studies which show the extraordinary extent to which FFPOs are pushing ahead with climate-resilience options. Five pathways are advanced to scale up the beneficial impacts of FFPO climate-resilience action – including poverty reduction, biodiversity conservation, forest landscape restoration and climate change mitigation. The close fit between globally accepted generic principles for resilience and the day-to-day characteristics of FFPOs argues for them playing a more central role in bringing about the climate resilience that is important to us all.

IIED is a policy and action research organisation. We promote sustainable development to improve livelihoods and protect the environments on which these livelihoods are built. We specialise in linking local priorities to global challenges. IIED is based in London and works in Africa, Asia, Latin America, the Middle East and the Pacific, with some of the world's most vulnerable people. We work with them to strengthen their voice in the decision-making arenas that affect them – from village councils to international conventions.

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Forest and Farm Facility

The Forest and Farm Facility (FFF) is a partnership between the Food and Agriculture Organization of the United Nations (FAO), the International Union for the Conservation of Nature (IUCN), the International Institute for Environment and Development (IIED) and the European Agri-agencies (Agricord). FFF strengthens the organzations of Indigenous Peoples, forest communities and family smallholders to secure their rights, organise their businesses, sustainably manage their forests, and provide social and cultural services to the poor and marginalised.

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