Pastoralism and Resilience of Food Production in the Face of Climate Change

Technical Background Paper

In cooperation with

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

CELEP Coalition of European Lobbies for Eastern African Pastoralism

IYRP 2026 International Year of Rangelands and Pastoralists

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by:
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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Photo credits:
Title image: ©Saverio Krätli

On behalf of
German Federal Ministry for Economic Cooperation and Development (BMZ)

Eschborn/Bonn 2022

On behalf of

Federal Ministry
for Economic Cooperation
and Development

Content

Acknowledgements

People and institutions who have played a supportive role in the process of realising the paper are listed below

Coalition of European Lobbies for Eastern African Pastoralism (CELEP) (**Ann Waters-Bayer**), VSF Belgium (**Anthony Denayer**) and Deutsches Institut für tropische und subtropische Landwirtschaft (DITSL) (**Brigitte Kaufmann**, **Timon Sennewald**) for organising and hosting a stakeholder webinar, **Michael Ochieng Odhiambo** (People, Land and Rural Development) for facilitating the webinar.

Feedback on the draft version was received from:

Sadia Ahmed, Pastoral and Environmental Network in the Horn of Africa (PENHA) Somalia

Véronique Ancey, Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) visiting scientist on pastoralism at Food and Agriculture Organisation of the United Nations (FAO)

Dawn Chatty, Professor emeritus, Queen Elizabeth House Department of International Development, Oxford

Ced Hesse, Senior researcher, Climate Change Working Group, International Institute for Environment and Development (IIED)

Bernard Hubert, Professor emeritus, former Chair of Agropolis International, Institut National de Recherche Agronomique (INRA), Montpellier, France

Ilse Köhler-Rollefson, League for Pastoral Peoples

Shoba Liban, Pastoral Women for Health & Education (PWHE), Kenya

Abdulkadir Mah, Director of Partnership for Pastoralist Development Association (PAPDA), Ethiopia

Maryam Niamir-Fuller, former United Nations Development Programme (UNDP), Vice-Chair of the Global Coordinating Group of the International Year for Rangelands and Pastoralism (IYRP)

Camilla Toulmin, former director of the International Institute for Environment and Development (IIED)

Hussein Wario, Director, Center for Research and Development in Drylands (CRDD), Kenya

Ann Waters-Bayer, Prolinnova, Coalition of European Lobbies for Eastern African Pastoralism (CELEP), Global Coordinating Group of the International Year for Rangelands and Pastoralism (IYRP)

Helen Young, Director of the Research Program on Nutrition, Livelihoods, and Conflict, Tufts University, Boston

Key messages

1 **As global temperatures continue to increase, food systems are facing a double burden.**
While emitting over one third of global greenhouse gases, they are jeopardized by climate change at the same time. Increasing energy inputs to stabilize production from rising climate variability also increases global warming. A fundamental rehaul of global food systems is needed with an alternative approach to climate resilience, with low emission strategies at the core.

2 **Resilience to climate change is conditional to avoiding catastrophic global warming.**
'Resilience in the face of climate change' refers to the unprecedented climate variability humanity will have to live with even if global warming is limited to 1.5°C and does not trigger a tipping point in one or more of Earth's natural systems. Therefore, today's resilience to climate change is only sustainable if it does not depend on the energy-intensive processes that have set the world on the current trajectory to runaway climate change.

3 **Variability in the ways of operating, especially mobility, is crucial to pastoralists' adaptive capacity.**
Pastoralists' resilience while making use of unpredictable environments is based on keeping options open. Variability is embedded in operational processes and institutional arrangements so that they can be rapidly adapted to short-notice changes in the external conditions. Mobility remains pivotal to this logic.

4 **Addressing non-climate stressors is key also to climate resilience.**
The analysis of climate vulnerability in pastoralism and small-scale agricultural systems, and the strategies to reduce it, must engage with non-climate stressors, as they are generally the primary cause of climate vulnerability. Promoting climate resilience starts from removing the legacy of non-climate stressors that undermine it.

5 **Smallholder farmers' livelihood systems in drylands can learn from pastoralism to address the challenge of sustainably producing food in an increasingly unpredictable climate.**
Small-scale rainfed agricultural systems, and especially pastoralism, might be the world's best bet in the face of the imperative to avoid catastrophic climate change while securing resilience. Pastoralism shows that resilience in the face of climate variability is possible even without the energy intensive solutions that keep the planet on the current trajectory to a climate catastrophe. Today, this lesson has relevance well beyond pastoralism and the drylands.

A short version of this technical background paper can be found in a policy brief: 'Climate Resilience – What can we learn from Pastoral Systems in Africa's Drylands?', available at: www.celep.info and www.giz.de/en/worldwide/104357.html

Background

Since the industrial revolution, global average temperature has increased by 1.1°C and we are now at the record of the last ten thousand years. The 6th Intergovernmental Panel on Climate Change Assessment Report (IPCC 2021) predicts that global warming will reach plus 1.5°C by 2040 or earlier. Beyond that threshold, the risk of triggering one or more of the critical tipping points on Earth's natural systems increases sharply. The Climate Change 2021 IPCC report warns that 'Low-likelihood, high-impact outcomes could occur at global and regional scales even for global warming within the very likely range for a given GHG emissions scenario. The probability of low-likelihood, high-impact outcomes increases with higher global warming levels (high confidence). Abrupt responses and tipping points of the climate system, such as strongly increased Antarctic ice-sheet melt and forest dieback, cannot be ruled out (high confidence)' (IPCC 2021: C.3.2). For humanity and many other species, this is a global catastrophe scenario.

Conventional agricultural and food systems are a major driver of climate change with a contribution of about 35 per cent to global greenhouse gas emissions (IPCC 2022a). At the same time, agricultural systems suffer significantly from climate change. Elevated CO_2 levels, increased weather extremes and pest and disease outbreaks destroy harvests, increase livestock mortality, reduce areas suitable to crop cultivation, and foster water scarcity (Bezner et al. 2022). The livestock sector plays a particular role for methane anthropogenic emissions which are estimated to count for 16 per cent of global GHG emissions by human activities (EPA 2021, quoting IPCC 2014a) and are attracting increasing attention (IPCC 2021; UNEP and CCAC 2021). About 40 per cent of anthropogenic methane emissions are from agriculture, the largest part from livestock's enteric fermentation. Scientists are thus calling for a fundamental rethink of conventional globalised agriculture and food systems, no matter their merits, and for moving beyond their dependence on high energy inputs and fossil fuel (FAO 2018; Dury et al 2019).

'Pastoralism' refers to a wide and diverse family of livelihood and food systems which share a specialisation in making a living from unpredictable climates through livestock (FAO 2021).

Even if global warming is kept below the 1.5°C-target, increasing climate variability and extreme weather events are expected to continue worldwide for decades. Achieving resilience without further increasing global warming is the biggest challenge. A world reshaped by unprecedented climate variability will still be closer to pastoralists' experience than to food systems developed in the relative stability of temperate climates or depending on artificially stable environments. Food production systems that are at home in highly variable environments and extreme weather conditions, such as pastoralism, thus carry valuable lessons.

A lesson from the drylands

The goal of this technical paper is to draw attention to the lessons pastoral systems offer in the face of climate change, in particular with regard to the challenge of achieving global resilience to climate variability without depending on unsustainable energy inputs. In particular, this paper aims to provide an understanding of:

i. pastoralism as livelihood and food production system specialised in managing and benefitting from variability in climate and natural environments;

ii. the key factors which support the resilience of pastoral systems, and on the other hand the role of non-climate stressors in pastoralists' vulnerability to climate hazards; and

iii. ways of capitalising on these learnings for pastoralism and other livelihood systems in dryland areas and beyond, to address the challenge of sustainably producing food given an unpredictable climate.

Pastoralists as professionals in dealing with uncertainty

Over half of the global land surface is rangelands i.e. regions that can be used economically and sustainably for food production only through grazing. Pastoral systems are able to make use of about 70 per cent of the rangelands, including some of the most extreme environments in terms of natural and climatic conditions (ILRI et al. 2021). Estimates of the numbers involved vary between 200 and 600 million people, depending on definitions (IUCN 2015). In Africa only, pastoral systems support the livelihoods of about 100 million people. Relying on pockets of relatively wetter rangeland and farmland to survive during the dry season, and in times of droughts, these systems produce substantial economic value by making use of the vast expanses of rangelands not suited for crop production. In Sub-Saharan Africa, despite chronic under-investment (African Union 2010), pastoralism's contribution to agricultural GDP averages 40 per cent, often including the bulk of meat for both domestic markets and exports. As these systems make only negligible use of cereals as feed, and of external inputs based on fossil fuels, they are amongst the most efficient in the world in sustainably producing human-edible proteins (FAO 2021).

Resilience to climate variability is at the core of pastoralism as a specialist livelihood and production system. Indeed, while managing uncertainty, pastoralists have the ability to achieve relative stability of food production from an unpredictable climate. A relatively stable level of production is achieved by working *with* nature rather than by separating from it. Pastoralists adopt production strategies and operational processes variable enough to match the variability of potential inputs from the natural environment and, so to speak, 'changing at the same pace' (Figure 1).

Figure 1 Achieving relative stability by matching highly variable inputs with equally variable strategies

Figure adapted from Roe E. 2020. A New Policy Narrative for Pastoralism? Pastoralists as Reliability Professionals and Pastoralist Systems as Infrastructure, STEPS Working Paper 113, IDS, Brighton, United Kingdom.

Social-ecological resilience in a pastoralist context

In the face of climate change, the concept of 'social-ecological systems' from resilience theory can be useful. The concept was introduced to emphasise that human systems and ecological systems are inextricably linked (Berkes and Folke 1998). Climate change is making it clear. The understanding of social-ecological resilience emphasises adaptability and transformability while recognising the circular relationship between ecological and social dimensions. When looking at pastoral systems, their underlying logic of fully integrating food production with the natural environment makes the social-ecological link particularly transparent. The analysis of the factors that support or weaken their resilience is pre-emptied by focusing only on climate, or 'nature' – it needs to be holistic.

Social-ecological resilience is 'the capacity to adapt or transform in the face of change in social-ecological systems, particularly unexpected change, in ways that continue to support human well-being' (Folke et al 2016).

Analysing risks and uncertainties in a pastoralist context

This interlinkage between climate, ecosystems and human society is also emphasised in the enlarged framework for climate risk which the IPCC updated in its most recent 6th Assessment Report (AR 6) (IPCC 2022b).

At the core of this risk framework are the concepts of climate hazards, exposure and vulnerability which originate from the IPCC risk framework elaborated in the 5th Assessment Report (AR5). This serves as the foundation for analysing the vulnerability and resilience of pastoral systems. Operationalising the IPCC (2014b) risk framework for a pastoralist context requires a few adjustments, as shown in Figure 2.

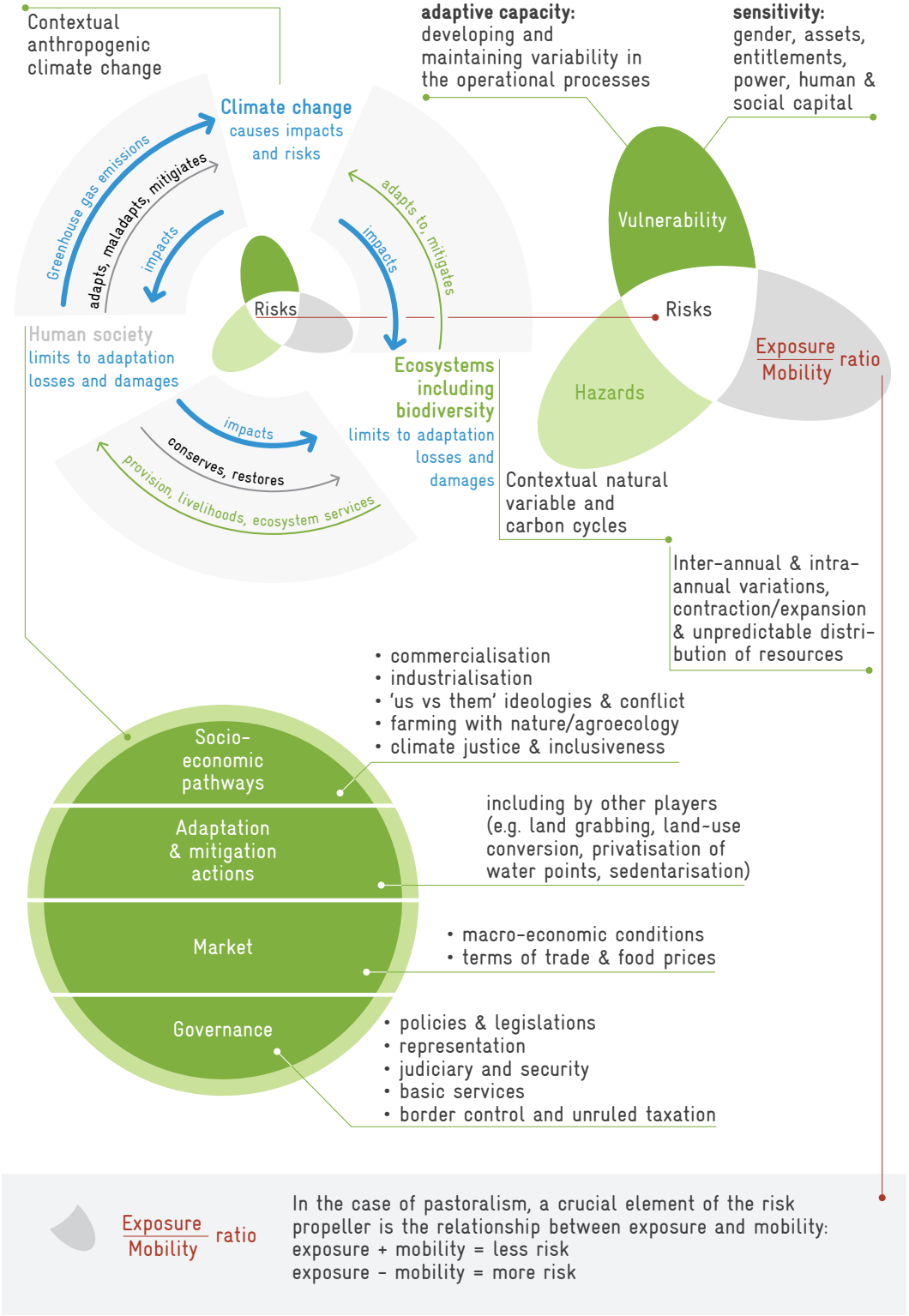
A risk framework for a pastoralist context – and more widely for the assessment of future disaster risk and coping capacities in drylands – **needs to explicitly acknowledge uncertainty**: when the likelihood of future outcomes remains unknown. This includes also the uncertainty associated with the state of knowledge and data about pastoralism (poor coverage and inadequate methodologies), as well as the centrality of uncertainty in the logic of pastoralism, given its integration with unpredictable natural conditions. While the IPCC definition of risk does not exclude uncertainty, an explicit acknowledgement is important in light of the strong tradition in development to reduce all unpredictability to risk, and to treat risk as a condition where the probabilities of future outcomes are known or can be estimated (Scoones 2019).

Climate change poses challenges beyond existing experience. But pastoralists, men and women, specialise in operating with uncertainty rather than by externalising it. In other words, they exceptionally well 'prepared to be surprised'. Linked to this point, a clear **distinction is important between natural climate variability and anthropogenic climate change.** This acknowledges the positive role played by natural variability in the functioning of pastoral systems on one side, and on the other side the sharp increase of climate change as a consequence of socio-economic processes.

It is equally important to emphasise that, with regard to both anthropogenic climate change and natural variability, **it is the immediate context that matters to pastoralist households**, not average values (Hermance 2014). It is necessary to take on board that pastoralists' vulnerability to climate change is rooted in socio-economic processes (non-climate stressors). In particular, pastoralists' exposure to climate change and natural variability is not given, but depends on their capacity to make use of mobility as a key strategy, as well as the institutional means available for implementing it; especially a land tenure system that acknowledges and facilitates access rights to grazing and watering opportunities.

And finally, when looking at the **socio-economic processes** influencing the vulnerability or adaptive capacity of pastoralists, it is important to include the market in the analysis, not just as a solution but as a complex dimension, with both positive and negative impact, alongside socio-economic pathways, governance, and adaptation/mitigation actions outside pastoralists' control.

Figure 2 Operationalising the IPCC's climate risk framework for a pastoralist context (IPCC 2022b).



Resilience of pastoral systems: A variability in strategies and a diversity of assets

Pastoralists' ability to use unpredictable environments, and indeed benefit from climate variability, does not depend on creating artificially stable production systems (separating production from nature). Instead, it is based on keeping the production system itself highly flexible: keeping options open by embedding variability in their operational processes so as to match uncertain conditions. When allowed to function according to its specialisation, pastoralism uses highly variable natural environments both profitably and sustainably (IUCN 2014, see also Box 1).

The most obvious example of systemic variability in pastoralism is **strategic mobility**: the ability to arrive in the right place at the right time to take advantage of unpredictably variable grazing opportunities. Most of the variability pastoralists embed in their system – for example, in customary land tenure – is aimed at supporting mobility. Strategic mobility enables pastoralists to arrive on the forage at the time when nutrients peak, and do so for months on although in every location they visit this opportunity only lasts for a few days. But mobility also allows pastoralist households to manipulate their exposure to drought and other stressors, climate-related and not – for example, social and political insecurity – as well as taking advantage of distant market opportunities. The importance of pastoral mobility for both productivity and resilience, including in the face of climate change, is widely recognised albeit with little follow up in practice (African Union 2010; IFAD 2018; FAO 2021; Cervigni and Morris 2016; IPCC 2014b).

Besides mobility, pastoralists achieve resilience by embedding variability in most of their processes of operation. Livestock breeding systems are a good example. Livestock breeding populations in pastoral systems are bred to make use of permanently changing landscapes. Thus, breeds are also permanently in the making, including not simply genetic diversity but multiple, complex and rapidly adaptable combinations of animal behaviour and performance (Kaufmann et al 2018; FAO 2021). Faced with the recent uncertainties of the COVID-19 crisis, pastoralists who had diversified their livelihoods have sought safety in livestock-based activities (Roque de Pinho et al 2021; Simula et al 2021).

Box 1 Evidence for pastoralist resilience

The adaptive logic of pastoralism to make use of highly variable environments has been described in simple terms in IIED (2015), Misereor (2019), and FAO (2021), and is being further explored in the work of PASTRES, an EU funded research project based at the UK Institute of Development Studies (IDS) and the European University Institute. It has also been captured in the 2021 two-minute animation **Pastoralism is the Future**, available at www.youtube.com/watch?v=DeqITzac9Ac. A more detailed theoretical analysis can be found in Roe (2020).

Access to **a diversity of assets** enables pastoralists to reduce sensitivity to individual hazards. Pastoral 'assets' include substantial livestock holdings of a variety of species, to take advantage of the specific qualities of different species. But livestock are not the only assets. Large networks of kin and friends spanning rural and urban contexts in often distant locations contribute to bonding and bridging ties within and outside communities and support pastoralists in their mobility both on their routine routes as well as for exceptional migration. Pastoralists' assets today can also include financial capital and non-livestock assets that can be easily converted into cash.

Also less tangible cultural assets, like pastoralists' **customary social organisation and institutions**, have evolved to support operational flexibility (variability in processes). They are usually based on inclusionary principles and a combination of individual and collective decision-making and governance – for example, in the managing of resources. And they favour negotiation, complementarity and integration over exclusivity, competition and separation. For instance, communal land tenure systems, developed as customary law over generations and tailored to the needs of natural resource users in drylands, allow multiple and overlapping access rights to grazing opportunities. They facilitate seasonal patterns of crop-livestock integration, with specialist farmers and specialist pastoralists using the same space for their purposes at different times of the year.

Environmental benefits – positive and welcomed, but often neglected

The value of pastoralism in their contribution to the wider social-ecological resilience in the face of climate change is increasingly acknowledged (IUCN 2014; FAO 2021). Pastoral systems benefit from their close integration with their natural environment. Their resilience does not come at a cost to the environment. Pastoralists allowed to operate according to their specialisation excel in water efficiency and in the provision of ecosystem services and biodiversity, from seed dispersal and control of shrub growth to landscape functionality and connecting diverse or distant ecosystems through their mobility (Sharifian et al 2022). Pastoralist food production thus can be achieved in ways that provide substantial ecosystem services while barely contributing to the anthropogenic greenhouse gas emissions at the origin of global warming (see Box 2).

Resilient pastoralism also means resilient crop farming, and not only because many pastoralist households also farm. Pastoralists raise animals for draught and transportation (oxen, donkeys, camels, horses, yaks, llamas) and, by moving with their herds, they take affordable high-value proteins and natural fertilizer to crop-farming communities (FAO 2021). Yet, many of the benefits pastoralists offer in relation to the ecosystems they naturally manage are still too often neglected and underappreciated. And it should not be forgotten that the resilience of regional economies is always manifold and cannot be secured by producers alone. Institutional interventions at state level, concerning services, employment and infrastructures, as well as price regulation for key resources, are a necessary condition today also for pastoralism to function.

Box 2 Pastoralism and greenhouse gas (GHG) emissions

The contribution of pastoralist systems to GHG emissions has been gaining more attention over the last years. Within the livestock sector, livestock in pastoral systems have been associated with above-average methane emissions per unit of milk and meat output due to low-quality diets. The evidence behind this argument, however, is muddled by poor data and a lack of methodological finesse (Houzer and Scoones 2021).

Evidence shows that pastoralism is not part of the anthropogenic processes that have caused global warming and climate change:

1. Conventional methods for the assessment of livestock GHG emissions focus on the animal in isolation from nature, based on models of industrial animal production. But pastoral systems operate as part of rangeland ecosystems, which hold amongst the largest carbon stocks in the world. Emissions are offset at the operational scale of pastoralism, which includes not only the livestock but also the ecosystem. An assessment of the carbon footprint of a pastoral system in the Sahel – based on an 'ecosystem approach' that includes the rangeland ecosystem that pastoralism uses and maintains – found it to be carbon neutral (Assouma et al 2019).

2. Ruminant livestock produce methane, but in pastoral systems this simply replaces natural emissions. Pastoral systems mimic natural carbon cycles, replacing natural emissions from wild herbivores rather than adding to them. If pastoralism were to be removed, the forms of land use that would fill the same ecological niche would either release soil carbon or maintain emission rates similar to those of pastoralist systems (Manzano and White 2019).

3. Livestock systems' largest contribution to climate change is from deforestation of land then used to cultivate animal feed and fodder. But this is a feature of large-scale market-driven and semi-intense systems. Pastoralism works best with the rich biodiversity of natural (uncultivated) landscapes.

The impact of non-climate stressors on pastoralist resilience

In contrast to the internal processes in pastoral systems, which enhance social-ecological resilience, pastoralists have been affected by several stressors linked to intended and unintended outcomes from a long history of ill-informed development policies and interventions (Herrero et al 2016). A very recent example are the political-economic stressors associated with the COVID-19 pandemic – additional restrictions to mobility, spikes in the prices of transport and food, and overstretching of already inadequate health services – that seem to have caused more harm to pastoralists than COVID-19 itself (Catley 2020).

The IPCC states explicitly that 'addressing non-climate stressors facing pastoralists, including policy and governance features that perpetuate their marginalisation, is critical for reducing vulnerability' (IPCC 2014b, Table 22-6, p 1237).

The IPCC highlights the strong influence of socio-economic conditions, and their institutional and governance context, on the resilience of pastoral systems. And it points out how non-climate stressors – especially those that limit mobility, reduce the diversity of assets, and undermine social organisation and institutions – have increased pastoralists' vulnerability to climate stressors (see Figure 2).

Many non-climate stressors relate directly to the **socio-economic development pathways** promoted over the years by international development cooperation and national governments, especially the ever-present promotion of **sedentarisation –** for example, through providing basic services only to settled population, or tolerating aleatory taxation of herders crossing administrative boundaries. Creating permanent water sources to encourage settlements in dry regions traditionally used only during the rainy season has also led to overgrazing and land degradation.

These socio-economic pathways include also the view of pastoralism as a barrier to development and the push for **cash-crops** and **industrialisation**, alongside **commercialisation** policies that are driving up **social inequality.** Even the promotion of livestock marketing as a development measure can act as an added stressor. Impoverished households need to sell fewer stock, not more, in order to rebuild their herds; and pastoralists are increasingly affected by the vicious cycle of crises and unfavourable cereal / livestock terms of trade, and by pikes in the price of feed (Catley 2017).

Inappropriate land policies are leading to the fragmentation of rangelands and the loss of crucial dry-season grazing reserves, competition with crop farming, mining, urbanisation, exclusionary conservation programmes, and privatisation of the commons. Medium and large-scale land acquisition (land grabbing) causes rangeland fragmentation and prevents access to grazing opportunities and water. In a growing number of contexts, combined with aggressive dynamics and armed conflict at the national scale and regional scales, this is destroying the livelihood basis of pastoralists and small-scale farmers alike, and is at the root of violent confrontations also between and within communities (see Box 3).

Most non-climate stressors limit or undermine the mobility of pastoralists and therefore their capacity to produce value from their variable environments. The less mobile pastoralists become, the more they become exposed and vulnerable to the environment they specialise in using. The lack of mobility also leads to overgrazing of the accessible rangeland areas, and impacts negatively on productivity, and consequently on their assets. This leads to a vicious cycle because the more vulnerable pastoralists appear, the more they are prescribed the same old medicine: sedentarisation and exit from pastoralism.

The geographical and political marginalisation of pastoral systems also places them mostly at the receiving end of the processes of risk-externalisation by other groups, from local to global: the **adaptation and mitigation measures** taken by more powerful groups to protect themselves from climate variability in conventional, unsustainable ways. These span from the privatisation of key resources and large-scale land-use conversion, to the ways global economies and food systems are deflecting their historical and ongoing responsibilities for anthropogenic global warming onto poorer nations and small-scale extensive agricultural systems – for example, through influencing the methodologies for assessing productivity, ecological efficiency and GHG emissions (see Box 2) (Gemmill-Herren et al 2021; Nature Food 2021, Houzen and Scoones 2021).

Box 3 Non-climate stressors: The case of Mali

In the Segou region of central Mali*, north of the river Niger, a large-scale land grant was made by the government to a Chinese company for irrigated sugar cane. The sugar is grown in large plantation blocks on land which had been farmed and grazed for centuries. Now irrigation water floods their settlements and agricultural chemicals poison their water supplies. Hundreds of farming families have been forced to migrate further north to seek land for cultivation. Each June, their carts piled high with provisions, people set off northwards, clearing new fields in former pasture areas. Local agro-pastoralists have found themselves increasingly edged out of areas they considered theirs, and relations between Peul herders and Bambara farmers have broken down completely.

Long distance herders seeking passage across the river Niger at Markala bridge have also found themselves in trouble. They are now tightly hedged in for days at a time, waiting in kilometre-long queues for their turn to cross the bridge, unable to water or graze their animals on land along the roadside, at risk of fines and confiscation by the sugar plantation security staff.

A total absence of government engagement at local, regional or national level has compounded the difficulties. No attempt was made to work out how to pay compensation for loss of land, to negotiate new realities, find complementarities, or seek better integration of people and livelihoods across this wide area of millet cultivation and extensive grazing lands.

Over the summer of 2021, a series of battles between jihadists and local villagers led to the submission by villagers across the whole region to the JNIM group. Jihadists have been very successful in recruiting young men from the pastoral community, whose interests have been so damaged over recent years. In many areas, farmers have been forbidden by the JNIM group from cultivating any land, on pain of death, and have no millet to harvest this year. Many settlements have emptied out as everyone moves away, needing to find whatever food and income they can, to pass the long dry season until they find out whether they'll be allowed to cultivate next rainy season.

A situation of mutual respect, complementarity, negotiation, and living with variability, has been transformed into one of killings, conflict, and communities set against each other.

* Mali is ranked 176 out of 182 in the ND-GAIN index Vulnerability score, which measures a country's exposure, sensitivity and ability to adapt to the negative impact of climate change (https://gain.nd.edu/our-work/country-index/rankings).

Source: Camilla Toulmin (2020) *Land, Investment and Migration;* and 2021 personal communication.

Adding to this, **public knowledge about pastoralism** is confused and highly politicised (Johnsen et al 2019), while standard methods for generating national and global statistics are generally inadequate to represent pastoral systems (Pica-Ciamarra et al 2014; Krätli et al 2015; Zezza et al 2016; Houzen and Scoones 2021).

Modelling, including of risk, is becoming more and more sophisticated, yet often pre-empted in the case of pastoralism by its dependence on data that are scanty, rarely at the relevant scale, and often misleading because generated from inadequate or false assumptions.

Enhancing pastoralist resilience in the face of climate change

Protecting and strengthening the social-ecological resilience of pastoral systems would help reduce exposure and sensitivity while increasing adaptive capacity in the face of climate change. This cuts across all four dimensions of the 'vulnerability to resilience' framework shown in Figure 3.

Figure 3 A social-ecological resilience framework based on pastoral systems.

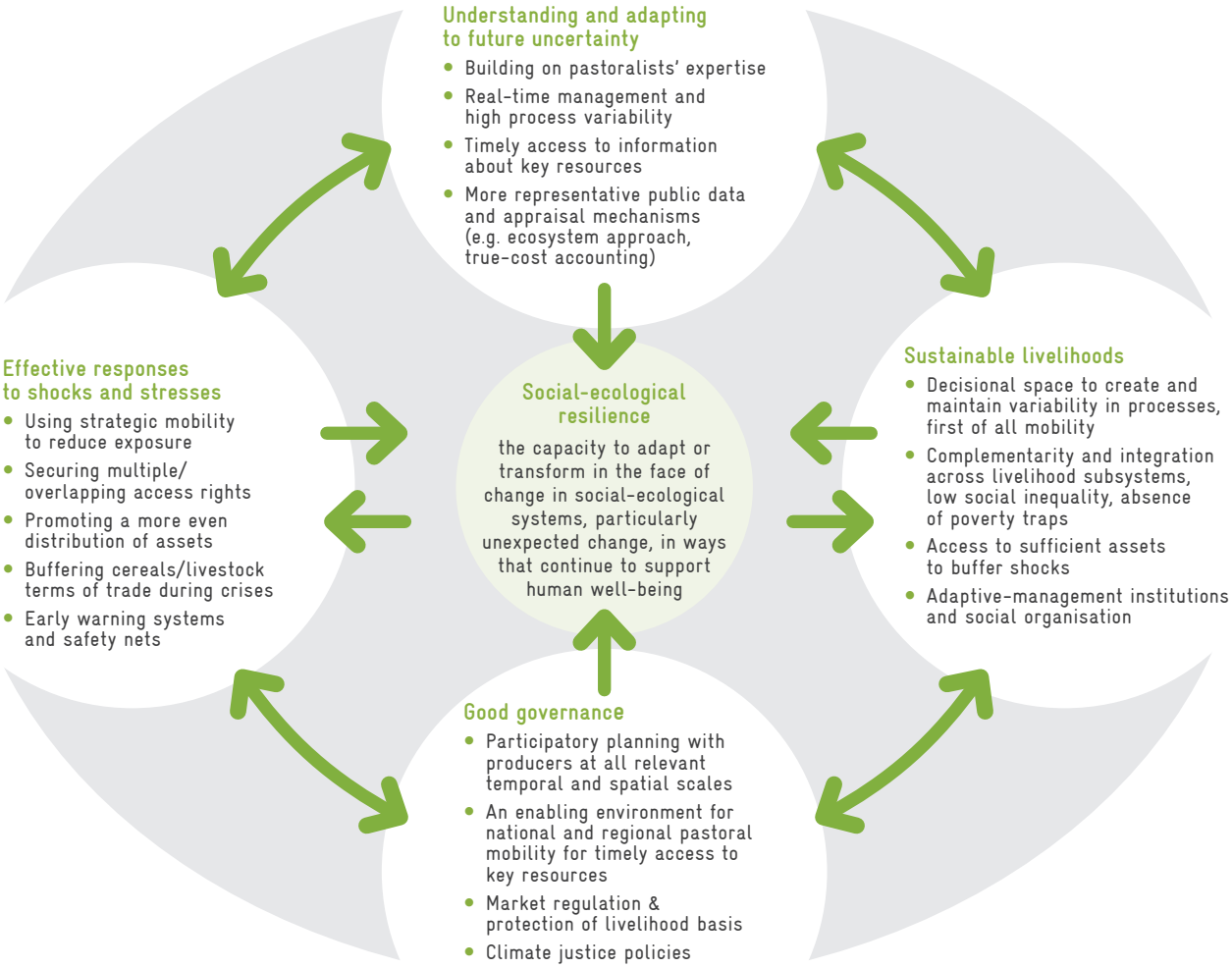


Figure adapted from Pasteur, K. 2010. From Vulnerability to Resilience, Practical Action, Rugby, United Kingdom.

Efforts to support resilience in pastoral systems would be greatly helped by taking on board the following conditions:

i. developing a sound understanding of the operational logic of pastoralism in dialogue with pastoralists themselves, and supporting pathways that build on its strengths while reducing external limitations;
ii. enabling a legal, institutional and policy environment that supports the roots of pastoralists' resilience, and especially their strategic mobility both within and across national borders;
iii. refraining from locking pastoralism onto supposedly 'optimal' pathways that inevitably increase both its exposure and its sensitivity by reducing the systemic variability that is key to its adaptive capacity.

Possible interventions under the four dimensions of the resilience framework need to keep in mind that all three conditions above are relevant to any kind of intervention.

Understanding and adapting to future uncertainty

Programmes and interventions need to learn to recognise systemic variability in pastoralism, support it and strengthen it in its function of harnessing unpredictably variable opportunities. This can be done successfully only in dialogue with pastoralists and building on their expertise. Resources in unpredictable environments are defined by time as much as space, thus information about resources needs to be accessible in a timely way. As uncertainty limits the scope of planning, facilitating real-time management by pastoralists themselves is crucial.

A great deal of confusion about pastoral systems comes from the fact that they are poorly represented in standard mechanisms of appraisal (e.g. censuses and technical surveys). Simply expanding the data set will not suffice to address this problem. Public data on pastoral systems will improve only when the methodological barriers in the mechanisms of appraisal are identified and addressed, and sound processes of true cost accounting[1] have been embedded in the methods for assessing economic and ecological efficiency in agriculture. In addition, data gaps must be closed to better understand future uncertainty. As pastoralists are directly affected by changes in their immediate context, data is needed on interannual and multiannual variability of rainfall at the lower spatial and temporal scales, and its interaction with highly specific variables such as biodiversity, soil or terrain (Hermance 2014).

Good governance

Pastoral systems have been undermined for decades by the very processes that were supposed to promote their development, but have done so by trying to stabilise and control both pastoralists and the environment. Today, securing resilience in pastoral systems needs to recognise this damaging legacy and counterbalance it in ways that support pastoralism's systemic variability. Genuine participatory planning with producers – men and women across wealth differences and all relevant temporal and spatial scales – is a long-overdue and necessary step in this direction.

Another essential step is the creation of an enabling socio-political and legal environment for pastoral mobility at national and regional level, to allow for timely access to key resources. Protection of the basis for pastoralists' livelihoods needs to become a governance focus, even when unrelated to market interests, for example by protecting mobility and customary common rights also over private land. Diversification programmes need to be monitored in relation to persons and households, the ecological and social context, and the pastoral system as a whole, ensuring that the outcomes of diversification are positive on *all* these accounts, not just some. Decision-making processes and policy formulation need to systematically include so-

[1] Dasgupta 2021; and FAO: www.fao.org/nr/sustainability/full-cost-accounting/en

cial-ecological approaches (for example, nature-based approaches like ecosystem-based adaptation) and climate justice[2], starting by making a clear distinction between natural CO_2 emissions or equivalents, and the industrial GHG emissions responsible for climate change.

Effective responses to shocks and stresses

To work effectively to support pastoral systems' resilience, it is necessary to address the legacy of regulations, institutions and practices that, by contributing to non-climate stressors, increase pastoralists' exposure and sensitivity to climate stressors. Strategic mobility, including cross-border mobility, allows pastoralists to reduce both their exposure and their sensitivity to climate hazards. Understanding and enabling pastoralists' strategic mobility as part of the systemic variability at the heart of their adaptive capacity, are essential steps for securing pastoralists' resilience in the face of climate change. All other resilience-building measures – from early warning systems, safety nets and humanitarian aid, to water development, service provision and income diversification – need to be consistent with this goal. They should not follow a 'one size fits all' approach, but rather develop ways of engaging positively with the diversity and variability on the ground.

Mobility is associated with transient but timely use of the natural space, secured through land-tenure systems designed to allow for multiple and overlapping access rights. In the transition to the market economy and related land-tenure reforms, such non-permanent and non-exclusive access rights have often been overlooked. They need to be better understood and acknowledged. The transition to the market economy has opened up opportunities but also introduced growing inequality. As a sufficient asset-base is essential to keep sensitivity to climate stressors low, mechanisms to reverse the current trend towards inequality and to promote a more even distribution of assets are needed. This includes buffering the cereals/livestock terms of trade during crises.

Sustainable livelihoods

As a general rule, all policy measures should avoid closing down options and railroading pastoral systems from flexibility to rigidity. Examples of positive interventions here may include:

- Embedding flexibility in the provision of basic services and infrastructure – for example, by combining school-based and distance formal education on easily interchangeable platforms (Republic of Kenya 2010), or by developing parallel channels of health-service provision for people and animals, mobile and internet-based; this would make services mobility-friendly while helping with the uncertainty associated with disasters, insecurity and failing states.

- Embedding process variability in land-tenure systems centred on supporting livelihood and peaceful co-management of multiple overlapping rights from different groups of users – for example, by moving beyond the current legal representation of commons and private land as mutually exclusive, and introducing the legal possibility of customary common rights of use also on private land (as is the case in UK and Europe).

- Promoting process variability within and between livelihood sub-systems:

  i. allowing for variable (opportunistic, partial and intermittent) forms of integration between pastoralism and crop farming beyond their current representation as mutually exclusive; and
  ii. supporting households' strategies currently reshaping urban-rural relations, including variable dynamics in the use of mobility and settlements, and the diversification of assets and income generation within the extended family.

[2] 'Climate justice' frames climate change as an ethical and political issue and relates it to equality, human rights, collective rights, and the different historical responsibilities for global warming.

Learnings for enhancing climate resilience in agricultural systems

Climate variability at unprecedented levels is going to stay for decades even if global warming can be stopped. Global agricultural and food systems need to find new ways of being climate resilient – ways that no longer depend on energy/resource-intensive solutions to externalise nature's variability. Livelihoods of small-scale producers in the drylands are already being destroyed in connection with climate change. The situation will drastically increase in the future and is likely to lead to a shift in areas suitable for staple food production, further straining local livelihoods and employment opportunities in drylands and beyond. This underscores the critical need to strengthen the resilience of smallholder-based production systems.

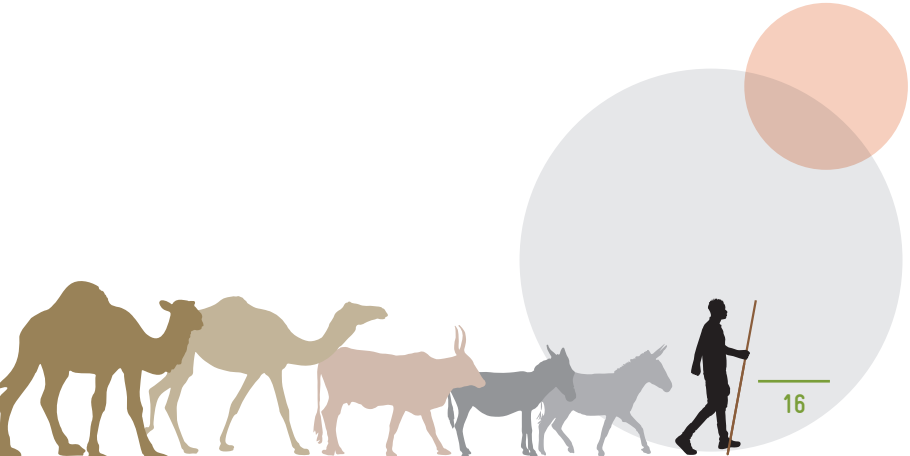
In the face of this challenge, learning from pastoralism and their underlying resilience elements can foster the resilience of smallholder-based agri-food systems more broadly. There are two main aspects to take from the experience of pastoralist systems:

- Resilience can be gained from embedding flexibility in the production systems so as to match the unpredictable changes in their operating conditions. This underlines the importance of the core elements of pastoralist adaptation strategies (process variability and diversity of assets).

- The analysis of climate vulnerability must also include non-climate stressors as they are often the primary cause of climate vulnerability in small-scale agricultural and food systems. Promoting climate resilience starts by removing the non-climate stressors that limits the capacity to adapt and push producers towards conventional, unsustainable forms of resilience.

Smallholder farming households also have developed variable strategies in their traditional farming systems, which have come increasingly under pressure through agricultural and economic strategies focussing on large-scale, conventional agriculture. Fostering resilience to climate change therefore needs to look at ways of supporting and enabling well-targeted process variability in drylands farming systems. At the same time, interventions should not pressure the local population to adopt adaptation measures based on high energy inputs to externalise natural processes. It is also important to embrace the diversity of existing farming systems – both sedentary and mobile – and to reflect and strengthen the interaction between them.

In conclusion, such an approach could enable both agroecosystems and rural communities to better cope with variable environmental circumstances, enhance adaptive natural resource management and achieve fairly resilient agri-food systems even in the face of increasing climate variability. Yet agri-food systems can only achieve their full resilience potential if backed by ambitious climate change policies to avoid a climate catastrophe, and by an appropriate political and a legal environment that allows for adaptative co-management of natural resources and the peaceful cohabitation of diverse natural resource user groups.



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List of abbreviations

AR ..... Assessment Report

FAO ..... Food and Agriculture Organisation of the United Nations

GDP ..... Gross Domestic Product

GHG ..... Greenhouse gas

GIZ ..... Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH

IDS ..... Institute of Development Studies

IIED ..... International Institute for Environment and Development

IPCC ..... Intergovernmental Panel on Climate Change

ND-GAIN ... Notre Dame Global Adaptation Index

V2R ..... Vulnerability to Resilience

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