PRISE
Pathways to resilience in semi-arid economies

Value Chain Analysis for Resilience in Drylands (VC-ARID): identification of adaptation options in key sectors

Step 1 Step 2 Step 3

VC-ARID synthesis report
June 2018

Elizabeth Carabine and Catherine Simonet
Overseas Development Institute

with Denis Akouwerabou, Nurali Asozoda, Parfait Bako, Samavia Batool, Assane Beye, Claire Bedelian, Néné Dia-Ndiaye, Waoundé Diop, Amirshoev Faizulloyev, Sebastian Gollnow, Abdulhamid Kayumov, Stephen Moiko, Nailya Mustayeva, Simon Wagura Ndiritu, Sharofjon Rakhimov, Fahad Saeed, Mohammed Said, Issiaka Sombie and Antoine Yerbanga.

Research for climate-resilient futures

Pathways to Resilience in Semi-arid Economies (PRISE) is a five-year, multicountry research project that generates new knowledge about how economic development in semi-arid regions can be made more equitable and resilient to climate change.

PRISE aims to strengthen the commitment of decision-makers in local and national governments, businesses and trade bodies to rapid, inclusive and resilient development in these regions. It does so by deepening their understanding of the threats and opportunities that semi-arid economies face in relation to climate change.

The PRISE consortium comprises the Overseas Development Institute (lead), UK; Grantham Research Institute on Climate Change and the Environment, UK; Innovation Environnement Développement en Afrique, Senegal; and the Sustainable Development Policy Institute, Pakistan; with country research partners the Regional Environmental Centre for Central Asia, Tajikistan; Kenya Markets Trust, Kenya; University of Ouagadougou, Burkina Faso; and the University of Central Asia, Kyrgyzstan.

Acknowledgements

The authors would like to thank John Wamahiu, Abdikarim Daud and Joseph Muhwanga at the Kenya Markets Trust for their assistance with stakeholder engagement and technical advice.

We are also grateful to Eva Ludi, Rebecca Nadin and Gaëlle Balineau for their support of the research project and for their review of this report. Many thanks to Pauline Castaing and Catlyne Haddaoui for their assistance on the synthesis analysis, and to Fiona Bradshaw for the value chain illustrations.

The authors would also like to express their sincere gratitude to all the respondents who participated in the research for their valuable information and willingness to cooperate, and also to the stakeholders in Pakistan, Burkina Faso, Senegal, Kenya and Tajikistan as well as at international level who engaged in the research, workshops and analysis.

Map disclaimer

All maps are produced by the authors, using data extracted from the GADM database (www.gadm.org), version 3.4, April 2018. The boundaries shown and the designations used on the maps in this report do not imply the expression of any opinion on the part of the authors, PRISE or the Overseas Development Institute concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Cover image: iStock.com/Succession of African Nguni cattle walking in the bush, ChanelBCreating

Contents

List of figures

Introduction

Climate change threatens development and economic growth in semi-arid lands. Climate-related risks will increase for individuals, businesses and infrastructure and have consequences in all sectors of the economy. Climate change will have significant impacts on economic activity and value chains as economic actors are forced to alter their production systems to maintain their production capabilities under changing conditions.

However, climate change can also lead to new possibilities for people and businesses in semi-arid lands, with opportunities to create new products and services, develop new markets and access new funding streams and finance mechanisms. Nevertheless, adapting to the impacts of climate change, and taking advantage of opportunities arising from it, will require action across multiple sectors and from both public and private actors.

The PRISE programme aims to identify opportunities for economic transformation and diversification in the semi-arid lands of PRISE countries, by integrating sectors rooted in semi-arid lands into national economies. Using a common three-step innovative methodology – Value Chain Analysis for Resilience in Drylands (VC-ARID) – it will identify climate risk, adaptation options and opportunities for private sector development in Burkina Faso, Kenya,[1] Senegal, Pakistan and Tajikistan, specifically for the livestock and cotton sectors.

[1] Two value chain studies have been included in Kenya, due to stakeholder demand. One is in the northern county of Laikipia, where there was particular interest in exploring the linkages between tourism and beef sectors. The other is in the southern Kajiado county, which borders Tanzania and where there are particular synergies with questions of land use tenure and management.

This research is designed to address the issues decision-makers raised during national stakeholder platforms held across all PRISE countries and national policy priorities identified by PRISE partners. As a result of this process, VC-ARID focuses on identifying investment options in the cotton sectors of Burkina Faso and Pakistan, and in the livestock sectors of Senegal, Kenya and Tajikistan. These sectors represent important economic opportunities in the countries in question and climate change has provided a window of opportunity to garner political support for them. This support is important if the appropriate investment-enabling environment is to be provided.

VC-ARID tests the hypothesis that there are two pathways for climate-resilient economic development in semi-arid lands. The first option is through upgrading of key value chains, such as cotton and beef (vertical transformation). The second is through diversification within the sectors or into related tertiary sectors, such as milk or tourism (horizontal transformation).

As such, two overarching research questions guide this work:

1. What are the pathways for climate-resilient economic development in semi-arid lands through vertical and horizontal transformation?

2. What are the adaptation options for public and private sector investment opportunities in responding to climate change in semi-arid lands?

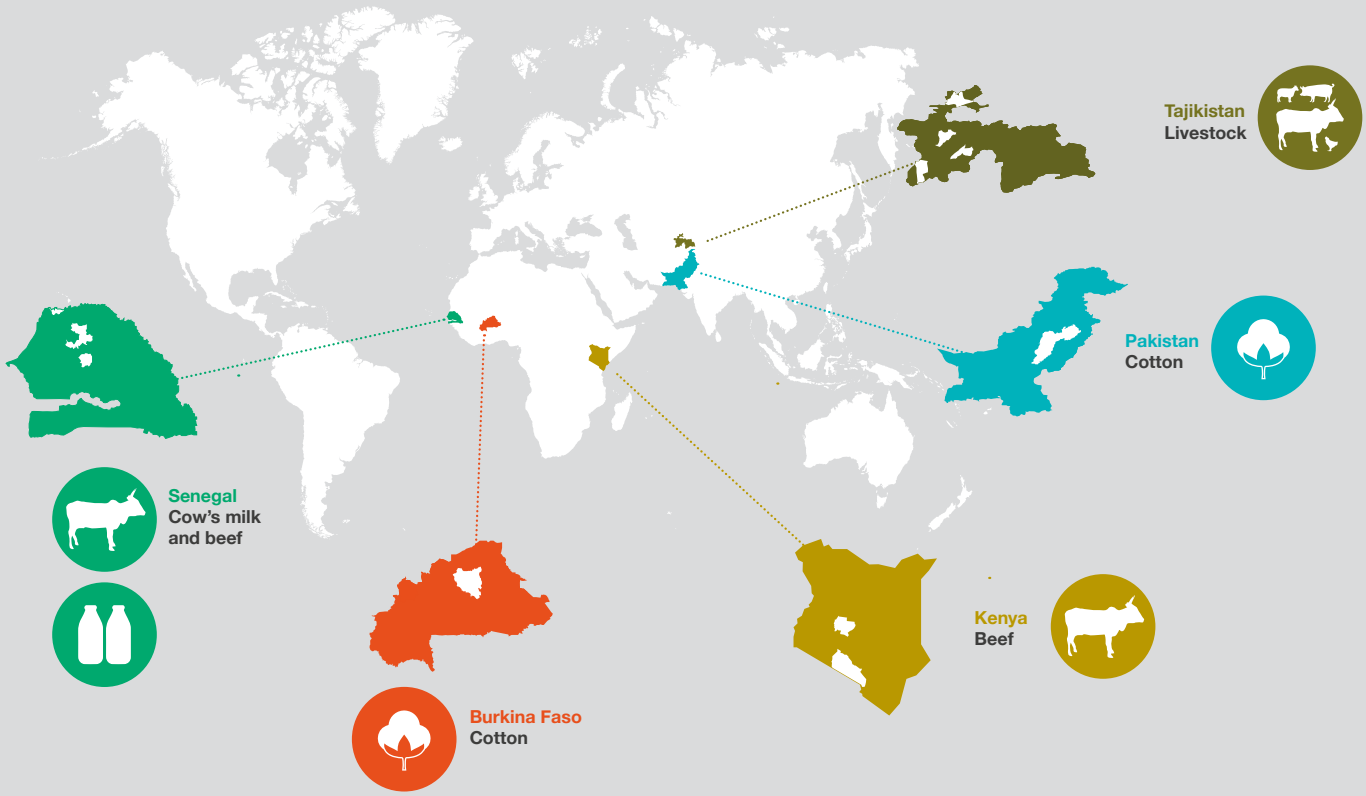
The livestock and cotton sectors were chosen against several quantitative and qualitative criteria, including their contribution to national gross domestic product, their national added value, their employment importance and their potential for economic growth in the future.

In answering these questions, we describe ways to both stimulate growth and support socioeconomic development by better integrating semi-arid lands into national economies through improved market access and enhanced trade. Figure 1 presents the countries and sectors in which VC-ARID was implemented for PRISE. Across the locations and sectors, VC-ARID follows a common three-step methodology.

“...we describe ways to improve market access and trade relations to protect people but also to stimulate growth by better integrating semi-arid lands into national economies.”

iStock.com/Cotton, ImagesbyBarbara

Figure 1. **VC-ARID countries and sectors**



Map disclaimer: All maps are produced by the authors, using data extracted from the GADM database (www.gadm.org), version 3.4, April 2018. The boundaries shown and the designations used on the maps in this report do not imply the expression of any opinion on the part of the authors, PRISE or the Overseas Development Institute concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Value Chain Analysis for Resilience in Drylands (VC-ARID)

VC-ARID is an innovative and interdisciplinary approach to value chain analysis in that it takes account of the specific characteristics of semi-arid systems. As such, the VC-ARID methodology integrates key principles that support its application in a territorial – or hotspot – approach as developed within the PRISE programme.

Key to the approach is the recognition that, in semi-arid lands, ecological and socioeconomic variability represent key structural differences when compared with other production systems. VC-ARID endeavours to avoid the tendency towards a 'single-path' approach.

For example, extensive livestock production systems are distinct from other productive sectors in their character. Therefore, new approaches are needed to understand them better and to identify appropriate interventions that support, rather than undermine, these systems. The five characteristics outlined below are particularly important to these production systems, and often form the basis of adaptive capacity inherent within them.

With the VC-ARID approach, PRISE has the potential to make a significant contribution to development in semi-arid lands. VC-ARID builds on existing value chain analysis approaches but has incorporated the following five key characteristics of semi-arid lands:

Image: Cattle in Karamoja, Uganda, by Elizabeth Carabine/PRISE

First, we consider the territorial approach of VC-ARID to be essential in understanding the potential of these sectors to contribute to climate-resilient economic development. For this reason, we focus on value chains that have their production rooted in semi-arid lands. In each country, semi-arid lands have been defined according to annual average rainfall.

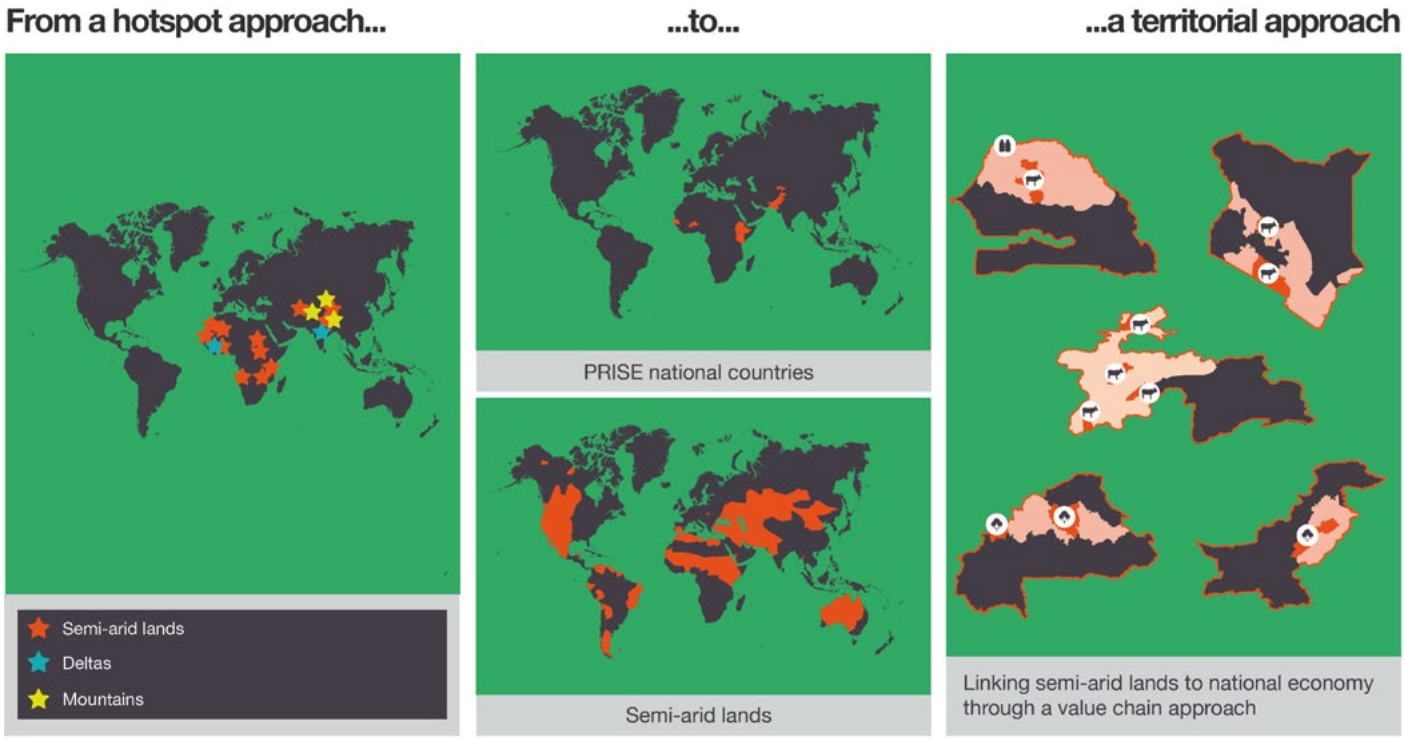
Second, VC-ARID is novel in its approach to analysing climate risk. At each step of each value chain, climate risk is assessed using both qualitative and quantitative methods. This allows us to start understanding response to risk and possible adaptation options across these chains in systems that are going to face increasing vulnerability as climate change interacts with other factors (according to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2014), for example).

Third, even before we consider climate change and increasing variability, semi-arid lands are already highly variable in their climatic and ecological conditions. This has huge implications for production (quantity and quality) and supply (prices, access) and therefore the entire chain is affected by seasonality; so, VC-ARID explicitly considers rainy and dry seasonal effects.

Fourth, there is already significant economic activity taking place in semi-arid lands, with approximately 2 billion people making a living in these areas (Kimani et al., 2014). However, these areas have been relatively marginalised both politically and economically and much production and trading activity is informal. Therefore, the VC-ARID methodology incorporates both informal and formal chains.

Fifth, there are also significant gender dimensions to consider. In Pakistan, the gendered roles of cotton production, picking, weaving and ginning, are explicitly recognised in the chain. In Senegal, inclusion of the cow's milk value chain, in which the actors are predominantly female, alongside the beef value chain, which involves primarily male actors, allows us to explore the opportunities for diversification of the livestock value chain to include both men and women.

Figure 2. VC-ARID – from hotspots to a territorial approach



The CARIAA framework: Identification of climate change 'hotspots', where strong climate signal and high concentrations of vulnerable people are present.

These hotspots include semi-arid regions and deltas of Africa and Asia, and glacier- and snowpack-dependent river basins of South Asia.

PRISE aims to strengthen the commitment of decision-makers in local and national governments, business and trade bodies to rapid, inclusive and resilient development in semi-arid regions.

VC-ARID is an innovative and interdisciplinary approach to value chain anlysis in that it takes into account the specific characteristics of semi-arid systems.

Key to the approach is the recognition that, in semi-arid lands, ecological and socioeconomic variability represent key structural differences when compared with other production systems.

Source: Authors

(Map disclaimer: All maps are produced by the authors, using data extracted from the GADM database (www.gadm.org), version 3.4, April 2018. The boundaries shown and the designations used on the maps in this report do not imply the expression of any opinion on the part of the authors, PRISE or the Overseas Development Institute concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries)

The starting point for developing the VC-ARID methodology is the 'hotspots' approach established by the Collaborative Adaptation Research in Africa and Asia (CARIAA) programme, in which PRISE is embedded. CARIAA's hotspots approach consisted of defining climate change hotspots, i.e. identifying geographical areas where 'a strong climate change signal is combined with a large concentration of vulnerable, poor, or marginalised people' (De Souza et al., 2015). These hotspots include the semi-arid regions (the focus of PRISE) and deltas of Africa and Asia, and the glacier- and snowpack-dependent river basins of South Asia.

In this context PRISE focused on promoting economic development in semi-arid lands that is inclusive and resilient to climate change. The challenge of VC-ARID is to propose a methodology that reconciles the place-based focus of semi-arid hotspots with the concept of economic development, which is often led by national bodies. VC-ARID reconciles these scales of analyses by proposing a territorial approach combined with a sectoral approach. Integrating the two perspectives allows for poverty reduction goals and broader economic development goals to be addressed.

Thus an innovative and interdisciplinary methodology is developed that (i) addresses the needs of national governments and socioeconomic development planning processes in taking a sectoral focus, (ii) recognises the climate change vulnerabilities and characteristics of semi-arid lands as specific geographies; and (iii) promotes integration of marginalised areas into the national economy by proposing evidence-based options for investment that are tested with stakeholder engagement across scales (see Figure 2). This is the means by which VC-ARID can be used as a tool to target adaptation and development investments to deliver climate-resilient economic development that is also inclusive.

Three-step VC-ARID methodology

Across the locations and sectors, VC-ARID follows a common three-step methodology:

Step 1:

Mapping the value chain

In the first instance, several workshops were convened in six countries to identify climate risks and policy priorities with stakeholders from national and local government, civil society, academia and the private sector. These discussions informed the design of the innovative VC-ARID approach and the selection of sectors for investment. During the implementation of Step 1, key stakeholders in the value chains became active participants in the approach through key informant interviews and focus group discussions. This step also included a literature review.

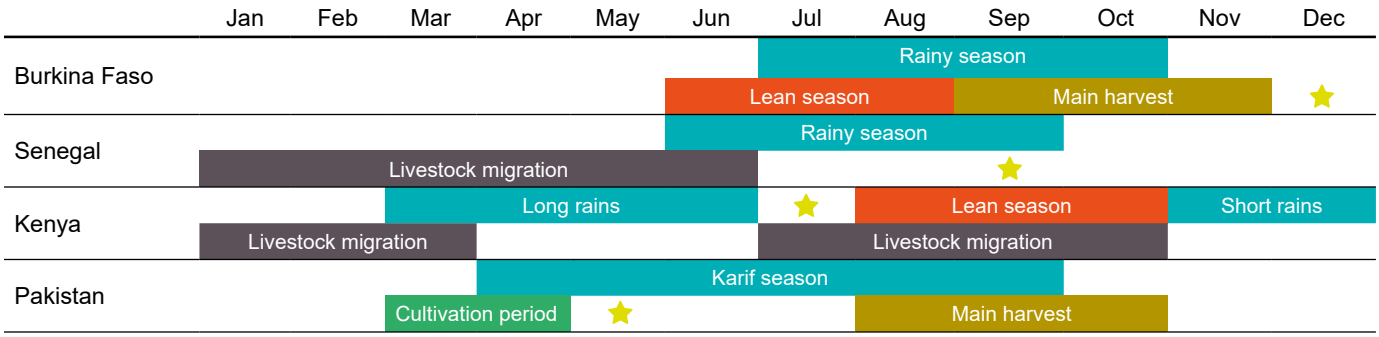
Step 2:

Assessing climate risks at each level of the value chain

Climate risk was assessed both qualitatively, through key informant interviews at each level of the value chain, and quantitatively, through carrying out surveys of producers and, in some cases, traders. For the quantitative surveys, a representative sample of the sites was selected with sampling adapted to each context. Information on sampling strategies is provided in the respective country value chain reports.[2] On average 400 producers were surveyed per value chain for Pakistan, Burkina Faso, Senegal and Kenya, totalling approximately 2,300 producers across these six value chains.

[2] See References on page 72 for full list of VC-ARID country reports.

Figure 3. Sampling timeframe, 2017 [3,4]



quantitative survey implementation

Source: Authors

Climate information was used at two levels. First, IPCC observations and projections of average temperature, rainfall and extremes, such as drought, heat waves and extreme rainfall were taken into account. Second, to assess perceptions of climate risk, producer-level quantitative surveys were carried out for all value chains and qualitative semi-structured interviews and focus group discussions took place with processors and market actors.

Across all the countries, the research tools include common sections on household characteristics; current livelihood activities and access to services; perceptions of climate change and extremes, and responses to them over the past 10-15 years; perceptions of and responses to named extreme climate events (for example drought or flood); and perceptions of and responses to other shocks, including conflict, price shocks and idiosyncratic shocks – such as the sickness of a household member or a robbery.

The methodology was consistent across all value chains, but the analysis took place in different contexts, the samples varied slightly and the questionnaires had small differences in order to take account of specific contexts and production systems. There was also a difference in the level of implementation. For example, Pakistan, Burkina Faso, Senegal and Kenya had 'full' implementation with quantitative surveys and extensive stakeholder engagement over three years, whereas Tajikistan followed a lighter implementation of VC-ARID over one year (see Box 1 on Page 63).

Step 3:

Identifying adaptation and private sector investment options for climate-resilient value chain transformation

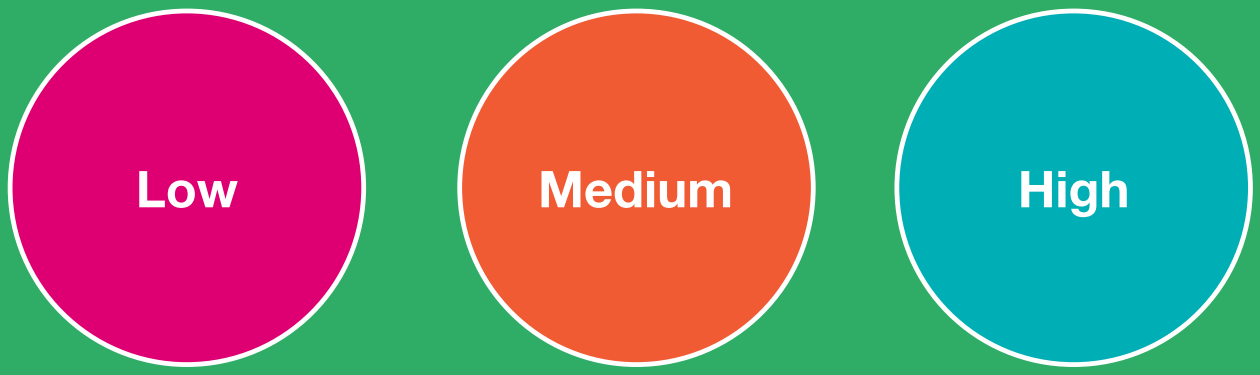
The evidence from the previous two steps was shared with stakeholders with the aim of working closely together to generate sets of evidence-based adaptation options that can address climate risk and promote inclusive and climate-resilient economic development in these sectors. Continuing on from the logic of the value chain approach, potential options for climate-resilient value chain transformations were identified first. Then, an assessment of existing and required adaptive capacity was made that can accommodate current and future climate impacts into potential transformations to the value chain, and where public and private sector investment and services can meet these needs. Next, in partnership with stakeholders, priority adaptation options were identified per value chain that were assessed for the potential for transformational change across the value chain and sector as a whole.

[3] Note: the stars correspond to the date of survey implementation.
[4] There are two main crop growing seasons in Pakistan. The winter crops (Rabi meaning spring) are sown during October-December and are harvested during March-April. The sowing season of summer crops (Kharif meaning autumn) starts in March-May for cotton with harvesting in September-December.

Levels of confidence in synthesis conclusions

Drawing on the IPCC categorisation of evidence, possible conclusions drawn from across the value chain studies are assessed according to level of confidence, from the options of low, medium or high level of confidence.

Figure 4. Levels of confidence in synthesis conclusions

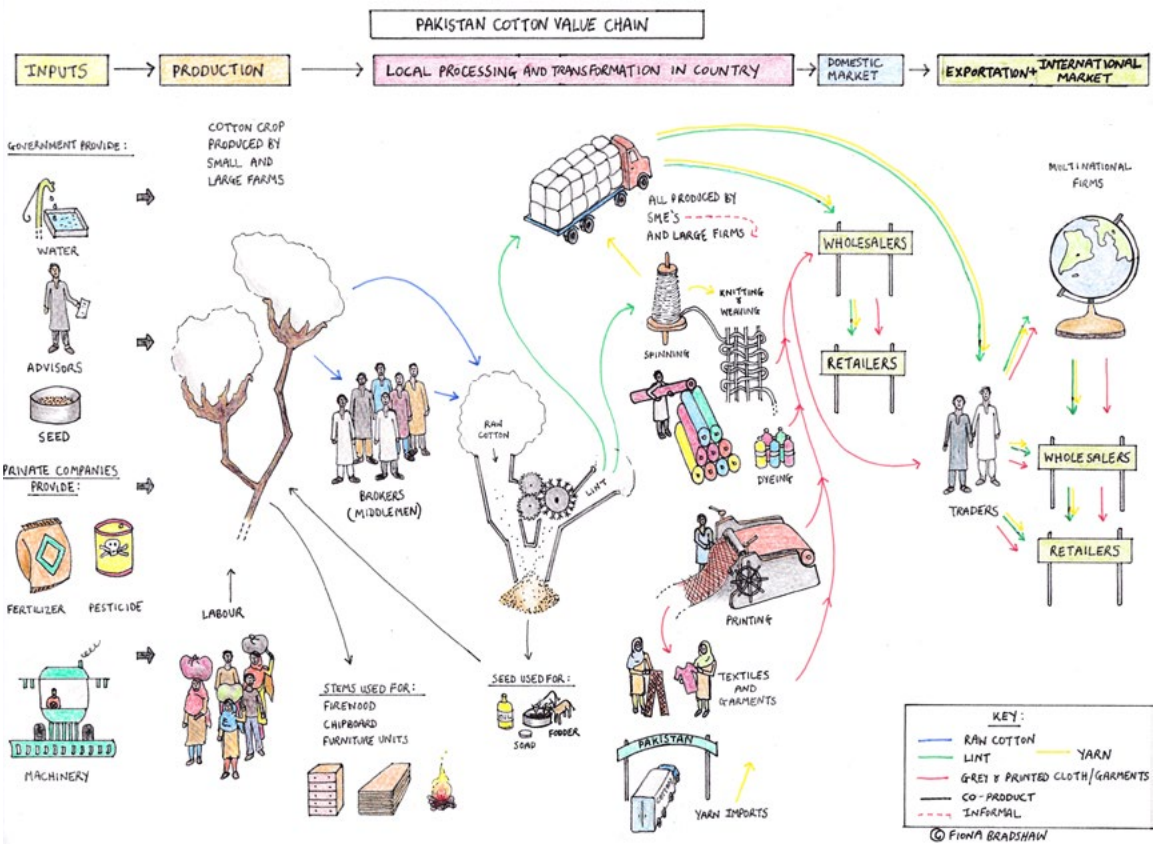


A finding is classified with a high level of confidence when it is a robust finding of five to six of the value chains studied (out of six total studies). A finding common to four or five value chain studies is considered to have a medium level of confidence, while a low level of confidence is classified as a finding common to only two studies. The results can also be similar by sector or region. For instance, a high level of confidence is judged for findings across the two beef value chains for Kenya.

Step 1

Results of VC-ARID Step 1

Pakistan's cotton value chain



By Fiona Bradshaw/PRISE

- Pakistan is currently the fourth-largest cotton-producing country after India, China and the USA; and the third-largest cotton-consuming country in the world. Pakistan is the third largest exporter of raw cotton and is the largest exporter of cotton yarn (Banuri, 1998).

- Within agriculture, the cotton sector is one of the major sectors providing economic support to the country. It contributes 55% of foreign exchange earnings and has a share of 10% in Pakistan's GDP (Government of Pakistan, 2016).

- After wheat and rice, cotton is the third most cultivated crop in Punjab by crop area and is sown only on irrigated land. A total of 42% of cotton-producing districts are semi-arid.

- There is a disconnect between cotton farmers and actors higher up the value chain, owing to the reliance of textile manufacturers on imported cotton.

- A primary factor determining the economic resilience of any farming household is access to credit. Currently, credit is accessible only by those farmers with some kind of land ownership status. Seasonal labourers cannot access credit so resort to employment in small- and medium-sized enterprises, such as local ice factories or brick kilns.

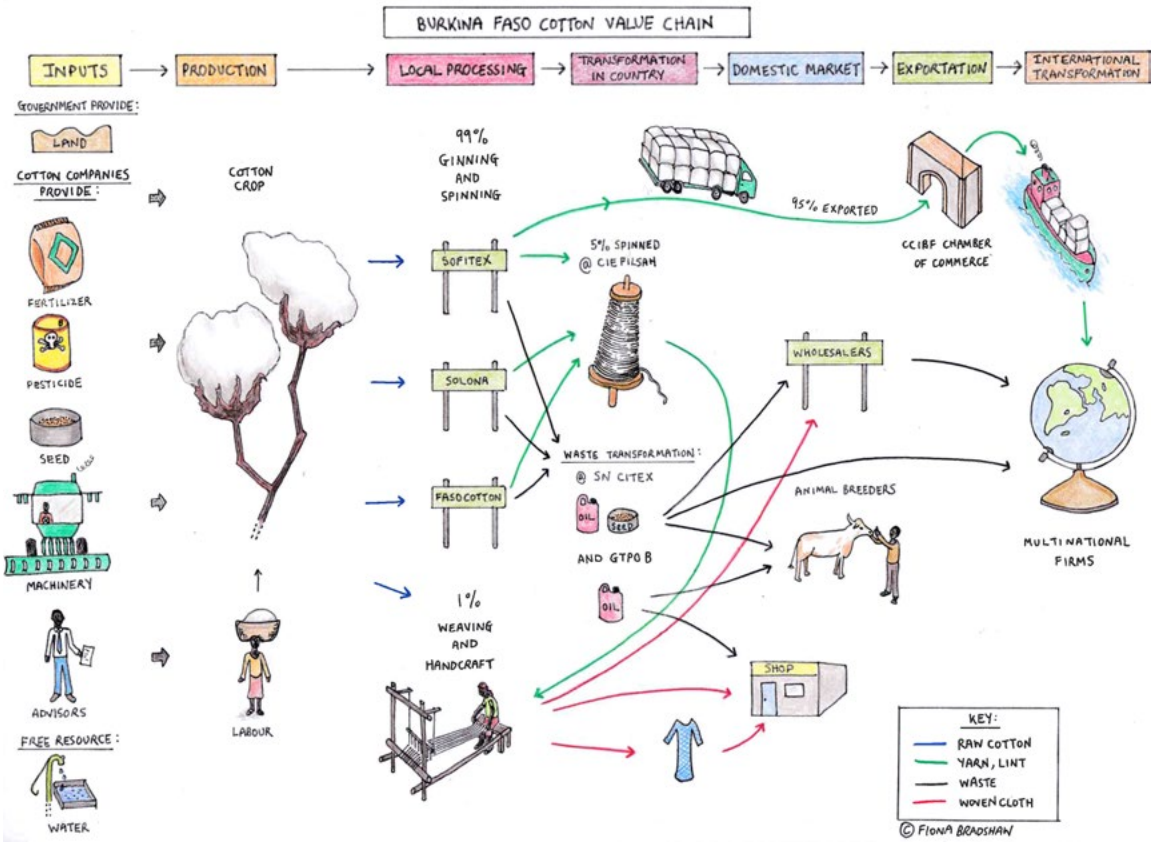
- Currently, policies are skewed towards the higher end of the value chain. Prices are set in a monopolised system that favours large textile companies, leaving little profit margin to farmers.

- Cotton farmers are generally well aware of the direct climate risks facing their production. However, they know relatively little about adaptation measures, and rely mostly on local methods such as using hand pumps to remove excess water from fields.

Image: Women decontaminating cotton near Faisalabad in Punjab, Pakistan, by Rajeshree Sisodia/PRISE

Step 1

Burkina Faso's cotton value chain



By Fiona Bradshaw/PRISE

- Cotton in Burkina Faso is a rain-fed cultivation system practised by about 350,000 cotton producers gathered within 9,000 cotton producer groups. In 2017, the country ranked as the first cotton producer among West African countries.

- Cotton contributes about 10% to the GDP. For a long period of time, exportation of the fibre was the main source of currency in Burkina Faso's economy. Indeed, cotton contributed on average to 56% of total revenues from export between 1995 and 2006 (Sebego, 2010). The growth of mining activities lowered this weight.

- Very high production levels of 731,000 tons were reached in 2017. Following the effects of measures adopted and implemented as part of a relaunching plan, production declined slightly.

- The cotton sector creates employment for rural households. Cotton activities were implemented in more than 400,000 households in 2007 (Lankoandé et al., 2011).

- National cotton companies fix prices well before the start of the production season. This can protect producers against price fluctuations in the international market, but can also have adverse effects if global prices rise.

- In the chain, transformation activities remain underdeveloped and it is relatively short, with few actors involved in each segment. As a result, opportunities for adding value and employment are lost.

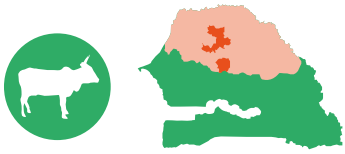
- The national government plays a key role. First, three national companies manage most exports, so there is relatively low competition. Second, the same companies provide pesticides and fertilisers on credit, then take a share of production as payment.

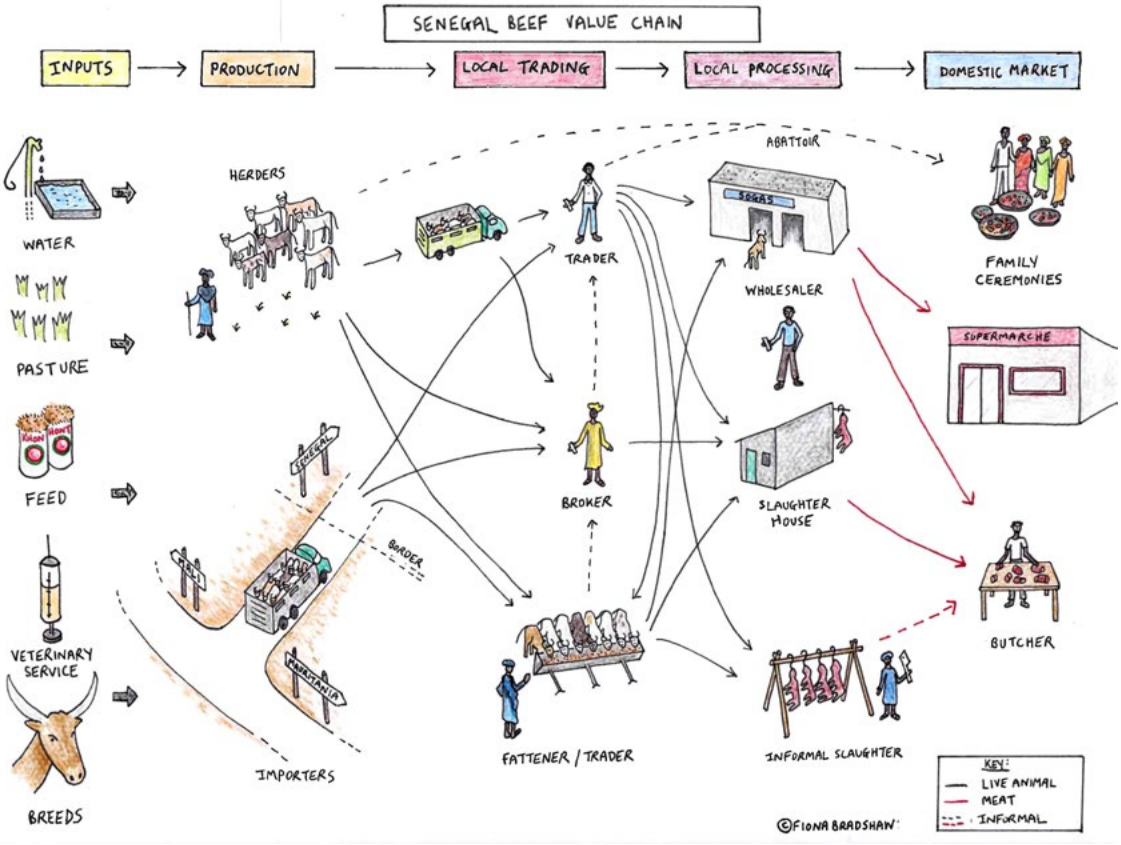
- There is renewed demand for woven cloths, which should benefit women weavers. However, availability of input remains a challenge. Good quality products are generally exported, and it is the files of medium quality that are sold on the local market.

Image: Cotton harvest - women carrying harvested cotton to be deseeded in Burkina Faso, by Ollivier Girard/CIFOR/Creative Commons License

Step 1

Senegal's beef value chain





By Fiona Bradshaw/PRISE

- Livestock production is practised by almost 30% of Senegalese households and it offers them significant income and employment opportunities. Cattle breeding is the second most important activity within the agricultural sector with an average contribution of 29% and 4% respectively in the formation of the primary sector and GDP. Value added increased on average by 6% over the 2000-2012 period, reaching more than 300 billion CFA francs[5] in 2012 at current prices.

- Beef remains the most important component of the livestock sector in terms of the volume of generated annual sales (394 billion CFA francs[6] in 2010). In fact, the industry has significant potential for transformation at almost every link in the value chain. Production is currently oriented to the domestic market and the sector has contributed to more than 90% of the meat consumed in Senegal in recent years. Over the past several years, Senegalese imports of meat tended to rise steadily up to 2005, reaching a maximum of 19,692 tons, prior to a downward trend.

- There is a good flow of information about prices, quality and quantity between producers and local markets because of the dual role herders play as traders.

- Integration of markets across the region depends heavily on the maintenance of transhumance corridors within Senegal and with neighbouring countries. These corridors are essential routes for trading activity.

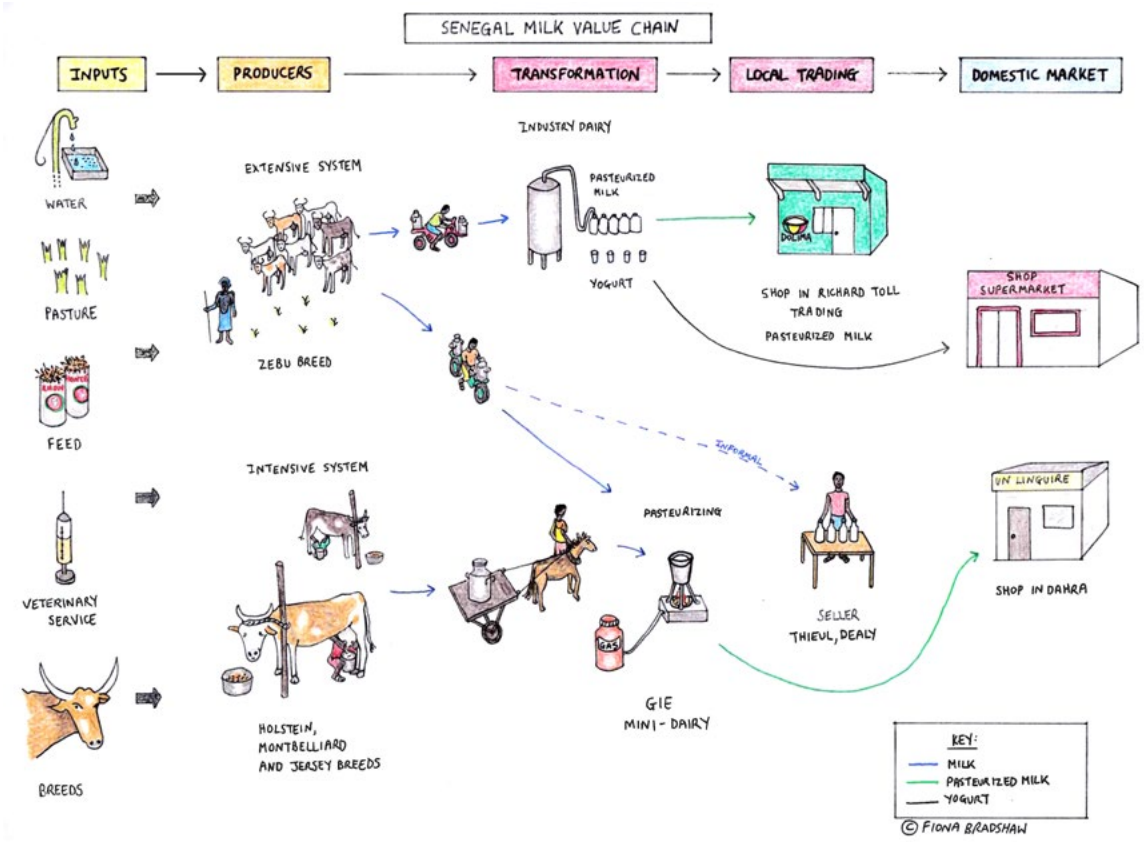
- The main constraint on the value chain relates to inputs, including water and fodder. Currently, producers bear these costs.

- Domestic demand for meat is likely to grow with the expansion of urban development around the capital Dakar. This provides an opportunity for transformation of the value chain.

[5] Approximately 80 million USD.
[6] Approximately 104 million USD.

Step 1

Senegal's cow's milk value chain

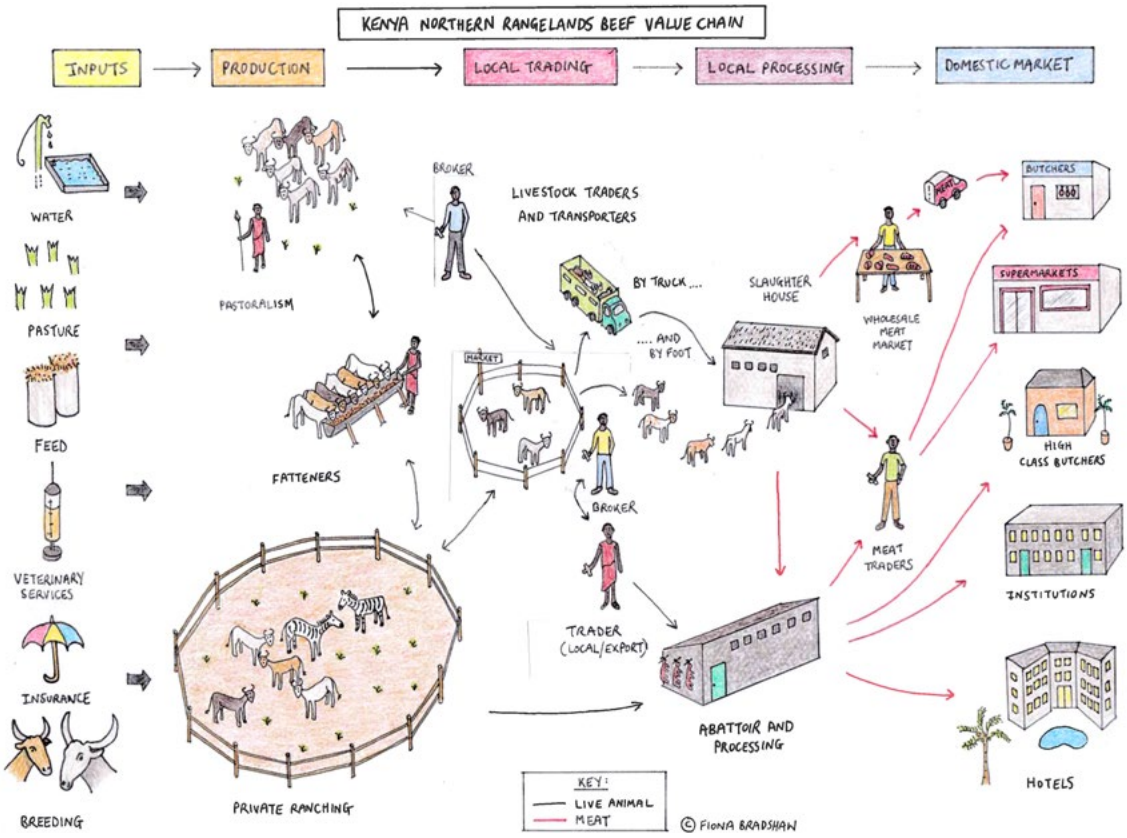


By Fiona Bradshaw/PRISE

- In 2013, domestic milk production supplied only 30% of domestic demand and Senegal was a major dairy importer. However, the gap between production and imports is narrowing, with Senegal's milk production growing by 43% during the 2000-2010 period while imports grew by only 5% (CFSI, 2013).
- There are two parallel chains in operation. One is the traditional (and mostly informal) chain and the other is more industrialised milk transformation (formal).
- In the extensive system, milk production is primarily the responsibility of women. Women also manage income from trading milk.
- Actors in the intensive system face financial and logistical constraints. The collection, storage and distribution of milk are a challenge. This has an impact on quality and therefore price.
- Seasonal fluctuations in production are a major constraint for both chains, affecting supply.
- Exotic breeds may not be climate-resilient in the long term, even though returns are higher in the short term as a result of increased productivity.

Step 1

Kenya's northern rangelands beef value chain



By Fiona Bradshaw/PRISE

- The livestock sector is one of the main components of the agricultural sector in Kenya, although estimates of the contribution to the agricultural sector and to national GDP vary. A recent study using revised estimates of Kenya's livestock population from the 2009 census estimated the contribution of livestock to national GDP was 13%, and accounted for 43% of agricultural GDP (Behnke and Muthami, 2011). This is a contribution of USD 4 billion versus the previous official estimates of USD 1.6 billion,[7] demonstrating a huge underestimation of the value of livestock to the Kenyan economy.

- There are two parallel chains in operation. One is more formal and incorporates fattening livestock on privately owned ranches. The other is more informal and involves more traditional, extensive pastoralism.

- Private ranches benefit from the value added of fattening livestock, and this is mostly a trader-level activity.

- Brokers dominate local markets, setting low prices that do not transfer value to producers.

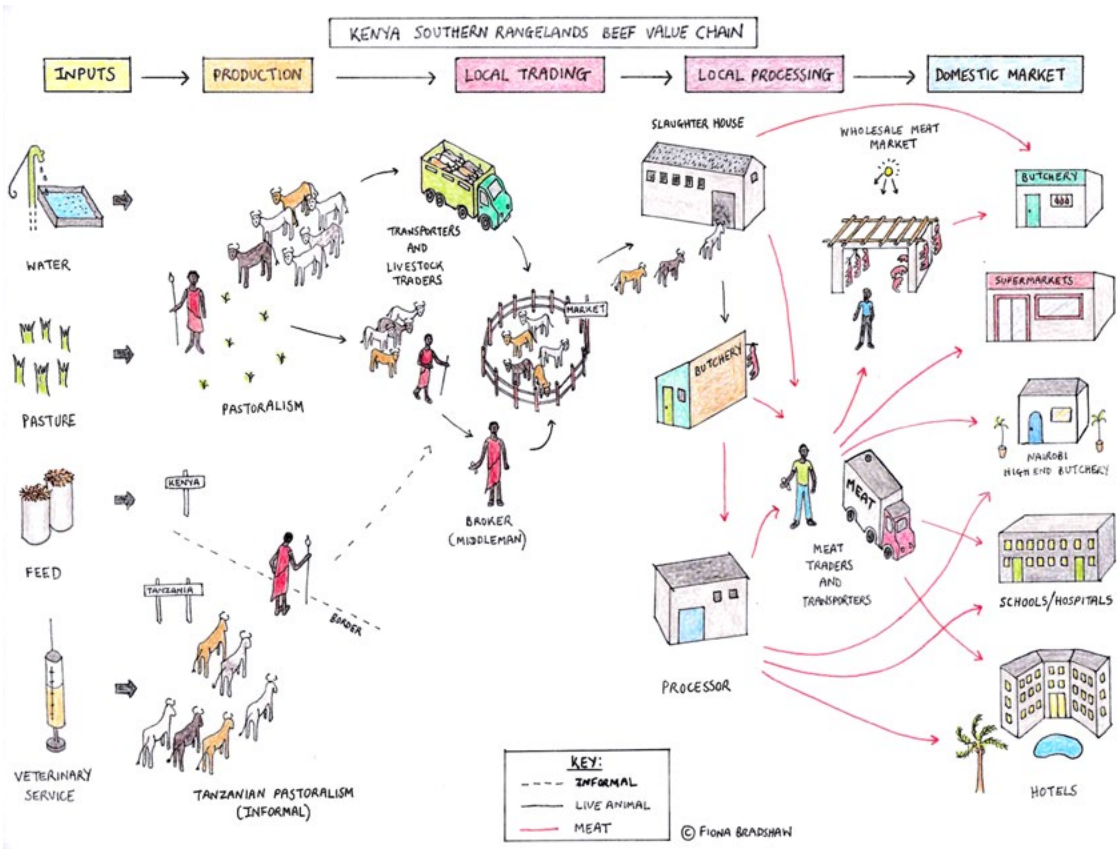
- There is evidence of diversification of the value chain into the tourism sector via wildlife management. Almost all communities in the area have access to wildlife conservancies for dry season grazing, as well as benefiting from employment and other forms of additional income associated with tourism.

- Producers rely on mobility for coping with climate risk. For example, herders move to the highland areas around Mount Kenya during times of drought and practise rotational grazing where access allows.

[7] Using a 2009 exchange rate of 1USD = 80 KES.

Step 1

Kenya's southern rangelands beef value chain



By Fiona Bradshaw/PRISE

- The livestock sector is a significant form of income and livelihood for people in Kenya. Livestock keeping is a major economic and social activity for communities in arid and semi-arid lands (ASALs) where animals are primarily raised for meat production, and in the higher rainfall areas (the highlands) where animals are raised primarily for dairy production.

- ASALs (with an annual rainfall of less than 600mm) cover 88% of Kenya's land surface and support 33% of Kenya's population. It is estimated that 80% of Kenya's livestock are found in ASALs, thus these are the major meat-producing regions in Kenya. The majority of meat consumed in Kenya comes from ASALs.

- As with Kenya's northern rangelands, most producers are pastoralists who manage their production on private land owned by individual pastoralists. Approximately 64% is privately owned and 20% is communal land owned by Kajiado County. The difference in the southern rangelands is that the private land is mainly owned by pastoralists as opposed to private ranchers, which is more often the case in the northern rangelands.

- There is a disconnect between pastoralists and the end market, meaning producers do not have good access to market opportunities. There are inefficiencies along the value chain and many actors are involved in a single transaction.

- Significant cross-border trade drives the beef value chain. For example, at least 50% of cattle is imported on-the-hoof from Tanzania. This indicates that Kenyan herds are not meeting the increasing domestic demand for meat.

- There is minimal value addition in the chain or diversification of the product. This is incentivising the supply of low quality meat sold cheaply in the Nairobi end market.
- As with Kenya's northern rangelands, there are some conservancies in operation, which offer dry season grazing for pastoralists and generate tourism-related income opportunities.

Image: Maasai, by Anita Ritenour/Creative Commons License

Step 1

Conclusions from VC-ARID Step 1

High

Semi-arid lands make a major contribution to national economies

The livestock sector and pastoralists in semi-arid lands (SALs) of Kenya and Senegal are vital. The livestock sector, based on extensive production systems, represents 5% to 10% of total GDP and 15% to 40% added value in agriculture in the Sahel and Horn of Africa, respectively. In East and West Africa, livestock supports 70% of rural dryland[8] populations and half are exclusively dependant on this key sector (de Haan, 2016).

The sectors are also important sources of trade and, therefore, foreign currencies. Between Burkina Faso and Mali, livestock trade is worth at least £120 million annually (SWAC-OECD/ECOWAS, 2008). Currently, policy-makers undervalue livestock even though trade driven by pastoral production systems in the Horn of Africa region is worth an estimated £660 million in 2010 alone (Catley, et al., 2013).

The textile sector in Pakistan, which includes cotton produced in the country's SALs, is the largest industrial sector and accounts for around 40% of the country's industrial labour force. Ten million farming families in Pakistan rely on the textile industry. Raw cotton is also the main exportation product, along with mining, in Burkina Faso. As such, the sectors selected for VC-ARID represent a major contribution of national economies and development.

Medium

These sectors have an important socioeconomic growth potential and have the potential to support transformation

The sectors selected are dynamic and their potential for growth can drive the socioeconomic development of SALs and the countries in which they are found in the future.

For example, the African Union Livestock Development Strategy for Africa (LiDeSA) 2015-2035 recognises a central role for the livestock sector in delivering a sustained annual agricultural GDP growth of at least 6%, as planned by the heads of state and governments of the African Union in the Malabo Declaration (AU-IBAR, 2015). The livestock sector has demonstrated a potential for transformation in terms of employment, food security and ecosystem services (Neely et al., 2009). Livestock trade should increase in East and West Africa. Demand for livestock products (particularly meat) is increasing globally and especially in the urban centres of Africa and the Middle East driven by rapid growth and economic development. By 2030, demand for red meat will surpass supply by about 25%, roughly tripling the current structural deficit (de Haan, 2016).

High

Private sector actors are diverse and coexist within all these value chains, linked both horizontally (competition) and vertically (transformation)

VC-ARID reveals that private sector actors can range from large spinning companies in Pakistan (such as multinational import-export experts) to mini-dairies run by women in Senegal, to individual transhumant pastoralists in Senegal and Kenya owning several hundred heads of cattle and employing transporters to take their animals to market, to large- and smallholder cotton producers in Burkina Faso practicing agro-pastoralism for both subsistence and cash crops. Individuals, households, groups and businesses of differing socioeconomic status can all be classified as private sector actors participating in the economy, although they may not define themselves as such. These actors coexist within the same sector along the same value chain, being linked by horizontal (for instance competition) or vertical relations (for instance transformation).

[8] According to the Millennium Ecosystem Assessment (2005), the term drylands includes hyper-arid, arid, semi-arid and dry sub-humid zones. As such, where drylands is used in this report it includes but is not synonymous with semi-arid lands.

However, most of the policy-makers consulted in the studies consider a private sector actor to be a business employing more than one person and registered as a company. This research shows that that individual producers are engaging in a range of activities, including trade, and as such the definition is too restrictive. In the qualitative interviews across the chains, it was a common suggestion to promote the assimilation of the private sector into the formal sector. But here the reality is very complex. Informal economic activity is a key adaptive characteristic of semi-arid lands. If formality is a key condition for public actors to recognise the private actor, there is a risk of undermining the adaptive capacity and economic potential of these areas.

This finding is key for adaptation programmes that aim to integrate the private sector. The recognition of the diversity of the private sector is essential to obtain tangible and efficient results, particularly in SALs. Thus, the Global Environment Facility (GEF) fund, and adaptation funds, donors and policy-makers, should apply a broad definition of the private sector to implement an adaptation programme in SALs.

Medium *There is a disconnect between producers and the rest of the chain*

This means the producers across all six value chains are often subject to inequitable price conditions and incur transactional costs. This can result in unequal distribution of the added value along the chain. Producers at the lower end get paid much less than they should in comparison to the profit margins for actors at the higher end of the chain. The disconnect indicates that there are opportunities for efficiency improvements along the chain by supporting greater vertical integration (for instance through an improved enabling environment), while retaining the important characteristics of the production system that maintain adaptive capacity.

The disconnect is accentuated only when the production linkage is based in SALs. When geographic marginalisation overlaps with economic marginalisation, the disconnection of producers with the other actors in the value chain becomes a significant barrier to an efficient and equitable share of added value. As a consequence of the disconnection, producers are expected by other sectoral stakeholders to manage most of the risks affecting the sector, while they do not always have the capacity to do so.

High *Challenge to access benefits of the terminal market and international trade and export chain*

In all cases, there are challenges to some extent in accessing the benefits of international trade and export markets. The cotton value chains demonstrate international trade, but this is largely absent from the livestock value chains, with the exception of Kenya's southern rangelands, where some informal trading activity takes place across the international border with Tanzania. As such, there are opportunities to consider in strengthening exports in these value chains.

Upscaling the value chain from national to global can be considered a means of leveraging economic development, exports being key drivers of national economic growth. Provided the disconnect discussed above can be overcome, the sectors can be considered key pillars of future national and semi-arid economies through improved connection to international markets.

At the national level, the benefits of urban terminal markets can be difficult to obtain. In addition to meeting increasing demand, national production rooted in SALs can also be competitive through international exportation. But remoteness, marginalisation and lack of efficiency can prevent economic actors or consumers from harnessing these opportunities, meaning they need to rely instead on expensive imports. It is important to control this trend and ensure the potential for the transformation of these sectors is supported.

High *There is potential for upgrading across all chains*

Across the value chains, there is significant potential to upgrade processing to add value and provide additional socioeconomic benefits, including employment opportunities. The exception is the Pakistani cotton value chain, which has a well-developed textile industry of national economic importance. The implication is that there are significant opportunities for vertical transformation in these value chains, which could address some of the constraints at production and international market levels.

For example, by harnessing the opportunities of urban growth, the Senegalese beef value chain could meet increasing demand through vertical integration. Similarly, renewed interest in high quality, traditional clothing in Burkina Faso is a window to increase the supply of cotton from semi-arid regions, for which there is a consumer preference.

High *Physical and political constraints are key barriers in all chains*

Additional constraints that are common to the value chains to differing extents include poor infrastructure, inadequate provision of financial services, limited access to markets for producers and lack of appropriate regulations. This is reflective of the relatively marginalised position of semi-arid lands in national economies. Clearly, there are significant opportunities to improve the enabling environment for these sectors in ways that are also climate-resilient and inclusive.

High *Informal economic activity is important in all chains*

Informality is an inherent feature of semi-arid systems and acts as a key driver of resilience in these areas. For example, in Senegal a single economic actor can play different roles in the livestock value chain according to the season or the shocks he has suffered. Depending on the production of their livestock, a Senegalese herder can be a producer or an intermediary, facilitating livestock transactions in the market. This flexibility in economic roles is a way of ensuring a source of income under different circumstances. At the same time, herders in Kenya rely on customary institutions that are important sources of resilience during and after shocks (Carabine et al., 2014a). For economic actors, these value chain studies demonstrate the importance of relying on social networks driven by customary norms in order to respond to shocks and perceived changes in climate. As such, informality can play a key role in socioeconomic stability and cohesion of the actors in the value chain beyond the primary economic role of informal arrangements.

In Kenya, the informal butcheries and slaughter slabs provide access to meat for segments of the population with low income who would otherwise be excluded from the market. These links remain critical to the overall value chain, complementing more formal, high-quality production and processing, and thereby demonstrating the importance of multiple chains in supporting the overall resilience of the sector. In this case, informality in the chain plays a key role in food security, poverty reduction and ultimately national economic development.

The value chain studies also demonstrate that informality can facilitate innovation and initiate the transformation of the sector. For example, in Burkina Faso the cotton sector is mainly oriented towards raw cotton exportation. The existence of women who work mainly informally spinning and weaving raw cotton constitutes transformative activities that can drive national transformation of the sector. These informal activities also support women's empowerment and social transformation in a country where gender equality remains a challenge. At the same time, there are drawbacks to wholly informal systems. For example, informality can be a barrier to accessing loans or extension services. It also poses challenges for government agencies that need to generate revenue. As such the multiple roles of informality in the value chains highlights the importance of flexible and tailored formal mechanisms in these sectors.

Step 2

Results of VC-ARID Step 2

IPCC Fifth Assessment Report – What's in it for semi-arid lands?

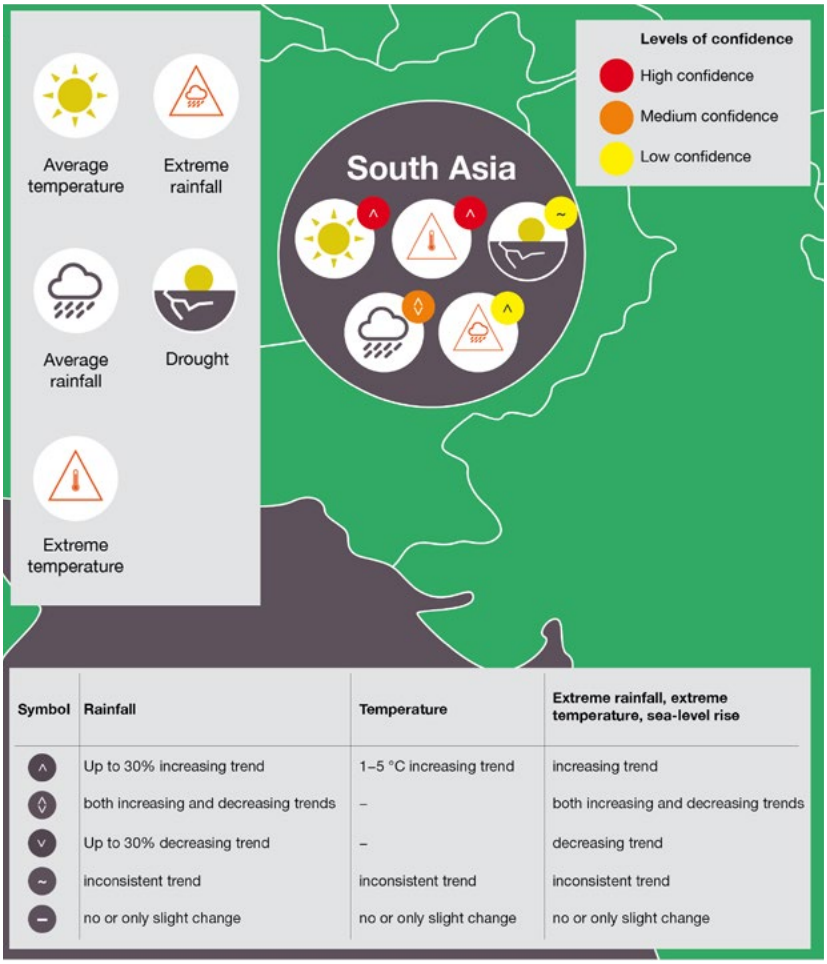
Observed climate change

South Asia

Observed temperature: the IPCC has reported that warming occurred across most of the South Asian region over the 20th century and into the 2000s, and that there were more temperature extremes (high confidence). Records indicate that there were more warm days and fewer cold days.

Observed rainfall: most areas of the Asian region lack sufficient observational records to draw conclusions about trends in annual rainfall over the past century. Rainfall trends, including extremes, are characterised by strong variability, with both increasing and decreasing trends observed in different parts of Asia. Observations also show that there have been more extreme rainfall events and fewer weak rainfall events in the central Indian region.

Observed extreme events: the frequency of hot days in South Asia has increased (medium confidence). Observations also show that there have been more extreme rainfall events in India and in many other areas.



Symbol	Rainfall	Temperature	Extreme rainfall, extreme temperature, sea-level rise
^	Up to 30% increasing trend	1–5 °C increasing trend	increasing trend
◊	both increasing and decreasing trends	–	both increasing and decreasing trends
v	Up to 30% decreasing trend	–	decreasing trend
~	inconsistent trend	inconsistent trend	inconsistent trend
–	no or only slight change	no or only slight change	no or only slight change

West Africa

Observed temperature: temperatures across West Africa have risen over the last 50 years. There were fewer cold days and cold nights and more warm days and warm nights between 1970 and 2010.

Observed rainfall: rainfall in the Sahel decreased overall in the 20th century, but recovered to previous levels in the 1980 and 1990s. The recovery may be due to natural climate variability or anthropogenic climate change. The many droughts in the Sahel in the 1970s[9] and 1980s are well documented.

Observed extreme events: a significant increase in the temperature of hottest days and coolest days has been observed in some parts of West Africa (medium confidence) although there is insufficient information available in other parts to identify trends. There is likely to be an increase in the frequency of hot days in the future (high confidence). There has also been an observed increase in drought in the region, although the 1970s Sahel drought dominates this trend. Greater variation between years has been observed more recently (high confidence).

East Africa

Observed temperature: the equatorial and southern parts of eastern Africa have experienced a significant increase in temperature since the early 1980s. Seasonal average temperatures have also risen in many parts of eastern Africa in the last 50 years. Countries bordering the western Indian Ocean experienced warmer temperatures and more frequent heat waves between 1961 and 2008.

Observed rainfall: rainfall in eastern Africa is very variable in time and space. Several physical processes, including the El Niño Southern Oscillation, affect rainfall. Some models suggest that rapid warming of the Indian Ocean may be the cause of less rainfall over eastern Africa between March and May-June in the last 30 years. Summer monsoon rainfall declined throughout much of the Horn of Africa over the last 60 years.

Observed extreme events: there is a lack of evidence about trends in extreme temperature, extreme rainfall and drought in East Africa (low confidence). However, droughts and storms have been more frequent in eastern Africa in the last 30-60 years. Continued warming in the Indian Ocean has been shown to contribute to more frequent East African spring and summer droughts over the past 30 years. It is not clear whether these changes are due to anthropogenic influence or to natural climatic variability.

Projected climate change

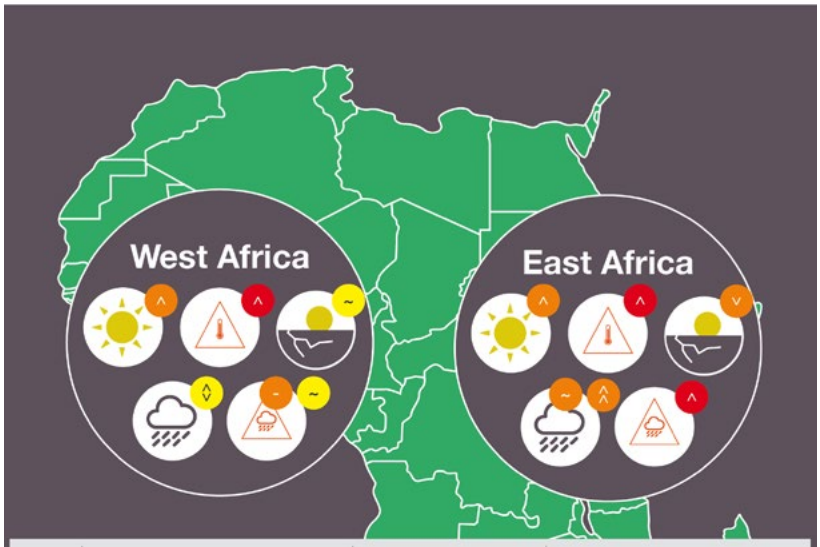
South Asia

Projected temperature trends: projections indicate that, compared to the average in the 20th century, average annual temperatures could rise by more than 2°C in South Asia by the mid-21st century and exceed 3°C by the late-21st century under a high-emissions scenario. Under RCP2.6, average temperatures could rise by less than 2°C in the 21st century, except at higher latitudes, which could be up to 3°C warmer. Oceans in subtropical and tropical regions of Asia could warm under all emissions scenarios and would warm most at the surface.

Projected rainfall: projections also indicate that more rainfall will be

[9] In Senegal, this drought was felt most severely in 1973.

very likely at higher latitudes by the mid-21st century under a high-emissions scenario and over southern Asia by the late-21st century. Under a low-emissions scenario, more rainfall at higher latitudes will be likely by mid-century but changes in rainfall are not likely at low latitudes.



Symbol	Rainfall	Temperature	Extreme rainfall, extreme temperature, sea-level rise
^^	Up to 30% increasing trend	1–6 °C increasing trend	–
^	Up to 10% increasing trend	1–4.5 °C increasing trend	increasing trend
◊	both increasing and decreasing trends	–	both increasing and decreasing trends
v	Up to 10% decreasing trend	–	decreasing trend
vv	Up to 30% decreasing trend	–	–
~	inconsistent trend	inconsistent trend	inconsistent trend
-	no or only slight change	inconsistent trend	inconsistent trend

Extreme temperature and rainfall events: based on data since 1950, evidence suggests that climate change has changed the magnitude and frequency of some extreme weather and climate events in some global regions already. In the next two or three decades, the expected increase in climate extremes will probably be relatively small compared to the normal year-to-year variations in such extremes. However, as climate change impacts become more dramatic, their effect on a range of climate extremes in South Asia will become increasingly important and will play a more significant role in disaster impacts.

The frequency of hot days is likely to increase further in the future (high confidence). More frequent and heavy rainfall days are projected over parts of South Asia (low confidence). Extreme rainfall events will be likely to occur where the centres of tropical cyclones make landfall in South Asia. An increase in extreme rainfall events related to monsoons will be very likely in the region.

West Africa

Projected temperature: projections indicate that temperatures in West Africa will rise by between 3°C and 6°C by the end of the 21st century under a range of scenarios. Regional-scale models support the range of change indicated by global models. Under a range of scenarios, the Sahel and West Africa are projected to be hotspots of climate change. Projections indicate that unprecedented changes in climate will occur earliest in these regions, by the late 2030s to early 2040s.

Projected rainfall: variations in the results of global models mean that confidence in the robustness of projections of changes in regional rainfall is low to medium pending the availability of more regional data. However, many global models indicate a wetter main rainy season with a small delay in the onset of the rainy season by the end of the 21st century.

Projected extreme events: projections of the risk of drought are inconsistent for this region. An increase in rainfall intensity has been observed (medium confidence), although projections indicate slight or no change in heavy rainfall in most areas (medium confidence). The results of regional modelling suggest an increase in more intense and more frequent extreme rainfall events over the Guinea Highlands and Cameroon Mountains.

East Africa

Projected temperature: projections for medium- to high-emissions scenarios indicate that maximum and minimum temperatures over equatorial East Africa will rise and that there will be more warmer days compared to the baseline by the middle and end of this century. Climate models show warming in all four seasons over Ethiopia, which may result in more frequent heat waves.

Projected rainfall: in spite of the declining rainfall trend observed, global projections suggest that by the end of the 21st century, the climate in eastern Africa will be wetter, with more intense wet seasons and less severe droughts in October-November-December and March-April-May, a reversal of recent historical trends.

Regional models suggest that most parts of Uganda, Kenya and South Sudan will be drier in August and September by the end of the 21st century. Projections indicate shorter spring rains in the mid-21st century for Ethiopia, Somalia, Tanzania and southern Kenya, and longer autumn rains in southern Kenya and Tanzania.

Projected extreme events: the IPCC's Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (IPCC, 2012) indicates that there will likely be more heavy rainfall over the region with high certainty and more extremely wet days by the mid-21st century. There will also likely be an increase in the frequency of hot days in the future (high confidence), although a decreasing dryness trend over large areas is also projected (medium confidence), and an increase in more intense and more frequent extreme rainfall events over the Guinea Highlands and Cameroon Mountains.

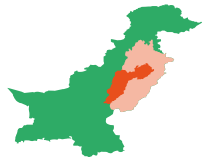
Key risks for semi-arid lands

Climate change impacts will increase risks of food insecurity and the breakdown of food systems, and loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists with minimal capital in semi-arid regions.

Climate change will amplify existing stress on water availability and on agricultural systems, particularly in semi-arid environments. Changes in climate, together with non-climate drivers and stresses, will exacerbate the vulnerability of agricultural systems, particularly in semi-arid areas (high confidence).

Step 2

Climate risks for Pakistan's cotton value chain



Perceptions of climate change

Cotton crops are mostly cultivated along the left bank of the Indus River, but these crops are extremely vulnerable to flash floods. Floods have been a major climate-induced disaster that has significantly reduced Pakistan's cotton production in the last few years. Since 1980, Pakistan has suffered 13 floods, with those in 1992 and 2010 being the most severe.

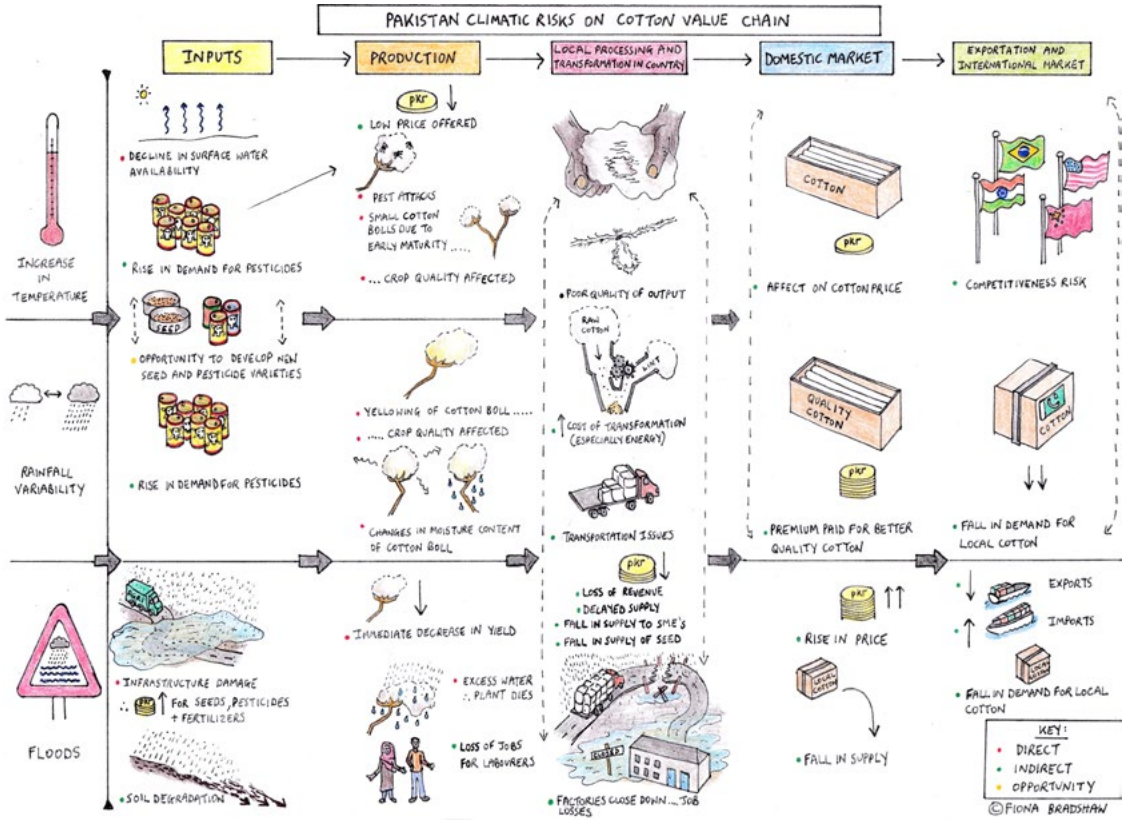
Cotton sowing usually takes place during the summer and mostly in areas where the average temperature is above 43°C. In the Punjab district, researchers demonstrated that cotton production may decline by approximately 43,000 bales per 1°C if the temperature exceeds 32°C. Further, if there is a 1mm increase in precipitation over the 40mm threshold, cotton production may reduce by 500 bales in the same district (for which the modelling exercise estimates an annual production of around 350,000 bales in 2018). Potential increases in temperature are a major risk to the cotton value chain as daytime temperatures in cotton producing regions can reach 50°C.

Heat stress also results in crop losses through declines in both yield and quality. Heat stress and monsoon variability are the climatic events most affecting producers. Approximately half of respondents reportedly experienced heat stress (51%, n=436) and monsoon variability (56%) at least one to three times during the last 10 years. A large proportion of respondents reported never having experienced floods or droughts.

In Faisalabad 60% of farmers interviewed were not aware of climate change phenomena while in the study sites in Dera Ghazi Khan (DGK) most farmers were aware. The level of education of the farmer was significantly positively correlated with the level of awareness about climate change. A greater level of exposure to climate risks can explain the relatively higher level of awareness of farmers in DGK.

The 2010 flood was a major disaster that affected about 200,000 people in 28 Union Councils[10] (UC) in DGK. Only approximately half of farmers (53%) reported that they had received warning prior to the 2010 flood. Among those who reported having been warned, 84% said that the warning included information about the severity of the flood.

[10] In Punjab, a Union Council is an area within a district consisting of one or more revenue estates or census blocks.



By Fiona Bradshaw/PRISE

As many as 90% of respondents consider that floods totally destroyed their production. For other climatic events such as droughts, increases in temperature or changes in monsoon pattern, negative impacts affect only a part of production, resulting in a decline in processing sector activity with associated unemployment and loss of profits.

Private adaptation action[11]

Cotton producers from the two areas of UC Kala and Mana Ahmadani have the largest percentage of very poor and poor cotton farmers. However, Kala also has the largest number of rich cotton farmers, followed by UC More Jahngi.

Only 34% of farmers reported having a bank account, while 40% of farmers said that they have access to crop loans and insurance. However, almost 18% of the farmers reported that they prefer not to take loans despite having access to these financial services. Major reasons cited for not taking loans are the high interest rates on borrowing and the low capacity to return loans with interest due to high losses suffered as a result of extreme weather events. A comparative analysis of access to financial services across landholders and landless farmers reveals that landless farmers do not have access to loans, with landholding being a basic requirement for becoming eligible for acquiring loan. As a result, landless farmers are more vulnerable to climate change.

Cotton farmers were asked if they changed any farm management practices after the 2010 flood. Almost 40% of the farmers resorted to changes in the kharif (autumn) season crop after the 2010 flood: 27% of farmers opted for changes in pesticides towards increased use and higher quality products; 25% opted for changes in seed varieties towards new types and genetically-modified (BT) cotton seed; and 21% opted for changing sowing dates to a later date in the season. Major adaptation practices with respect to changes in the kharif crop included shifting to sugarcane and rice or stopping cotton production for a few years. Some farmers (4%)

[11] Throughout this report, the term 'private adaptation' refers to action taken by individuals, households or businesses in response to climate change (either intentionally or otherwise). This term is synonymous with the definition of autonomous adaptation provided by the IPCC Fifth Assessment Report: adaptation in response to experienced climate and its effects, without planning explicitly or consciously focused on addressing climate change. The distinction here is that VC-ARID strives to emphasise that individuals and households are also private sector actors in the context of SALs and these value chains.

also preferred to plant other crops (vegetables, fodder and so on) instead of cotton. Changes related to shifts in sowing and harvest dates are quite common due to the relatively low financial cost. A significant proportion of farmers (12%) have reported starting to use BT cotton as a long-term adaptation strategy.

Determinants of private adaptation action

The results highlight some of the potential drivers behind farm-level adaptation decisions. Wealth (asset-based) does not significantly help to build adaptive capacity. However, weekly weather updates do appear to play an important role in determining the decision to take adaptation action of any kind in response to an extreme event. Access to weather information significantly incentivises farmers to change their production towards new crop systems and using new seeds. Being aware of future weather, they are also more likely to fix new dates for sowing and harvesting operations.

Climate risks are key factors driving private adaptation decisions. In Pakistan, producers who have experienced numerous floods are more likely to change their crop production, to change dates of sowing and harvesting and to prepare soil differently. Cotton producers who experienced changes in monsoon patterns tend to be more likely to use chemical inputs for cotton.

Similarly, it was stressed that enhancing the quality of agricultural inputs would significantly increase resilience to climate change, particularly in the case of increasing temperatures. Furthermore, improved irrigation systems and capacity development through the enhanced and proactive role of the agriculture extension department could play a positive role in promoting resilience. Access and timely dissemination of climate information could be another factor of resilience at the farm level. Farmers also see the option to shift to other crops as highly important long-term strategies for adapting to climate change.

At the processor level, the characteristics of firms are key factors in explaining their vulnerability to climate change. These include: demand cycle for final product (for example hosiery versus home textiles); type of market targeted (local ginners relying on raw materials versus exporters relying on imports); type of industry (for example secondary cottonseed oil units); and, formality or informality of the firm (women and poor labourers in the informal textile industry versus companies in the formal textile industry).

Step 2

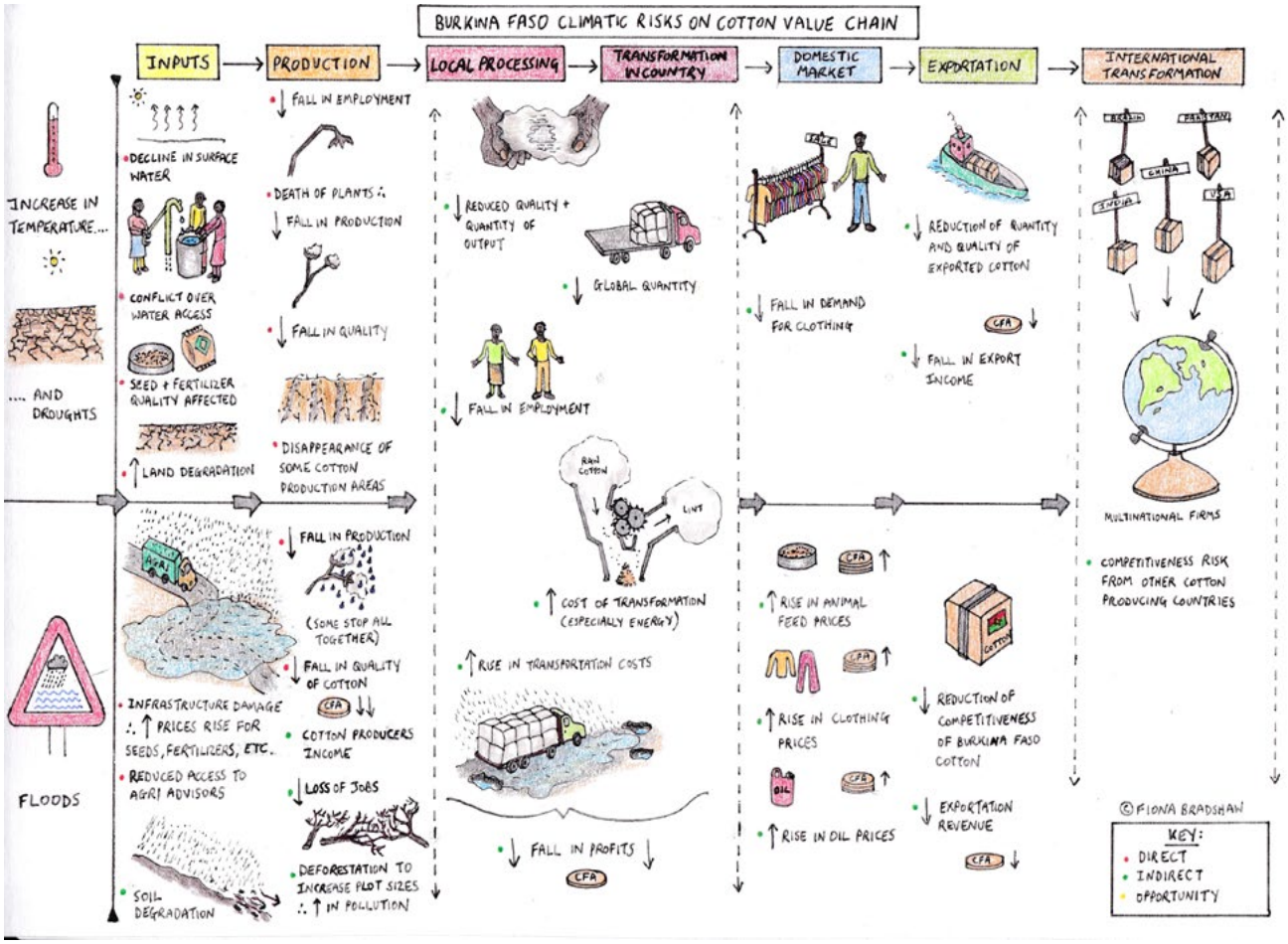
Climate risks for Burkina Faso's cotton value chain

Perceptions of climate change

Farmer perceptions of past climate change do not perfectly match observed trends. The majority of producers declared observing changes in temperature (87%, n= 436) and rainfall (100%) over the past 10 years. Of the producers surveyed in semi-arid lands, 73% reported a decrease in rainfall levels with increased variability. Perceptions of temperature change distinguish respondents who observed a decrease since 2000 (26%) from those who believed temperatures increased (33%).

During the past 15 years, more than half of surveyed cotton producers had to cope with drought, the late start of rainy seasons, floods and heat waves, which correspond with the observations of increasing rainfall variability and weather extremes.

Climate risks



By Fiona Bradshaw/PRISE

As many as 90% of cotton producers considered that observed changes in rainfall levels led to reduced yields and lower quality cotton. Although 81% of respondents believe that changes in temperatures have impacted their production, the different channels through which cotton production is affected are not well identified by farmers.

Approximately 70% of farmer activities suffered 'severely' or 'very severely' from the 2009 flood. Some producers were not able to anticipate the event since information did not diffuse among the threatened community. However, only 24% of the farmers reported that they would benefit from an early warning system or general information about upcoming extreme events.

More than 90% of cotton farmers reported no improvement or support initiated to help farmers to cope with such events since 2009. To offset the lack of assistance from public actors, 19% of producers responded by changing the dates that they usually sow and harvest the crop. Farmers only marginally adopted other adaptation strategies.

Private adaptation action

Effective awareness of climate change does not appear to be sufficient enough to include adaptation strategies in the production process due to limited capacities to adapt. Indeed, approximately half of cotton farmers decided not to change their behaviour in response to perceived changes in rainfall (45%) and temperature (53%). The reasons for inaction include insufficient financial means and lack of knowledge about appropriate methods to adopt in response to climate change.

Among those who did report adaptation responses, 75% revealed a strong preference for soil and water conservation (SWC) technologies in response to perceived changes in rainfall trends. Among producers who decided to take action in response to perceived changes in temperatures, 30% chose crop rotation.

Determinants of private adaptation action

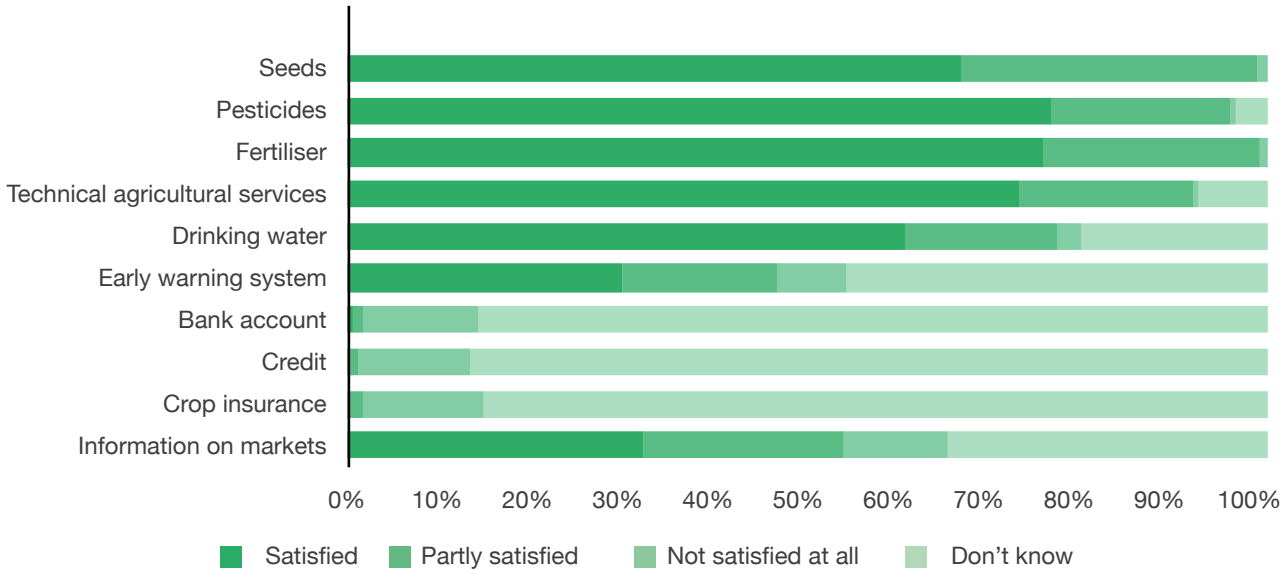
Surprisingly, the level of wealth (as indicated by characteristics of household assets and dwelling) does not influence the likelihood of taking adaptation action. The experience of rainfall availability also drives adaptation action in that owners of plots who benefit from higher average rainfall levels tend to be less likely to adopt SWC techniques and new crop rotation systems.

Cotton producers' decisions to adapt are mostly associated with their access to services. For example, cotton firms' extension services to producers positively affect the adoption of SWC techniques. Furthermore, when farmers are informed in advance about an upcoming extreme weather event, they implement these SWC measures. Thus, access to early warning systems significantly drives the decision to adapt in these ways. When they have access to financial services such as microcredit, producers significantly opted for a new system of rotation for their crops.

Consequently, financial and information services are core determinants in the decision to adopt new production strategies. However, only approximately half of surveyed producers judged early warning systems (47%) and provision of information about markets (54%) as 'satisfactory'. Given that information and communication channels are key determinants of SWC adoption strategies, there is a potential to utilise these more effectively and bring them to scale.

Cotton producers are also very satisfied with most of the services such as provision of pesticides, improved seeds, fertilisers and agricultural extension. However, farmers expressed lower satisfaction for information services such as early warning system or news on the state of the market. Access to financial services is very limited and is not addressing their needs when implemented.

Figure 5. Burkina Faso level of satisfaction in inputs and extension services provision



Source: Authors

Step 2

Climate risks for Senegal's beef value chain

Perceptions of climate change

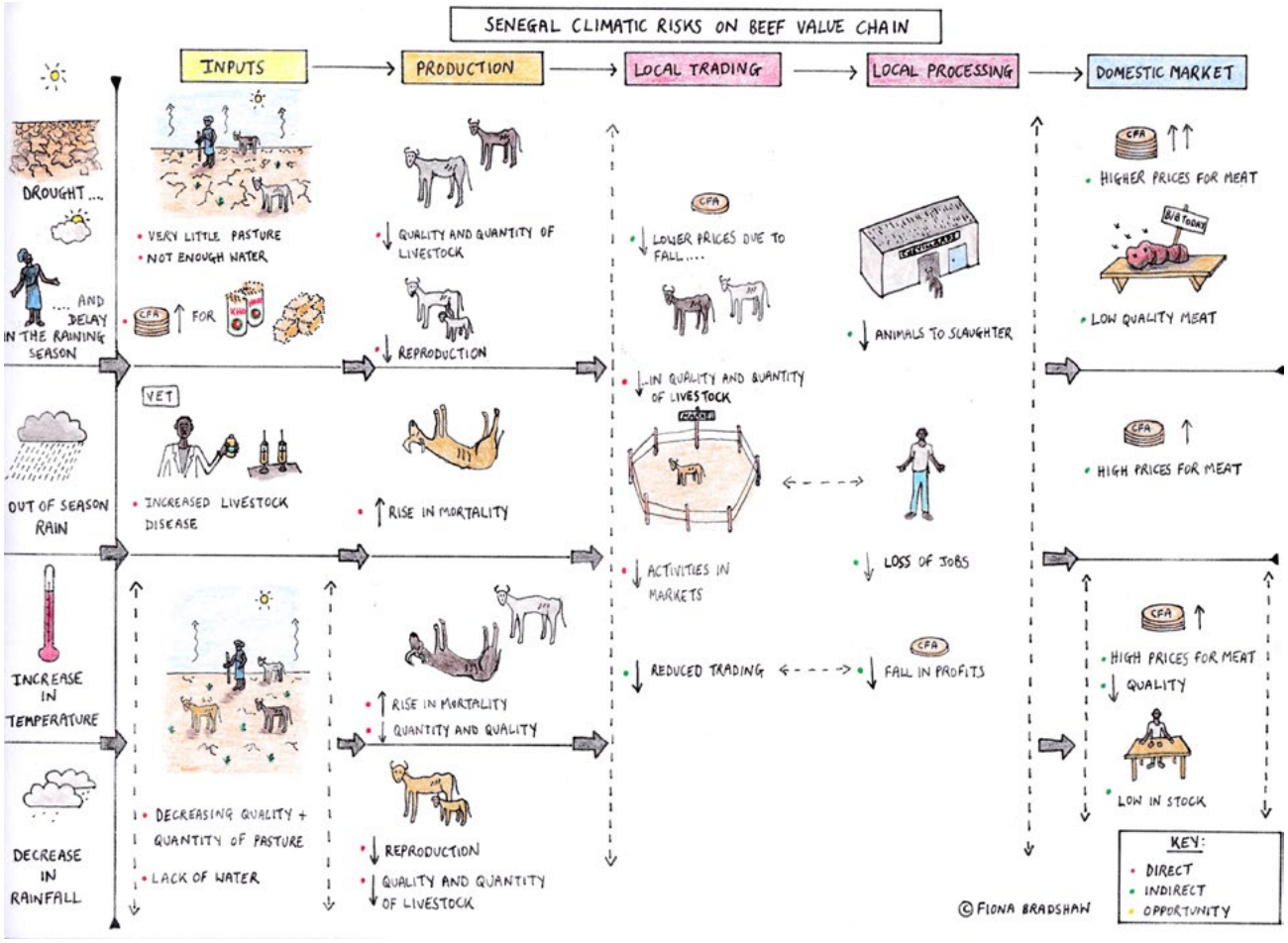
In the Ferlo region, producer perceptions of climate change corroborated with observed trends. Most herders declared perceived changes in temperature (97%, n=410) and rainfall patterns (98%). Even more in line with climatic predictions, the herders perceived a decrease in rainfall levels and an increase in temperature.

Almost 100% of the surveyed herders reported having to cope with drought, a late start to the rainy season and unseasonal rainfalls. Approximately 94% of the beef producers reported suffering 'severely' or 'very severely' from the 2014 drought in the Sahel. Only 18% of the herders could benefit from an early warning system or general information about the event. Following the drought, about half of the respondents decided to change their way of managing the cattle herd mainly by reducing its size, considering new commercial strategies or redrawing their transhumance routes.

Respondents reported some improvements since then to help herders cope with such events, such as better access to water sources, grazing areas or heavily-subsidised cattle feed. Despite improved financial and technical support from the government, the negative effects were still felt by producers, with about 95% reporting they have not yet completely recovered from the shock.

In addition to extreme climate events, household shocks also affect the production of herders in Ferlo, with 90% of respondents subject to cattle rustling and associated adverse consequences on income and wellbeing.

Climate risks



By Fiona Bradshaw/PRISE

In general, herders and traders are the actors most exposed to climate shocks, but all the economic actors of the chain are affected by seasonality and climate extremes, either indirectly from the production level or directly. It is important to note that the terminal market is located in the national urban centre where demand for meat is only partially affected by variation in prices or production. Therefore, price increases due to climate-induced production losses and to increased prices imposed by traders may have consequences mainly on the urban informal meat sector and for marginalised and poor consumers.

Private adaptation action

Effective awareness of climate change is not sufficient for herders to include adaptation strategies in their production. Indeed, a large proportion of herders decide not to change their behaviour in response to changes in rainfall (30%) and temperature (44%) trends. These herders tend to explain their inaction as being due to a lack of knowledge about appropriate methods to adopt in the face of climate change.

Those who did report taking action revealed strong preferences for the storage of cattle feed and mobility as adaptation strategies. The majority (69%) of herders have already relied on feed storage for livestock. Almost 40% of beef producers have become more mobile in response to perceived climate change, showing an increase in both distance travelled and frequency of travel. The destination generally corresponds to a zone with higher-quality fodder and availability of water. Although less common, other adaptation strategies include: change in herd composition (22%); change in water management (15%); and diversification of activities (8%).

Determinants of private adaptation action

Wealth (as indicated by household assets) does not appear to influence decisions to adapt. However where action is taken, wealth does drive up the likelihood of saving in bank accounts as a response to perceived climate change, but the richest people are significantly less likely to rely on feed storage or mobility. Perceived increases in the occurrence of drought significantly increase the likelihood that herders will shift their production to other livelihoods and save more money in banks.

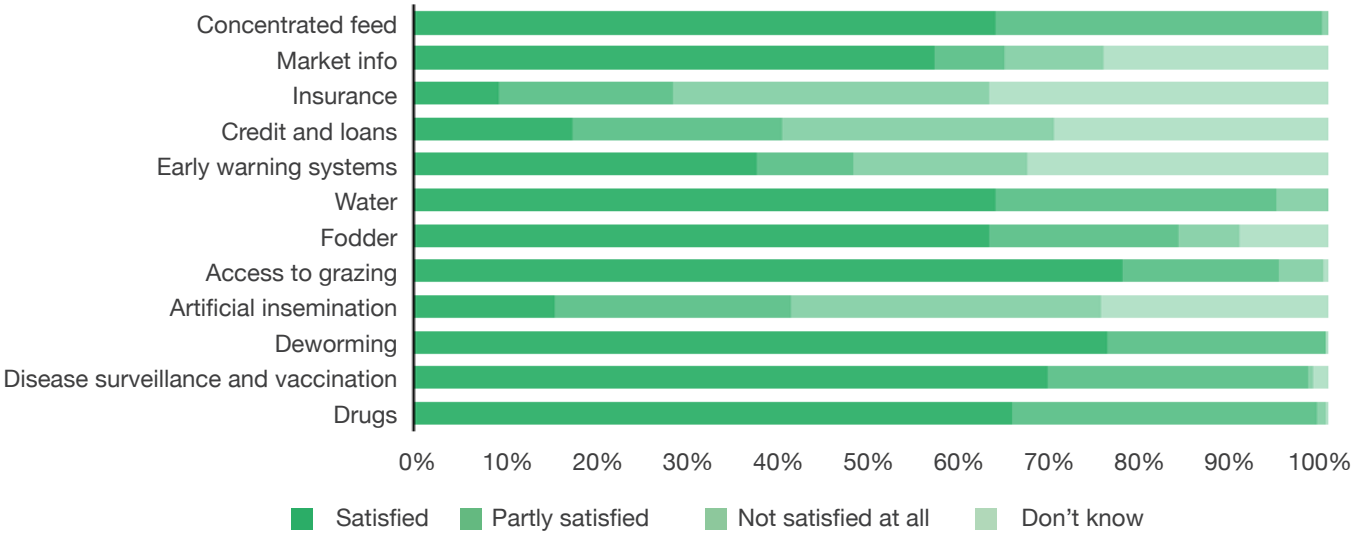
Access to services is a key determinant of adaptation action. When herders have access to early warning information systems, they are more likely to become mobile. In parallel, herders with access to this information increase their reliance on cattle feed storage and are less likely to diversify their herd management.

When they have access to financial services such as microcredit, herders significantly opted for new management strategies both in terms of water resources and herd composition. With access to loans, herders significantly decrease their reliance on mobility with a more settled way of life and production. At least this financial support significantly helps herders to shift to other livelihoods in the face of climate change.

Consequently, financial and information services are core determinants in the decision to adopt new production strategies. However, the low satisfaction for those services reported by respondents illustrates the potential for improvement. Only 48% and 40% of surveyed producers judged early warning system and credit services respectively as ‘satisfactory’. On the contrary, direct services to livestock, such as veterinary services, and inputs, such as fodder and water, are widely accessible and bring high levels of satisfaction.

When they have access to some services beneficial to their livestock, most of the herders are satisfied. Access to water and feed, as well as health and monitoring services for their cattle, are very appreciated. However, artificial insemination is not.

Figure 6. Senegal level of satisfaction in inputs and extension services provision



Source: Authors

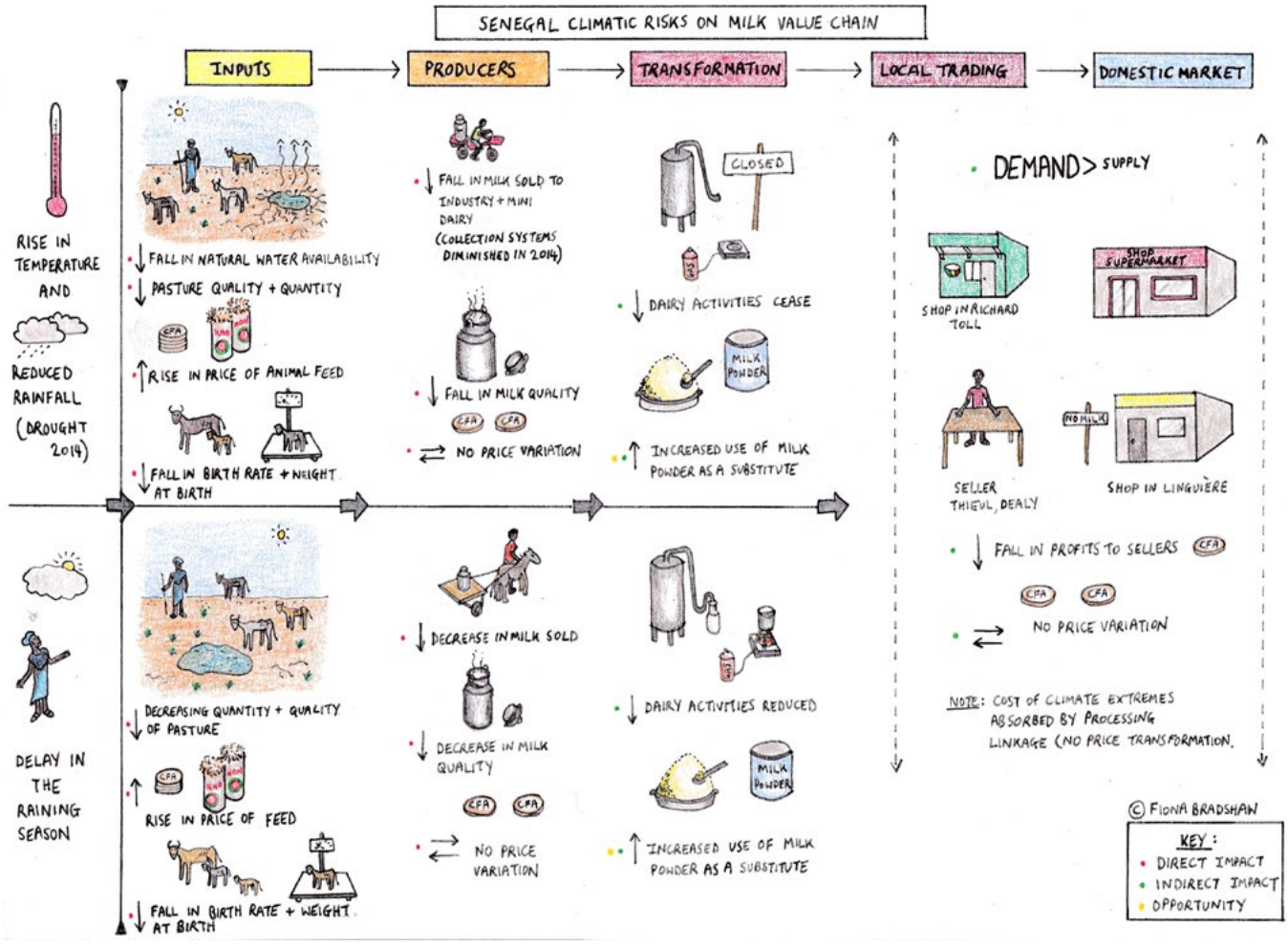
Step 2

Climate risks for Senegal's cow's milk value chain

Perceptions of climate change

In northern Senegal, perceptions of climate change from surveyed producers corroborated the observed trends. Most producers declared perceived changes in temperature (94%, n=191) and rainfall patterns (99%). Even more in line with climate projections, the producers observed a decrease in rainfall levels, increased variability and an increase in temperature. More than half of surveyed dairy producers had to cope with drought, a late onset of the rainy season and heat waves.

Climate risks



By Fiona Bradshaw/PRISE

Perceived climatic risks were reported to lead to negative impacts at each step of the dairy value chain. A total of 84% of dairy producers consider that a decline in rainfall levels reduces grazing areas with indirect impacts on the quantity and quality of milk produced. According to 78% of respondents, temperature is important for dairy production, but the different channels through which variability in temperatures affects milk quantity and quality are not well identified by producers.

Low and bad quality milk may lead to declines in processing activity followed by a rise in the use of milk powder. Overall, the impacts of climate extremes do not affect the prices of final products in the terminal market. Milk and dairy products produced in semi-arid lands represent a small proportion of the national market so seasonality and climate extremes have limited consequences for urban consumers and national markets in terms of prices and demand.

Approximately 82% of the households suffered 'severely' or 'very severely' from the 2014 drought in the Sahel, through higher livestock mortality and decline in birth rate. About 50% of the producers could benefit from early

warning systems or general information about extreme events. More than 66% of respondents decided to sell part of their cattle as an immediate response to drought. This is a strategy that can reduce herders' capacities to adapt in the future. Beyond this, they relied on their savings and bought feed products for their surviving animals.

More than half of the dairy producers reported no improvement in services to help herders to cope with such events. Since the drought occurred, only better access to water was identified as supporting households in production. In the absence of public sector support, 45% of producers engaged in private adaptation strategies by adjusting their cattle management.

In addition to extreme climate events, household shocks affect milk production. Of the respondents, 73% are subject to cattle rustling and 65% to global insecurity, with adverse consequences on income and wellbeing.

Private adaptation action

Dairy producers are the most vulnerable to climate change in the dairy value chain. They appear to be key actors for the proper functioning of the value chain and require deeper attention. In our study, we distinguish formal dairy producers, who sell their product to industrial or small dairy factories, from informal dairy producers, who distribute their output on the market.

The effective awareness of climate change isn't enough to include adaptation strategies in their production process. Indeed, 27% and 65% of dairy producers decide not to change their behaviour in response to change in rainfall and temperature trends respectively. They motivate their production stagnation by their lack of knowledge about appropriate methods to adopt under threat of climate change.

Other surveyed herders revealed strong preferences for the purchase of cattle feed to make up for decreases in available grazing sources. As a second step, those same households usually decide to store feed for livestock, revealing a complementary adaptation strategy.

Determinants of private adaptation action

Wealth (as indicated by household assets and dwelling) does help producers to adapt to climate change, but is not sufficient.

The majority (90%) of respondents reported having access to veterinary services and medicine. However, such services as access to sources of water (45%), industrial feed products (68%) or fodder (23%), are less available for producers. Belonging to a farmers' association significantly increases the likelihood of using savings in cases of extreme climate events, as producers can access collective savings and become more aware of the necessity to rely on savings thanks to information flow within the group. However, access to loans and membership of a producer association appear to significantly reduce the probability of purchasing feed for livestock in preparation for shocks.

In Fulani culture, dairy production is mostly assigned to women, who represented 94% of the producer sample. As a perishable product, sales of dairy are heavily dependent on infrastructure and transportation to reach the market.

Step 2

Climate risks for Kenya's northern rangelands beef value chain

Perceptions of climate change

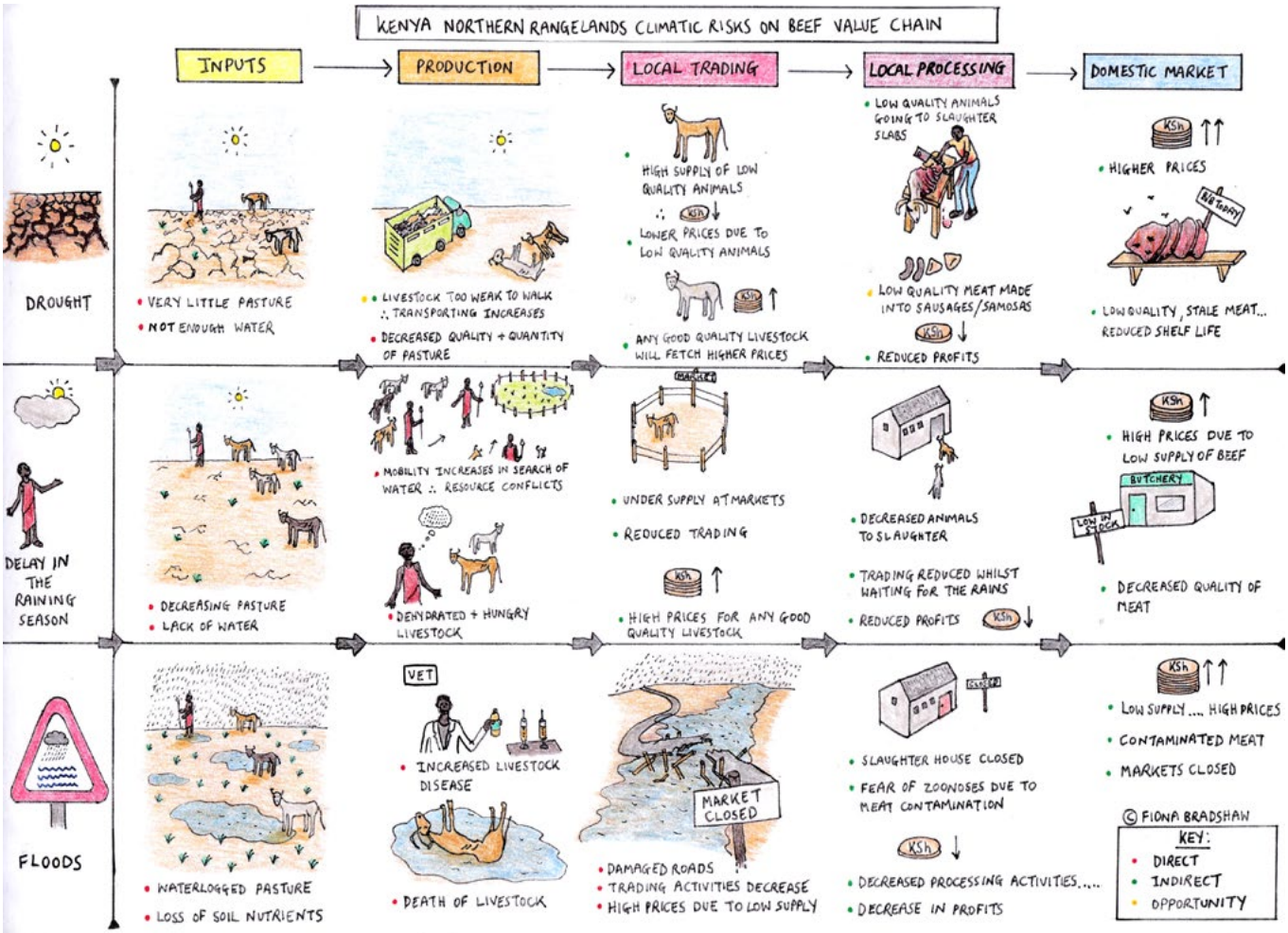
In Laikipia County, perceptions of climate change from surveyed producers and traders corroborated well with temperature projections, with 98% (n=440) of herders observing an increase in temperature in the past 10 years. However, 99% of herders observed decreased rainfall levels. The main climate extremes that affect livestock are drought (99%) and delayed onset of the rainy season (96%).

The 2009 drought was the worst since 2000, as reported by most of the producers surveyed. The drought severely affected the production and income of both producers (76%) and traders (68%). To enable herders to plan for anticipated climate extremes, there is a need for appropriate early warning systems. Currently, the early warning system in Laikipia North appears to target a low proportion of herders (39%).

In 2009, 79% of the respondents received external support, such as food or grazing access to help them to recover from the drought, but few of them were satisfied with this support (30%). Some of the strategies adopted in preparation for the 2009 drought included early selling or destocking for 37% of the herders. Water management was also cited as a key livestock management practice in times of drought.

About 96% of producers revealed that livestock mortality is a shock that has affected their production. Other severe shocks that affected the majority of the producers are large drops in prices of livestock (81%), livestock injured or killed by ingesting invasive species (71%), human/wildlife conflict (67%) and livestock disease outbreaks (67%).

Climate risks



By Fiona Bradshaw/PRISE

Although almost all respondents think that rainfall changes affect their livestock production, slightly fewer (87%) are convinced that temperatures are important. As expected, decreases in fodder and water availability were the main effects of changes in rainfall and temperature patterns on livestock production systems.

Private adaptation action

The wealth index was used to group households into five quintiles from lowest to highest wealth level. It turns out that Kurikuri is the wealthiest group ranch while Tiamamut is the poorest. Male-headed households are wealthier than female-headed households.

Awareness of climate change does not appear to be sufficient to prompt adaptation action by producers, with a proportion of herders deciding not to respond to perceived changes in rainfall (24%) and temperature (36%). The main reason cited was lack of knowledge about appropriate action to take.

Adaptation strategies identified by the pastoral communities can be categorised into two main actions: adjustment in pastoral practices and shifts to non-pastoral livelihoods. Adjustment of pastoral practices comprises a number of adaptation choices such as increased mobility, change in herd size and management, storage or purchase of fodder, change in water management and banking livestock assets. In semi-arid areas in Laikipia North, rangelands are often degraded and grazing becomes further limited during dry periods. During these times pastoralists often move their livestock to alternative grazing areas, usually the government forest and the private ranches. Mobility is a survival and resource management strategy commonly practised by 27% of the pastoralists interviewed. Partial shifts to other livelihoods (18%) are becoming a very important adaptation strategy after migration. Pastoral communities adopt similar measures in response to perceived changes in temperature patterns.

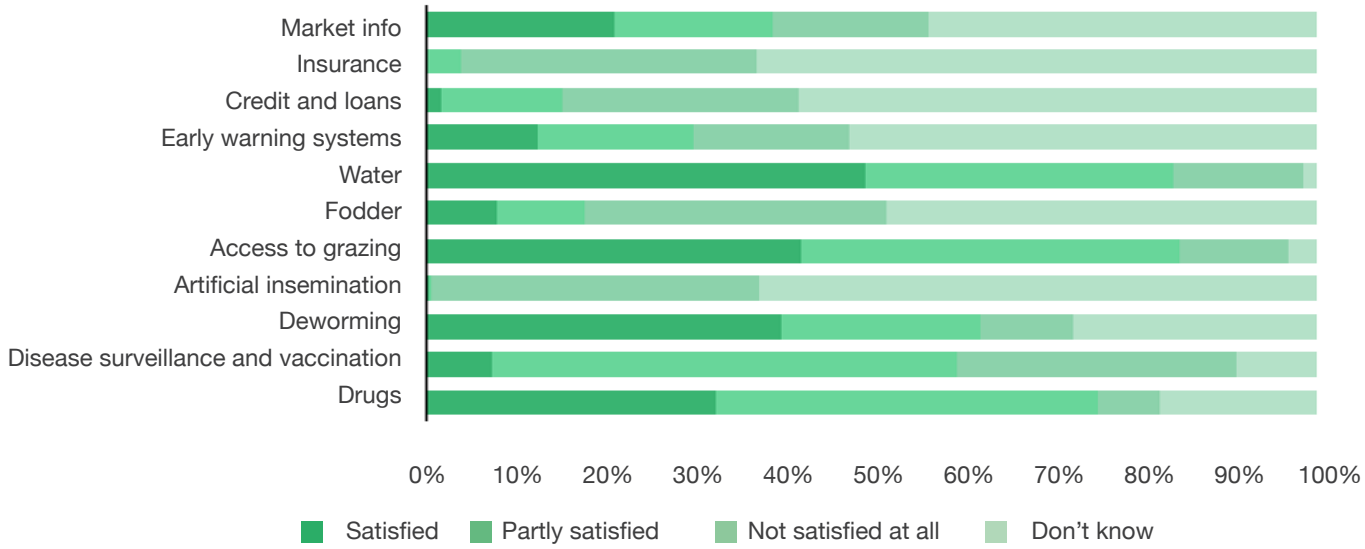
Determinants of private adaptation action

Several factors are affecting the choices of adaptation strategies for livestock production in Laikipia County. Specifically, the study investigates the role of climate extremes (frequency of dry spells and droughts), early warning information and access to private ranch grazing, in determining strategies in response to climate change. Several responses are included: increased mobility, storage/purchase of fodder, change in water management, partial shift to other livelihoods, banking livestock assets and herd management. The results reveal that pastoralists jointly adopt these adaptation strategies as complements and substitutes. According to the empirical result, increases in the number of dry spells and drought, access to early warning information, access to private ranch grazing, main market distance from homestead, access to credit and highest level of education in the household are the key determinants of the choices of responses. Surprisingly, wealth score does not lead herders to adopt any new livestock production strategies.

Consequently, financial and information services are core determinants in the decision to adopt new production strategies. However, the low satisfaction for those services reported by respondents illustrates the potential for improvement to enhance adaptation strategies.

Some services that support livestock production are well received by herders. For instance, access to water and grazing areas for cattle are satisfactory. Though service provision has recently improved, both traders and producers are not satisfied with some services such as artificial insemination services, which was overwhelmingly reported as not available for 96% of herders. Livestock insurance and loans are not available for 87% and 70% of respondents respectively. Both traders and producers agree that drugs for livestock are available but blame delay in the access to the service. Most of the respondents agree that deworming, access to grazing and access to water for livestock are the only services that are available in a timely fashion. About 49% and 58% of the respondents reported that market information and early warning systems respectively are not available.

Figure 7. Northern Kenya level of satisfaction in inputs and extension services provision



Source: Authors

Step 2

Climate risks for Kenya's southern rangelands beef value chain

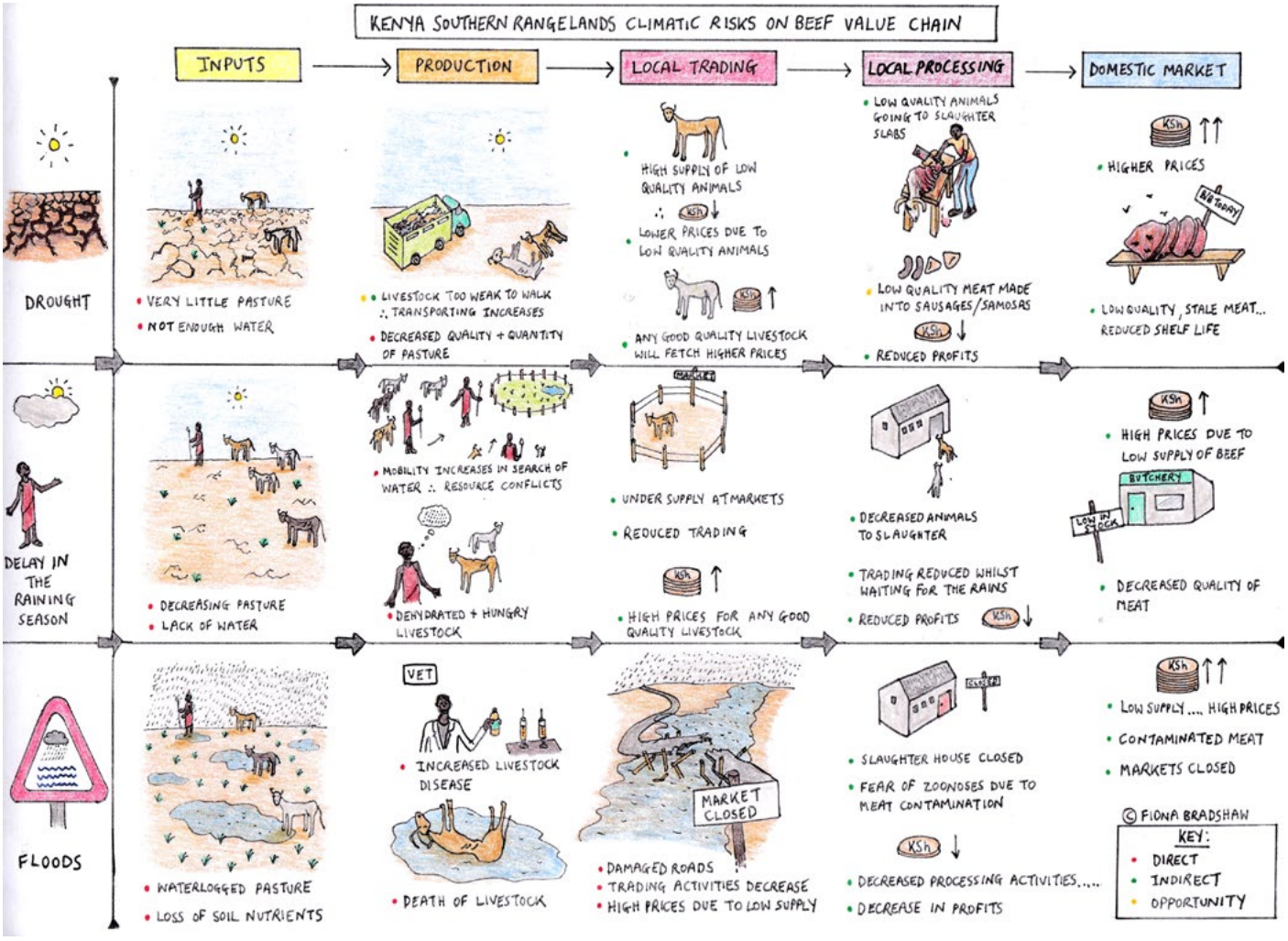
Perceptions of climate change

In the Magadi and Namanga regions, perceptions of climate change from surveyed producers and traders corroborated well with temperature and rainfall projections, with 97% and 92% (n=351) of herders observing an increase in both, respectively, in the past 10 years. However, most herders observed a decrease in rainfall levels as well as increased unpredictability and variability. The main climate extremes that affect livestock are drought (99%) and the delayed onset of the rainy season (96%).

The 2009 drought severely affected the production and income of producers in Magadi (68%) and Namanga (59%). Also in 2014, 24% of producers in Magadi had to face severe impacts on their activity because of a severe drought. To enable producers to plan for an anticipated climate extreme, there is a need for well managed early warning systems. However, the early warning system targeted few herders in 2009 (27% for Magadi and 23% for Namanga) and 2014 (29%). The case of Magadi illustrates that from one drought to another, the early warning system did not succeed in reaching more producers. Some of the strategies adopted in response to the 2009 drought are fodder production, vaccination of livestock and improvement of water management. In 2014, adaptation strategies shifted to early sales of livestock as well as herd splitting.

Of the surveyed beef producers, 93% revealed that livestock death is a shock they have encountered in their production system. Other severe shocks that affected the majority of the herders are large falls in prices of livestock (83%), livestock disease outbreaks (86%) and a sharp rise in food or input prices (76%).

Climate risks



By Fiona Bradshaw/PRISE

Drought resulted in reduced quality and quantity of animals going to the market, and since there were fewer livestock going to the market, this drove up market prices. Traders would have to travel to more distant markets in search of livestock to buy, especially to find animals that were still in good condition. Trucking was also more complex during the 2009 drought.

Although almost all of herders think that rainfall changes affect livestock, fewer (84%) are convinced that temperatures matter for livestock. As expected, decrease in grass quality and quantity and reduction of herd size were the main effects of changes in rainfall and temperature patterns on the livestock production systems.

Private adaptation action

Awareness of climate change does not appear to be sufficient to prompt adaptation action by producers, with a proportion of herders deciding not to respond to perceived changes in rainfall (24%) and temperature (36%). The main reason cited was lack of knowledge about appropriate action to take.

Adaptation strategies identified mainly refer to adjustment in pastoral practices such as changes in grazing management (40%) and an increase in mobility (12%) as a first step. In semi-arid areas in Magadi and Namanga, rangelands are often degraded and grazing becomes further limited during dry periods. During these times pastoralists often move their livestock to alternative grazing areas. A second phase of adaptation strategies consisted of reducing herd size. Pastoral communities adopt similar adaptation measures in response to changes in temperature patterns, as well as making changes in water management.

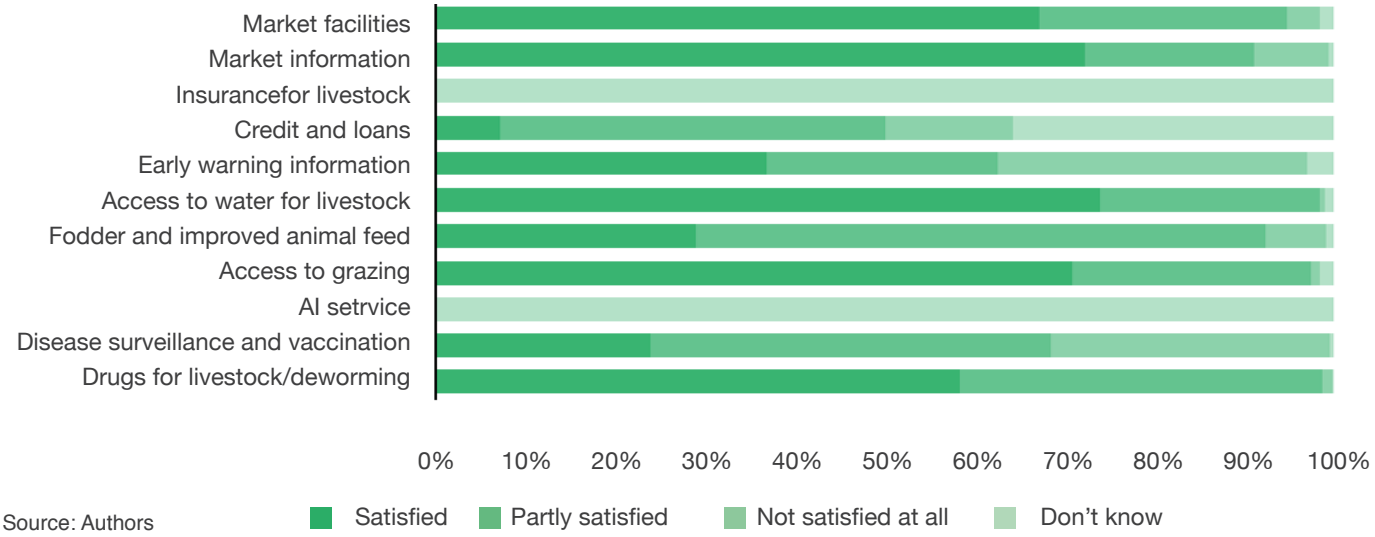
Determinants of private adaptation action

Wealth (based on household assets) does not significantly influence the choice to adapt strategies to protect livestock from harmful effects of climate change. There is an interesting gap in the decision to adapt to climate change according to the location of herders and the land management system: when they own their livestock in group ranches in Magadi, beef producers tend to be less likely to adopt adaptation strategies such as changes in water or herd management and storage of fodder compared to those herders who reside on private land in Namanga.

Information and surveillance services are core determinants in the decision to adopt new production strategies. When disease surveillance and vaccination services are available for livestock, herders are significantly more likely to adopt new herd management (changes in composition, breed and/or size of cattle). In addition, access to an early warning system significantly drives up the decision to store fodder to protect livestock against a potential feed shortage. However, the low satisfaction for those services reported by respondents illustrates the potential for improvement to enhance adaptation strategies. Information on markets, and particularly early warning systems, still have room for improvement in terms of satisfaction.

Although there have been minor improvements in service provision since devolution, there is still no provision of artificial insemination services and poor provision of credits and loans.

Figure 8. Southern Kenya level of satisfaction in inputs and extension services provision



Source: Authors

Step 2

Conclusions from VC-ARID Step 2

High

Climate change is already having an impact in SALs and these are likely to increase in the future

There is strong evidence that warming over land across Africa has increased by 0.5°C to 2°C over the past 100 years, and temperatures have increased in most South Asian countries over the same period. Since 1950, data suggests that climate change has changed the magnitude and frequency of some extreme weather events in Africa and Asia, affecting peoples' health, livelihoods and food security. For example, there is evidence that temperature changes have played a key role in in the increased incidence of malaria in parts of East Africa; on the production of wheat and maize in parts of Africa; on fruit-bearing trees in the Sahel; and on the contamination of urban water supply due to increased flooding in Pakistan's cities (Carabine et al., 2014a and Carabine et al., 2014b; IPCC 2014).

Temperatures in SALs are likely to rise above the United Nations Framework Convention on Climate Change (UNFCCC) global target of a 1.5°C increase, and rainfall will become more unpredictable over the next century. Key risks for Africa in the short and long term include stress on water resources, reduced crop productivity and changes in the incidence and distribution of diseases. For Asia, increased flood damage to infrastructure, livelihoods and settlements as well as food and water shortages are key risks, as is increased heat-related mortality.

In SALs, strong social networks and diverse, multi-local livelihoods are already examples of private adaptation[33] to the natural variability found in the climate and environments of SALs. If these approaches can be harnessed and scaled up, there are real opportunities for inclusive and climate-resilient economic development.

High

Producers are the actors of the chains that are the most exposed to climate risk

In general, climate risk and the direct impacts of climate change on the quality and quantity of production and prices is well understood at producer level. However, there is limited knowledge on how to take private adaptation measures that go beyond coping mechanisms.[12] Without proactive adaptation, shocks such as the 2009 drought in Kenya or 2010 floods in Pakistan have the potential to overwhelm existing coping mechanisms. Where adaptation action is identified, producers have limited capacity to put this into practices. Similarly, in terms of climate change adaptation policy, there is a corresponding disconnect for producers at the higher end of the value chain. It is therefore important to analyse the economic opportunities identified along the value chains, including those relating to transformation or improvements in the enabling environment, in order to inform appropriate adaptation policies.

This result depends on the level of vertical integration and the nature of demand in the chain (elasticity to prices and volume). It also highlights the importance of tailoring early warning systems and climate risk management towards producers, recognising the direct and indirect benefits of their activities.

In most of the chains, perceived climatic risks were reported to lead to negative impacts at each step of the value chains. These risks were reported to directly affect the quality and quantity of both inputs and outputs in the production process. Climate-related hazards result in a decline in processing sector activity with associated unemployment and loss of profits. Eventually, the scarcity and poor quality of final products hinder distribution on both foreign and local markets.

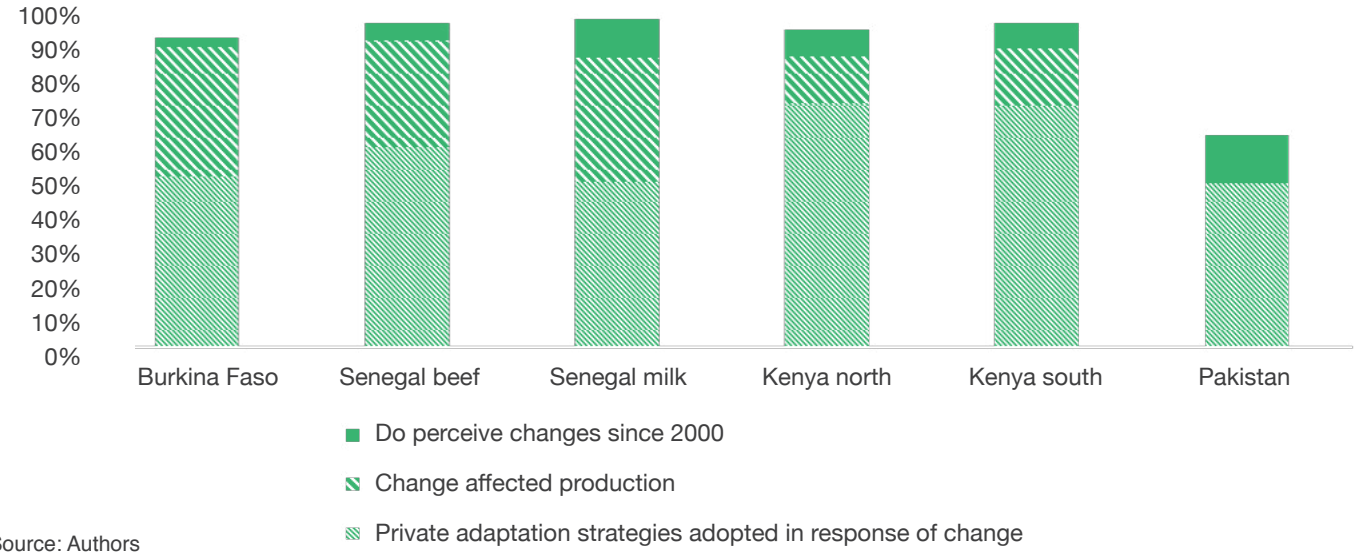
[12] Coping with climate variability and shocks such as drought implies reactive, short-term responses for survival or subsistence where options are limited. Adapting to climate change should involve more proactive, continuous and longer-term action (Tanner and Horn-Phathanothai, 2014).

As producers are the most exposed to climate change in all value chains studied, they are key actors for the proper functioning of the value chain and require specific investment and attention.

Medium *Most producers perceive climate change accurately and respond appropriately to shocks, but are less aware of adaptation options*

Most producers surveyed (90% to 98%) perceive climate change accurately (see Figure 9). Most of them identify a clear impact of climate change on their production in terms of quantity or quality and the majority (49% to 73%) are taking decisions to respond appropriately to these identified changes. There is good correlation between IPCC observations and projections with the perceptions of producers reported in the surveys.

Figure 9. Climate change — perceptions and adaptation[13]



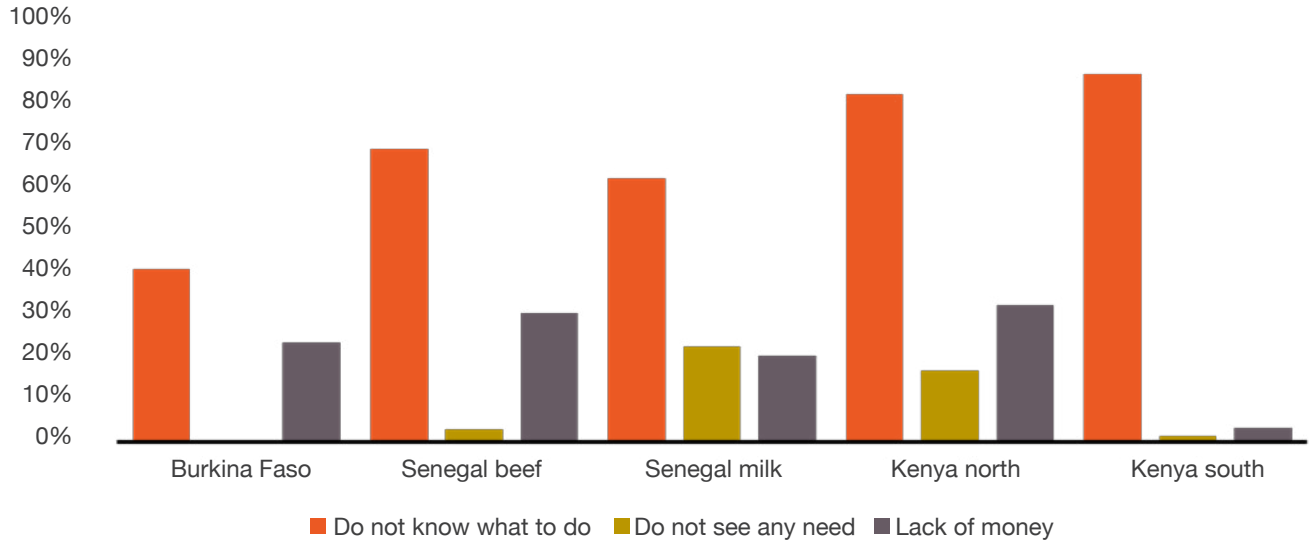
Source: Authors

High *Producers are less aware of adaptation options and there is a knowledge-action gap*

There is a gap between knowledge and action. Most actors in the chain expect producers to manage this risk, but these actors have the least capacity to do so. For example, cotton producers have limited climate information in order to plan, whereas textile manufacturers are well aware of risks but are not compelled to invest in value chain adaptation. In Senegal, urban livestock producers/traders are more aware of adaptation options than rural producers, but that does not indicate action. There is a need to support the tailoring of services to close this gap for example financial, climate information and animal health services. Lack of knowledge and financial support are the two main reasons explaining the lack of private adaptation from economic actors along the chain (see Figure 10 for traders and producers).

[13] All figures in this graph are combined statistics about both temperature and rainfall changes except for Pakistan, for which the survey includes direct questions on perception and adaptation to climate change. In the case of Pakistan, the question of whether climate change affected production was not asked to the households. The adaptation strategies identified here are private adaptation responses. The sustainability of these responses needs to be explored.

Figure 10. Reasons for not adapting to climate change: the knowledge gap[14]



Source: Authors

Medium *Wealth is necessary but not sufficient for private adaptation action*

Those who take private adaptation action score higher in wealth indices, but not all those who score high take action. Wealth index can also have a negative impact on some adaptation decisions. Therefore, income generation at producer level may not necessarily lead to adaptation action. However, there is an equity dimension, because those with the least income/assets, for instance smallholders versus larger landowners, are often least able to act.

For each value chain, a wealth index analysis was conducted at the producer level. In semi-arid areas, production systems are different to tropical or humid agricultural zones, so traditional indicators of wealth are not always representative of wealth distribution within these communities. A common methodology for wealth index calculation was constructed and alternative measures of household assets were tailored to the context of each case study. For instance, livestock holdings were included for Senegal and Kenya and land holdings were included for Pakistan. This analysis ensured that the wealth indices more accurately represented the wealth distribution in each case. Further details of this analysis can be found in each value chain analysis report, details of which can be found in the References section.

Medium *Access to extension services as well as individual characteristics, such as education, are key drivers of private adaptation decisions*

Access to extension services plays a key role in explaining private adaptation decisions, as summarised in Figure 11. In particular, early warning systems (including prices and climate information) and access to loans play critical roles in private adaptation.

[14] The questionnaire implemented in Pakistan did not include this question, but focus group discussions and other questions in the survey confirmed a similar pattern.

Figure 11. Determinants of private adaptation decisions in the livestock value chains[15]

	Increased mobility			Storage/ purchase of feed and fodder			Change in water management			Partial shift to other livelihoods			Change in herd management		
	Senegal beef	Kenya north	Kenya south	Senegal beef	Kenya north	Kenya south	Senegal beef	Kenya north	Kenya south	Senegal beef	Kenya north	Kenya south	Senegal beef	Kenya north	Kenya south
Wealth index	<0*			<0*		< 0**									
Livestock size	>0***					<0*									
Education level		>0**		>0**				>0**							<0*
Distance to market															
Early warning system	>0***	>0***		>0*		>0***			< 0**				<0***		
Surveillance & Vaccination						< 0**									>0***
Loans	<0***	>0*		>0*	<0*		>0*	>0**		>0**			>0***		

Source: Authors

Figure 12. Determinants of private adaptation decisions in the cotton value chains[16]

	Change crops system	
	Pakistan	Burkina Faso
Wealth index		
Information on weather and warning	>0***	>0**
Loans		>0***
Rainfall average		>0***
Number of floods	>0***	

Source: Authors

The results demonstrate the importance of tailoring information to these specific production systems and the climate and weather-related risks they face. It appears that while services exist in most cases, the impacts of drought and the structure and function of market systems are not well understood and lead to the production of information that is not useful for supporting resilience. If sales and investment in inputs are critical to coping with climate shocks and stresses, then it is also essential that price information be shared using appropriate media for communication, for instance mobile phones. Similarly, if the role of early warning systems is now well recognised, as suggested by the survey results, the challenge of tailoring these to the context of SALs and extensive livestock production systems remains.

The design and provision of tailored financial services is also a challenge in the context of SALs. The access to financial support that considers the characteristics of the economic activity – for instance seasonality and mobility – is a real challenge that could support the resilience of productions systems in SALs. The overall sector will benefit from these innovations that need to be supported through an enabling environment that incentivises the financial sector to take risks and invest in innovative, tailored financial products.

In most of the value chains, the decentralisation or devolution experiences lead to a rise in extensive services provided by the public sector (information, water, education) but few improvements in services provided by the private sector. This demonstrates the remaining effort required from decentralised and devolved entities in terms of an enabling environment for supporting such services in marginalised regions.

[15] Comparisons in these tables should be taken with caution, as the econometric models are not the same for all estimates. Please refer to individual value chain reports for details of the econometric analysis. In yellow are significant positive impacts and in blue are significant negative impacts. The level of confidence (p-value) is indicated by stars: * 10%, ** 5 % and *** 1%.

[16] Comparisons in these tables should be taken with caution, as the econometric models are not the same for all estimates. Please refer to individual value chain reports for details of the econometric analysis. In yellow are significant positive impacts and in blue are significant negative impacts. The level of confidence (p-value) is indicated by stars: * 10%, ** 5 % and *** 1%.

High

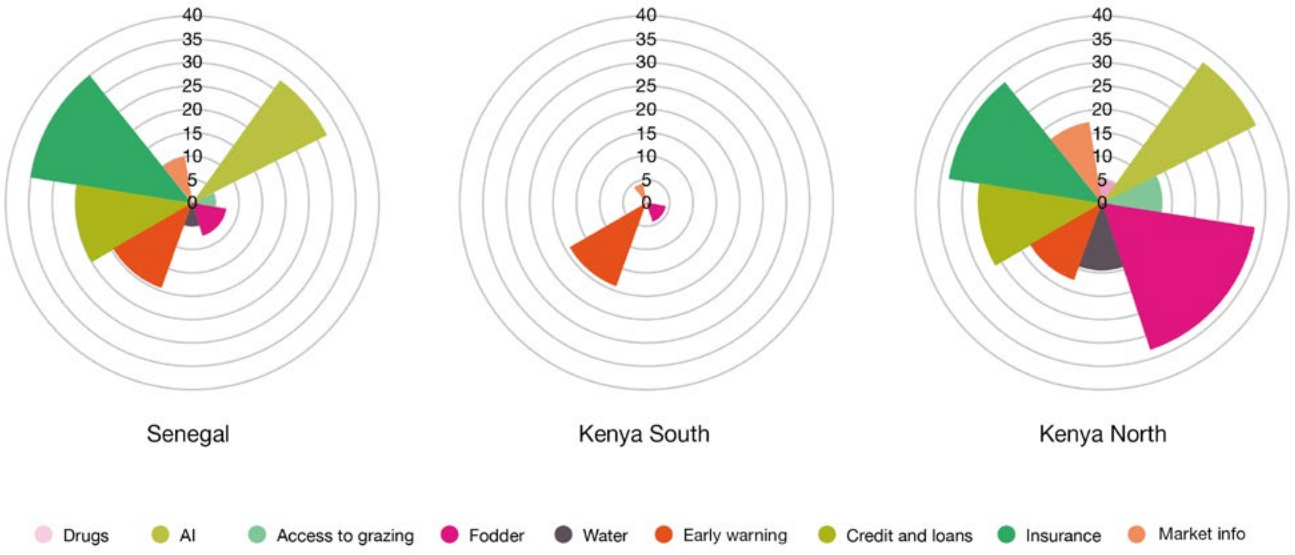
The provision of, and satisfaction with, extension services is critical in private adaptation decisions across the value chains, but there are differences depending on type of service, sector and country

Questions of satisfaction with extension services have been tailored to the specific context of these value chains. Nonetheless some key services are identical from one chain to another, yet the level of satisfaction reported by actors of these services varies depending on the country or the production system. The comparison of levels of satisfaction is a good point for regional comparison and where there are clearly identifiable opportunities for learning and exchange between stakeholders at regional, national and local levels.

For instance, Figure 13 shows a relatively higher level of satisfaction among producers and traders in Senegal, in terms of fodder provision and drugs services, than in Kenya. Interestingly, such services are more commonly provided by the private sector in Kenya compared to Senegal, raising questions about the specific roles of the public and private sectors in the provision of supporting services. Also, the very low level of satisfaction in Kenya's southern rangelands compared to the northern rangelands has created dialogue between devolved institutions and technical and financial partners on equitable service provision at the county level.

Provision of inputs (such as drugs, fodder and water), early warning systems (such as prices, climate information and animal health surveillance), access to markets and land (including mobility) and access to financial services (such as loans and insurance) are considered services for which regional exchange and national discussions are particularly relevant. As such, PRISE has given rise to a regional dialogue between key stakeholders and regional bodies in the Sahel and Horn of Africa on these key issues.

Figure 13. Satisfaction in extension services in Kenya and Senegal



Source: Authors

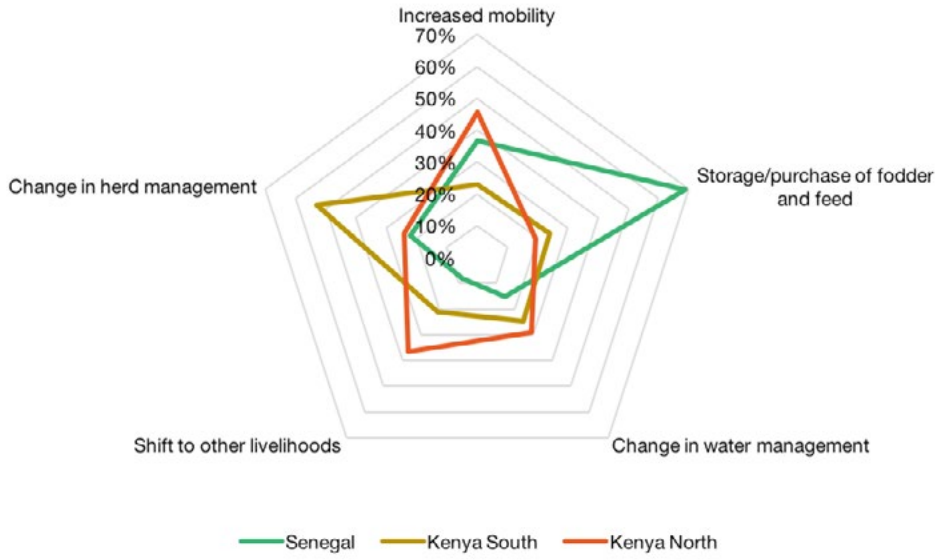
High

Climate risks and shocks are key factors driving private adaptation decisions, but that does not mean that they are sustainable over time

In Kenya, Senegal, Burkina Faso and Pakistan, climate shocks influence private adaptation decisions. The experience of climate- and weather-related shocks in the past has had a significant impact on private decisions at producer and trader levels in most of the value chains. The results of qualitative interviews and focus groups demonstrate that other actors along the chain also make decisions in response to experienced or anticipated climate risks. As shown in Figure 14, the actual private adaptation decisions made by economic actors are diverse and specific to the value chains, depending on the sector and the context (in other words, the 'territory').

Even within the same sector – livestock – there are differences in the most popular decisions, with Senegalese herders preferring the storage and purchase of fodder and feed while herders in Kenya differ in their practices depending on their location. This is likely dependent on the available options. For example, in northern Kenya herders choose to either increase their mobility or store fodder in response to drought risk depending on their ability to move and access fodder and water resources, whereas herders in southern Kenya tend to make changes to their individual herd management as well.

Figure 14. Private adaptation strategies in response to perceived climate change



Source: Authors

Nonetheless, these private decisions are not necessarily driven by the right incentives nor respond appropriately to climate signals. In this way, decisions at the individual or even community levels without the appropriate enabling environment are not always economically viable, socially acceptable or sustainable over time, in a context of climate change. As such they can lead to maladaptive outcomes. For example, climate shocks may drive pastoralists towards privatisation of communal resources, thereby curtailing mobility, or shift to alternative livelihoods and land uses, like water-intensive agriculture, that are less climate-resilient in the long term.

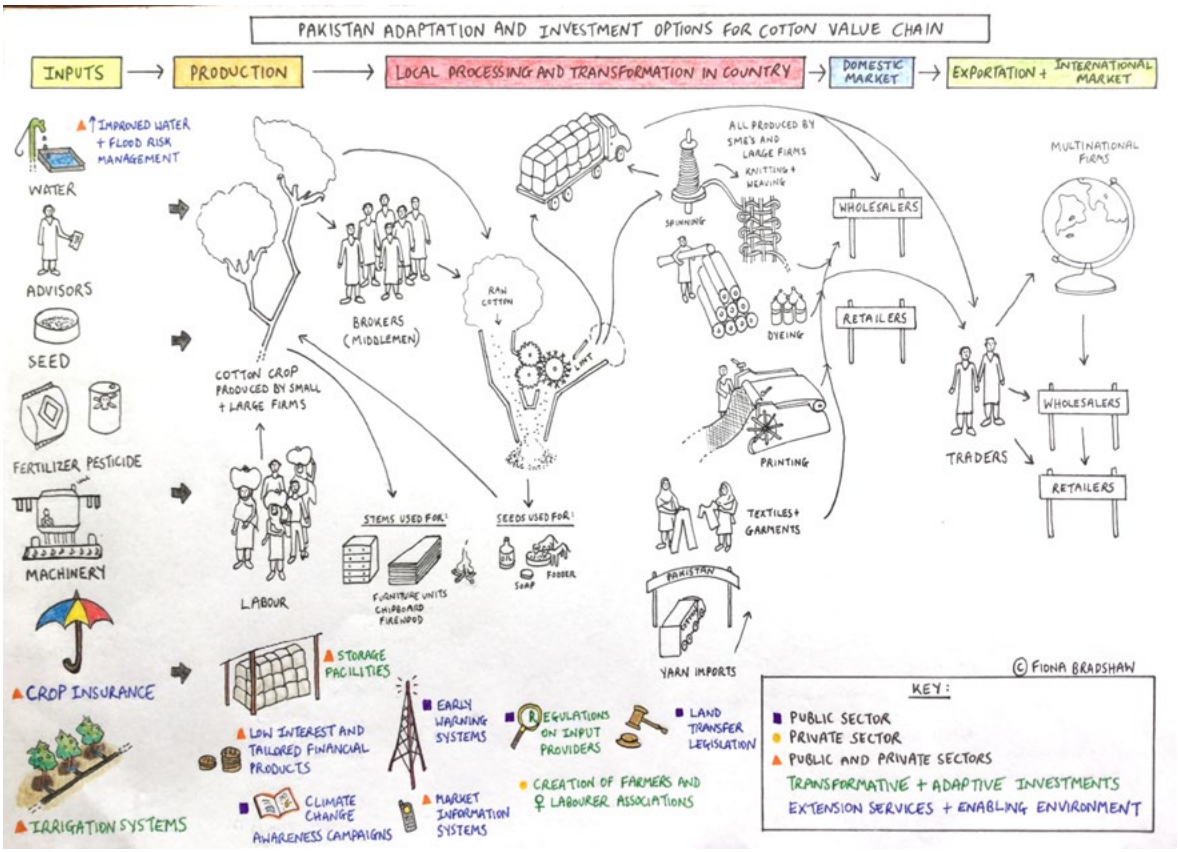
The decision to utilise water resources for crop irrigation in areas where rainfall and groundwater is projected to decline in the near future is not a viable adaptation option, even when made in response to climate shocks. Instead, water management should be organised and optimised at the territorial level. The VC-ARID approach allows for consideration of both private (or individual) adaption decisions that aim to optimise individual circumstances and adaptation planning (as described in Step 3).

Image: Cattle herders in the semi-arid region of Dahra, Senegal, by Rajeshree Sisodia/PRISE

Step 3

Results of VC-ARID Step 3

Pakistan cotton value chain recommendations



By Fiona Bradshaw/PRISE

As cotton producers face direct impacts of climate change, which then trickle down to the processing sector and other related actors in the cotton value chain, it is extremely important to promote adaptation at the production level. For this reason, targeted policy interventions are proposed to support and promote adaptation decision-making at the farm level.

Development of cotton sector policy, with a focus on promoting adaptation

There is a clear demand from PRISE stakeholders to formulate a targeted cotton-sector policy that addresses the needs of cotton farmers at a local level and presents a way forward to implement market-based approaches to climate-resilient cotton production. Stakeholders have put forward specific policy interventions in the following areas:

- Improved water distribution systems, promotion of water-saving technologies and raising awareness of water resource conservation;
- Climate-resilient infrastructure investment such as irrigation systems and storage facilities;
- Effective land transfer legislation regulating the division of agricultural land upon inheritance;
- Provision of accessible, low interest credit facilities for small farmers directly oriented towards cotton production;
- Capacity-building via local agriculture offices to conduct awareness-raising campaigns on climate change issues and effective adaptation planning;
- Effective climate information system with improved weather forecasting technology an effective mechanism

for the smooth flow of information through farmers' organisations and district-level agriculture and extension departments (however, these will have to be carefully designed to be inclusive and equitable to the various producer groups involved).

- Improved market information systems, including sensitisation about the Pakistan Cotton Standards Institute's quality standards;

- Strict regulations for actors operating in input markets, so that only authentic input providers are able to sell their products in the market;

- Promotion of hedge trading to incentivise quality.

Bridging knowledge gaps on climate change through the creation of specialised farmers' associations at the village level

Currently, there is no formal mechanism to disperse climate information to the ground level, where it is needed the most. This information gap results in major losses in productivity and limited adaptation to future climate risks.

Hence, there is a need for the creation of specialised farmers' associations at the village level, which would also act as awareness-raising and knowledge-sharing bodies. These could also help strengthen the linkages between agriculture and extension offices and the farmers, and strengthen the bargaining power of producers in raw cotton sales.

District-level agriculture departments can be instrumental in bringing stakeholders together. Agriculture departments can sensitise relevant stakeholders about the need and potential benefits of having such a platform. Moreover, a body representing female cotton labourers can be formulated along similar awareness-raising lines, for example on the health risks for female labourers.

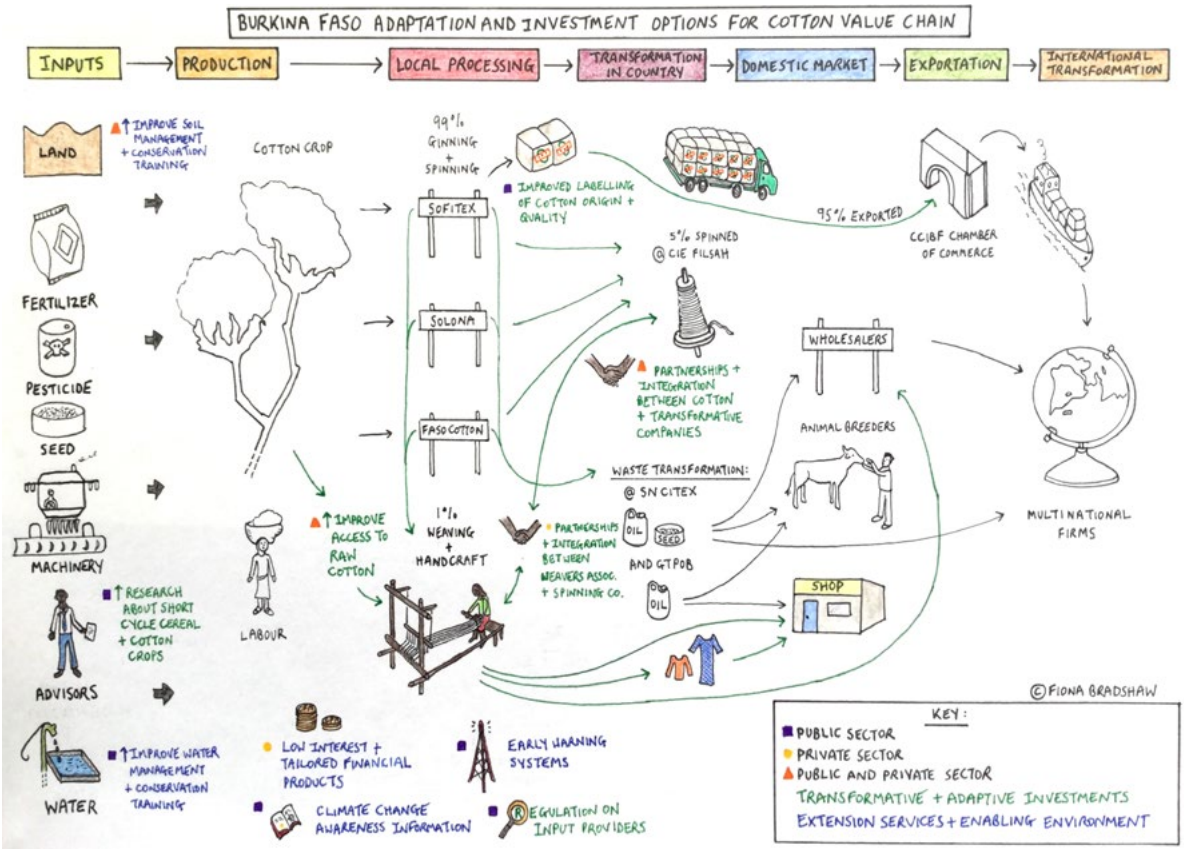
Development of effective crop insurance market, in partnership with the private sector

Crop insurance is now increasingly seen as a potential solution to reduce crop loss due to floods. There is a need for a more organised, private sector-dominated crop insurance market, which would not only help compensate climate-related loss but could also enhance productivity (through the promotion of risk-taking behaviour and increased income) by transferring specific risks. Thus, increased investments and risk-taking in agriculture would be incentivised, leading to development co-benefits (Weingärtner et al., 2017).

Government can provide a legal and regulatory environment conducive for private firms willing to enter the crop insurance market. An effective policy intervention should be government support in the form of a premium subsidy, where farmers pay between 25% and 50% of the cost of insurance. Considering the low level of uptake, this premium would be an absolute condition for the sustainability of the insurance provision. Subsidy support is critical in sustaining the private crop insurance market on a long-term basis. In order to deliver effective support, government should also: (1) undertake an assessment/comparison of a range of risk financing options (including insurance) to better understand what is the most beneficial and cost-effective option for which specific target group; and (2) explore further options for risk financing across the value chain that could help stabilise the chain more widely to cope with floods (and potentially other hazards).

Step 3

Burkina Faso cotton value chain recommendations



By Fiona Bradshaw/PRISE

Maintain quality cotton production in the semi-arid zone

Cotton produced in Burkina Faso benefits from its reputation for quality, an important driver of exportation. More specifically, cotton from the Bam region is famous for its quality and colour both in Burkina Faso and abroad. The sector should reinforce this image through branding and improving the labelling of origin and/or quality standards. Therefore, against the current trend for the large cotton companies to abandon northern regions of the country, it is recommended that they continue to support rain-fed cotton produced in semi-arid areas. Standards of origin and quality labelling can improve the value of the cotton produced in these zones and place a premium on traditional, or artisan, techniques. In addition, supporting production in semi-arid areas can have co-benefits for national security, as these areas were historically supported by the government and cotton institutions but are increasingly marginalised politically and economically at a time when extremism is on the rise in the region. The economic reintegration of these northern regions via cotton production could contribute to stabilisation of the region. Cotton producers' associations represent an important network that could support this integration.

Continuing to produce cotton in semi-arid areas also has remarkable co-benefits for food security. The economic analysis shows that semi-arid cotton producers are also the largest producers of cereals. The rotation of crops on agricultural plots allows for cereal crops to benefit from fertilisers applied to plots planted with cotton the previous year. Therefore cotton production is a good complementary activity to cereal production, which supports soil regeneration.

Support the adoption of soil conservation techniques

The sector should support farmers who engage in soil and water conservation techniques, either through subsidies, aid, or premium or subsidised loans. Financial incentive mechanisms must be explored to support their adoption. The adoption of these techniques can help build the resilience of production to climate change. However, this is expensive and will require training and extension services. By relying on the existing network of

cotton producer groups, the government and the cotton companies can together promote these techniques to ensure the sustainability of the sector.

Government technical services, and more specifically research centres, need to be more involved in seeking strategies that increase the cotton sector's resilience to climate change. For example, it may be possible to complement improved short-cycle cereal seeds with short-cycle cotton seeds. The Institute of Environment and Agricultural Research (INERA) could identify the appropriate technological package for each cotton zone that will reconcile the objectives of increasing agricultural productivity and protection of agricultural biodiversity.

Cotton farmers also need to be made aware of the impacts of growing cotton. To date, cotton production is done without any precautions to protect the soil. The current strategy implemented by the cotton companies (and government) is not cognisant of this issue. When the land of one area becomes degraded, production is moved to another zone. Since the farmers will not be able to leave their areas after the degradation of their agricultural soils, they must be sensitised to either adopt agricultural soil protection strategies or establish funds to serve as royalties for future generations. As the government and cotton companies are unlikely to take this long-term sustainability action, civil society needs to raise awareness with all these actors.

The Inter-professional Cotton Association of Burkina (AICB) could consider a climate adaptation fund that would allow cotton companies to support producers in implementing adaptation strategies.

Promote competition in the inputs market

Through the permanent secretariat of the liberalised cotton sector (SP/FCL), the government must ensure that the bidding process for the control of cotton sector inputs is transparent. The SP/FCL must also ensure that the quality of the inputs ordered through these calls for tenders complies with the standards indicated in the provided terms of reference.

Accelerate the transformation in direction to the local market rather than promoting diversification into other less climate-resilient sectors

The transformation of the cotton industry in Burkina Faso is a major economic challenge. By relying on existing informal actors that are already engaged in transformation, the sector can promote the development of weaving and spinning industries within the country. This can support the production of cotton in semi-arid areas. However in order to be viable and sustainable, these industries must be oriented towards a national market. Nonetheless, the transformation of cotton production is regarded as more socially acceptable to farmers who wish to continue practising it, and potentially more economically viable than alternative crop production systems in areas where rainfall is likely to decline in the future under climate change. The government, through initiatives such as the 8 March promotion of traditional local cotton clothing, supports the development of this industry. In addition to this, the fact that the government has chosen to make traditional clothing woven in cotton as its official dress is another important demonstration of support for these actors who are mainly women. In addition, economic and financial support are also needed (for example tax exemption in the first years of formal activity). In addition, the supply of raw cotton for this industry is a critical issue since, at present, all raw cotton is directed to the current national cotton companies that are only exporting raw cotton. An integrated model at the cotton company level could be pursued.

In order to allow the cotton sector to create more jobs and incomes for the Burkinabe population, it is necessary to increase the share of cotton transformed at the local level (to date, this quantity represents less than 1% of the national production). To do this, the association of cotton companies (APROCOB) must be connected with the associations of stylists, oil mills and soap factories as well as those who carry out the traditional spinning. In short, it is necessary that the coordination of activities between the actors of this sector is not limited between the producers and the cotton companies, but that it integrates all the local actors who are involved in the ginning industry.

Help cotton companies to engage in private-public partnerships

Following the previous point, public-private partnerships with the large cotton companies that address various aspects should be explored: first, the opportunity for an integrated model within a transformation industry; and second, the production and export of other products such as cotton cakes should be explored

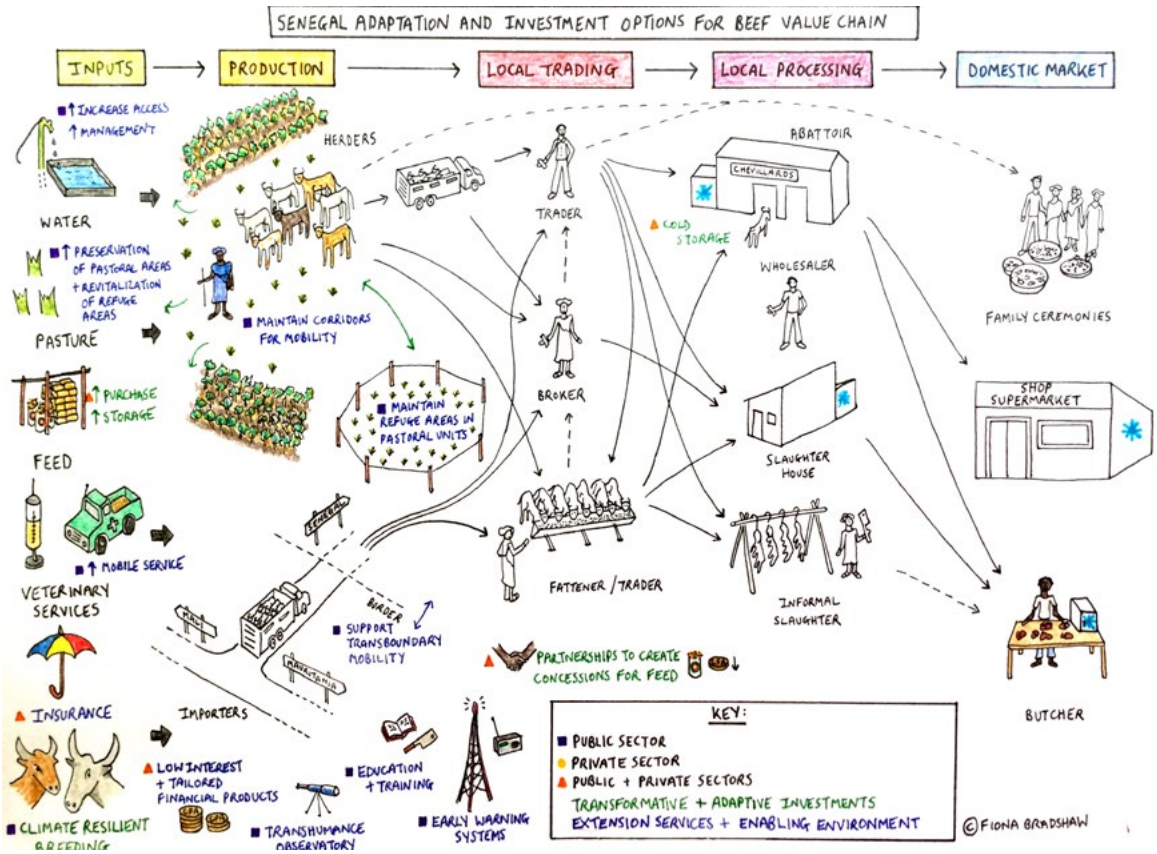
with government. Cotton cakes play an important role in food security for herders in the semi-arid lands of West Africa as high-quality animal feed. Complementarity of the two sectors should be harnessed, with the government orienting the balance of production and distribution of cotton products in order to support the resilience and complementarity of both important sectors.

Facilitate access to financial services and climate information, including early warning systems

To date, producers and other actors of the chains have struggled to get access to climate information and financial services. The promotion of an enabling environment supporting the implementation of innovative financial products for cotton farmers is a real challenge in remote areas, and needs to be addressed. Also, climate information and early warning systems that are specific to cotton production and transportation are needed by all actors along the chain. The government, together with the national meteorological agency, could explore this potential. But, since in some cotton zones farmers still refer to subjective norms (endogenous predictions of climatic events), advanced broadcasting of climate warnings is desirable so that the uptake of information is more efficient and effective.

Step 3

Senegal beef and milk value chains recommendations



By Fiona Bradshaw/PRISE

There are options that address both climate risk and also have an opportunity to upgrade and transform the value chain. Selected adaptation options were explored and deliberated with selected stakeholders to identify specific feasible options for public and private sector investment.

Maintaining mobility

Access to land is key for a resilient and sustainable livestock sector. The creation of protected grazing areas dedicated to livestock represents a key condition for consistent land policies in Senegal. The county government needs to maintain and protect specific areas for livestock grazing (especially dry season grazing areas) as well as livestock corridors that facilitate the mobility of livestock. Migration is still a fundamental adaptation strategy used by pastoralists during drought. By providing both corridors and grazing areas for cattle, policy-makers would support more resilient beef production since mobility is the second main private adaptation strategy.

Fodder and feed production

Feed and fodder storage is the main private adaptation strategy adopted in response to climate shocks and stresses. Nonetheless the suitability of this strategy is disputable (it can lead to an over-exploitation of grazing areas). As such, policies supporting this strategy must be very well defined and targeted, so they are not competing with mobility or livestock production. Feed for livestock is crucial during the dry period to substitute for lack of fodder. It appears to be one of the preferred options for herders when they feel threatened by climate change. The creation of public-private partnerships between beef producers and manufacturers in the sector could promote a more efficient supply of livestock products to the market. Governments should support such initiatives and monitor the distribution of feeding products during tough droughts to prevent speculations and illegal resales. Furthermore, the country could benefit from the creation and development of a fodder and feed sector complementary to its beef sector.

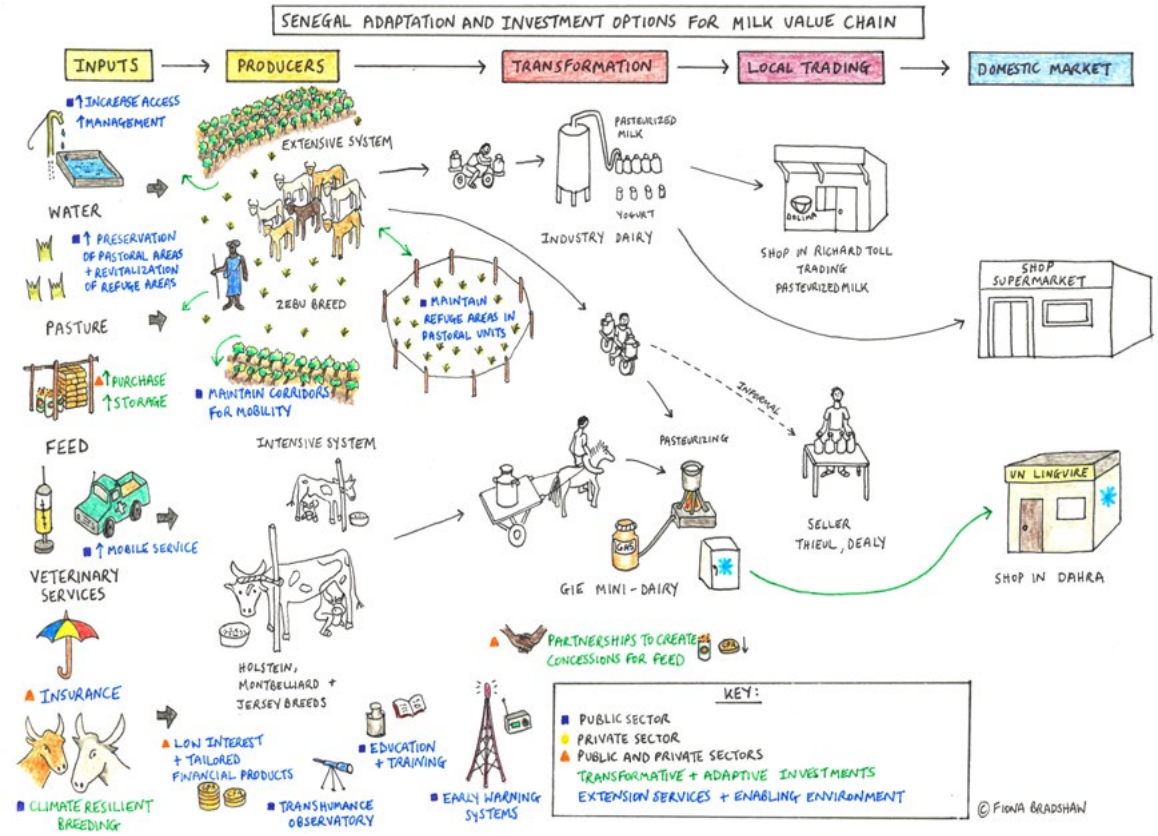
Improved and tailored extension services

Access to diverse services supporting the production of beef and dairy products from livestock is a key determinant to farmers' resilience. Services trying to preserve and improve human capital have to be developed to fit the mobile characteristic of producers, e.g. mobile veterinary, education and health services that are available early and targeted at transhumant herders.

Although some actors in the chain may have access to informal credit arrangements, the limits on credit availability and a lack of capital were identified as barriers to implement adaptation options. More support from financial institutions and the provision of further opportunities for value chain actors to access financial services and credit systems, and also ones that are better designed for pastoral production systems, can help producers and traders to engage in hay production or in the fattening of animals. Access to insurance services can also support pastoralists.

Access to weather information influences herders' decisions to adapt. Early warning systems, where correct and functional, could play an important role in mitigating the impact of climate change related hazards to communities. At a regional scale, weather information has to reach producers across borders on a more regular and efficient basis. The priority is to identify needs to make sure that the information is useful to the production system. Mobile herders should benefit from information channels wherever they carry out their transhumance (through radio or mobile phone for example).

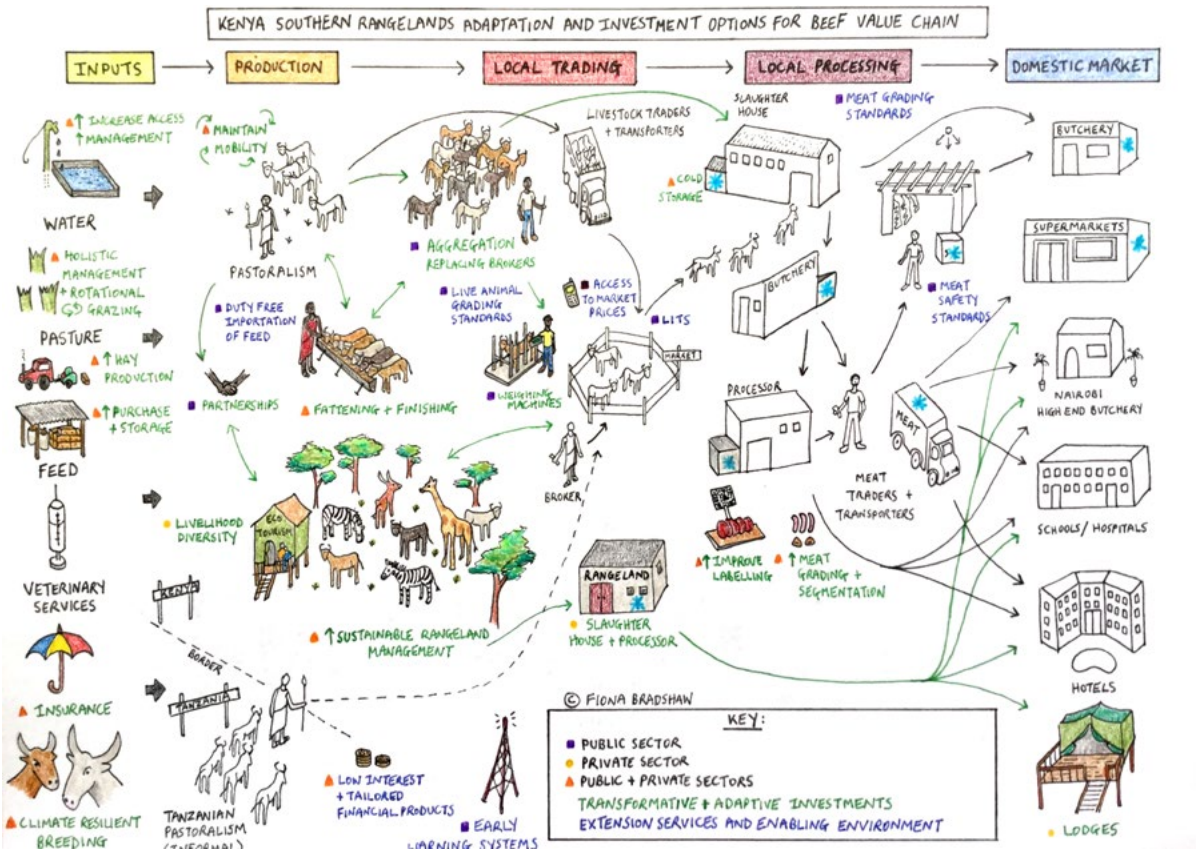
Establishment of a formal platform bringing together all actors in the chain can support existing representative organisations to coordinate funding and operational activities.



By Fiona Bradshaw/PRISE

Step 3

Kenya northern rangelands beef value chain recommendations



By Fiona Bradshaw/PRISE

There are a number of specific investment options for the public and private sectors, as well as the donor community, with the potential to deliver adaptation and development co-benefits.

Improved quality and value addition along the value chain

There is significant potential to improve and expand the fattening stage of the value chain, which would fulfil demand in the expanding high-end markets that require well-finished and high-quality meats. This would require proper planning of the pasture in group ranches or hire pasture in the private ranches to fatten well-selected young steers for about six months to finish steers to the desired weight. Applying holistic rangeland management could achieve this through pastures conservation by the community for its dry season grazing needs and fattening. Feedlotting can also be explored as a potential market for underweight livestock.

Fattening programmes need support from the government, such as feedlot development in the semi-arid areas, through access to leased land and low interest rate financing for pastoralists. During drought, the government can invest in feedlot salvage of livestock for breeding after the drought. This will reduce the current loss of livestock in the ASALs during drought. The government can also allow duty-free importation of fattening feeds given the shortage of feeds in the country.

The county government should invest in livestock weighing machines in every market to enable animal weight to be accurately determined to reduce exploitation of pastoralists by traders. There is also a need to invest in livestock holding grounds near these markets. Such holding grounds—with the provision of feed and water for a small fee—can increase pastoralists' bargaining power by providing them with the option of holding their animals until another market day when prices may be higher.

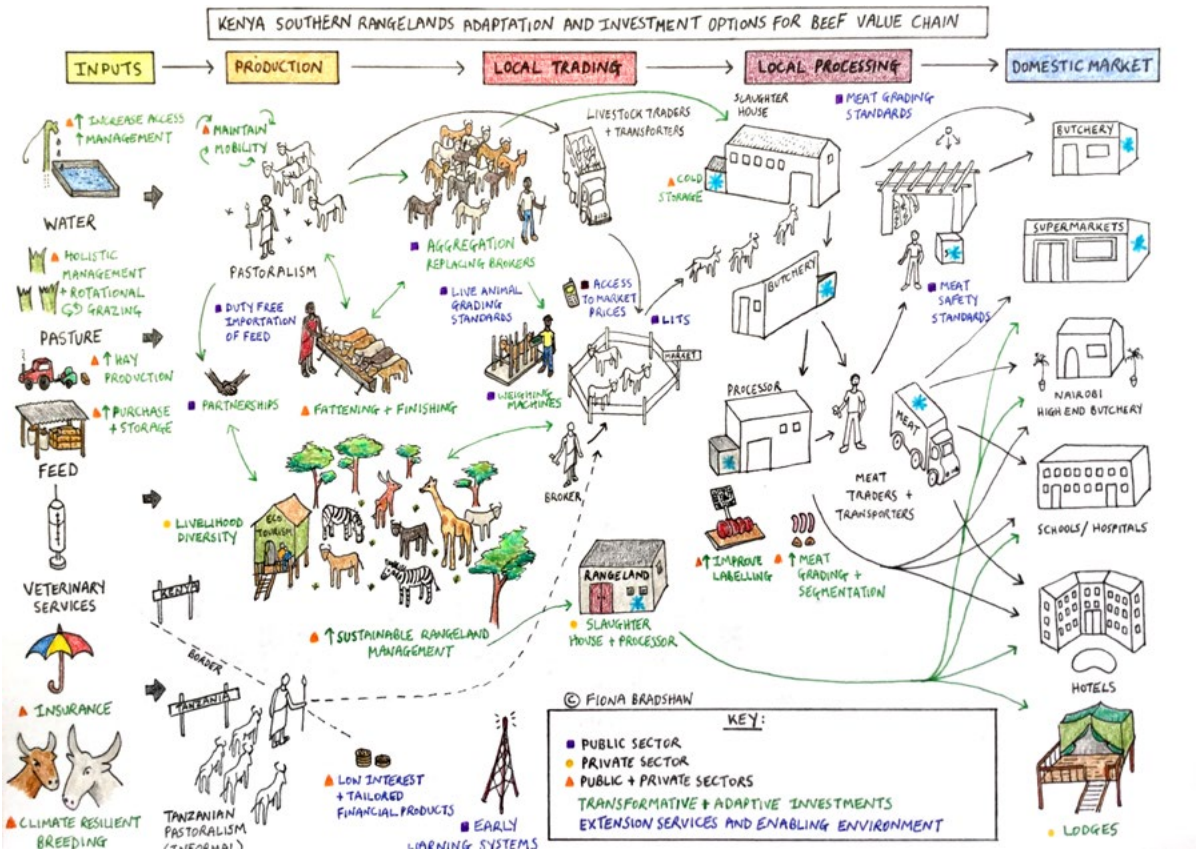
Diversification into tourism-related sector

Pastoral production systems in semi-arid areas face challenges occasioned by scarce and sparsely distributed pasture and water resources, erratic rainfall seasons, and competition from other group ranch users for scarce resources through overstocking. These challenges have led some group ranches in Laikipia to venture into ecotourism to diversify the communities' income. Initiatives such as the creation of conservancies seek to promote livestock/wildlife coexistence and lessen pastoralists' vulnerability to endemic livelihood and environmental challenges such as climate change.

Image: Livestock market in Mali, by ILRI/Creative Commons License

Step 3

Kenya southern rangelands beef value chain recommendations



By Fiona Bradshaw/PRISE

There are options that address climate risk and also have an opportunity to upgrade and transform the value chain. Selected adaptation options were explored and deliberated with selected stakeholders to identify specific feasible options for public and private sector investment.

Increasing quality across the value chain to support adaptation and transformation

There is a range of options identified that can act to increase value addition and quality across the chain. These include:

- The production or purchasing of hay or other sources of feed to maintain production and sustain cattle during drought periods;
- Breeding programmes to promote climate-resilient and commercially attractive traits;
- Fattening of lean cattle within producer or trader groups, to convert them into market-ready animals to sell at a profit;
- Investments in cold storage in the meat chain that allow the development of a ‘cold chain’, beyond the high-end markets (this can prevent meat being spoiled or sold at reduced prices);
- Increased value addition to beef, especially low quality meat (for the low-end markets);
- Vertically integrated private or community livestock enterprises that link livestock directly to markets (for the high-end markets).

Maintaining mobility to preserve the resilience of the sector

The Kajiado County government needs to maintain and protect specific areas for livestock grazing (especially dry season grazing areas) as well as livestock corridors that facilitate the mobility of livestock. Increasingly livestock are forced to move beyond county and national boundaries in search of pasture. It is necessary to create an institutional framework through which coordinated livestock movements and the sharing of grazing resources can happen between counties and countries (in this case Kenya and Tanzania). The Department of Livestock at the county government and the National Drought Management Authority (NDMA) should take the lead in creating such a framework.

Encourage livestock marketing groups/associations

There was little evidence of organised livestock marketing groups operating in the study sites. This absence reduces the opportunity for producer-based negotiations for market access and for more price-informed transactions. Marketing groups or associations offer the potential to increase the participation of small-scale producers in formal markets, and acting as a group improves their market bargaining power further than if they were to act alone. Producer marketing associations provide horizontal linkages and there are economies of scale as pastoralists can bring their cattle together to sell. There are also vertical linkages as the associations group their animals for contracts or sales. This can reduce the need for middlemen or brokers. The Kenya Livestock Marketing Council (KLMC) and the Departments of Trade and Livestock could help form these groups so producers can be able to access larger and more organised markets, and improve their marketing and business skills.

Support to integrated livestock-wildlife conservancies

Support should be given to creating and maintaining community-orientated livestock-wildlife conservancies as areas that provide dry season grazing zones for livestock. This would include recognition of conservancies as a viable form of land use to maintain livestock production as well as wildlife conservation. Conservancies help to reduce vulnerability to drought as well as facilitate wildlife/livestock coexistence.

Improved services

Access to finance was limited for many actors in the value chain and financing opportunities rare. Although some actors in the chain may have access to informal credit arrangements, the limits on credit availability and a lack of capital were identified as barriers to implementing adaption options. More support from financial institutions and the provision of further opportunities for value chain actors to access financial services and credit systems, and also ones that are better designed for pastoral production systems, can help producers and traders to engage in hay production or in the fattening of animals. Livestock insurance is another financial service that would provide useful cushioning to pastoralists against drought. The government plans to roll out livestock insurance services for pastoralists through the Kenya Livestock Insurance Program (KLIP) in a number of counties in Kenya, following its successful implementation in pilot counties in northern Kenya.

Access to pricing information is a constraint in livestock marketing. Local government can improve livestock marketing infrastructure to include weighing scales at the secondary markets, to inform better price negotiations between producers and traders. Also, better price discovery mechanisms that can inform producers and traders of livestock prices at remote and distant markets will also help them to better exploit these markets. If producers are able to receive better prices for their animals, this can incentivise them to produce animals more strategically for the market.

Early warning systems, where correct and functional, could play an important role in mitigating the impact of climate-change-related hazards to communities. Although NDMA already has an early warning system in place, including in Kajiado, this is not always available to the people who really need it due to the timings and methods of dissemination. Effort should be made to ensure that critical early warning information is shared to people who need it and is in forms that they can easily access and understand.

Development of more profitable private sector and vertically integrated businesses

For better links between producers and end markets, the development of private-sector enterprises that link

pastoralist cattle to high-value markets in cities can provide producers with higher and more reliable incomes. These vertically integrated enterprises link the opposite ends of the value chain, and bring producers closer to markets and customers. Mara Beef is an example of a private enterprise based in the rangelands that links livestock to high-value markets and is horizontally linked to conservancies and tourism in the Mara area of the southern rangelands.

If pastoralist communities as well as individual private investors can be facilitated to set up these types of enterprises, or do so in partnership, producers could also appreciate a larger share of the profits, beyond the reliable markets and good prices they get for selling their animals. These could potentially be set up through climate-financing mechanisms and supported by training in business and marketing skills. There are opportunities for the branding of products, such as 'Conservation Beef' or 'Maasai Beef' that would attract and tap into growing customer awareness of and demand for good quality beef. This type of branding could potentially also open up international export markets in countries where consumer preferences for environmentally- or climate-friendly products draws a premium.

Image: Maasai cows, by Matt Biddulph/Creative Commons License

Box 1: Tajikistan Livestock Value Chain

As described in the methodology, VC-ARID was also implemented in Tajikistan, for the livestock sector. This was a briefer, less detailed study and therefore the findings of Steps 1, 2 and 3 are included in this box.

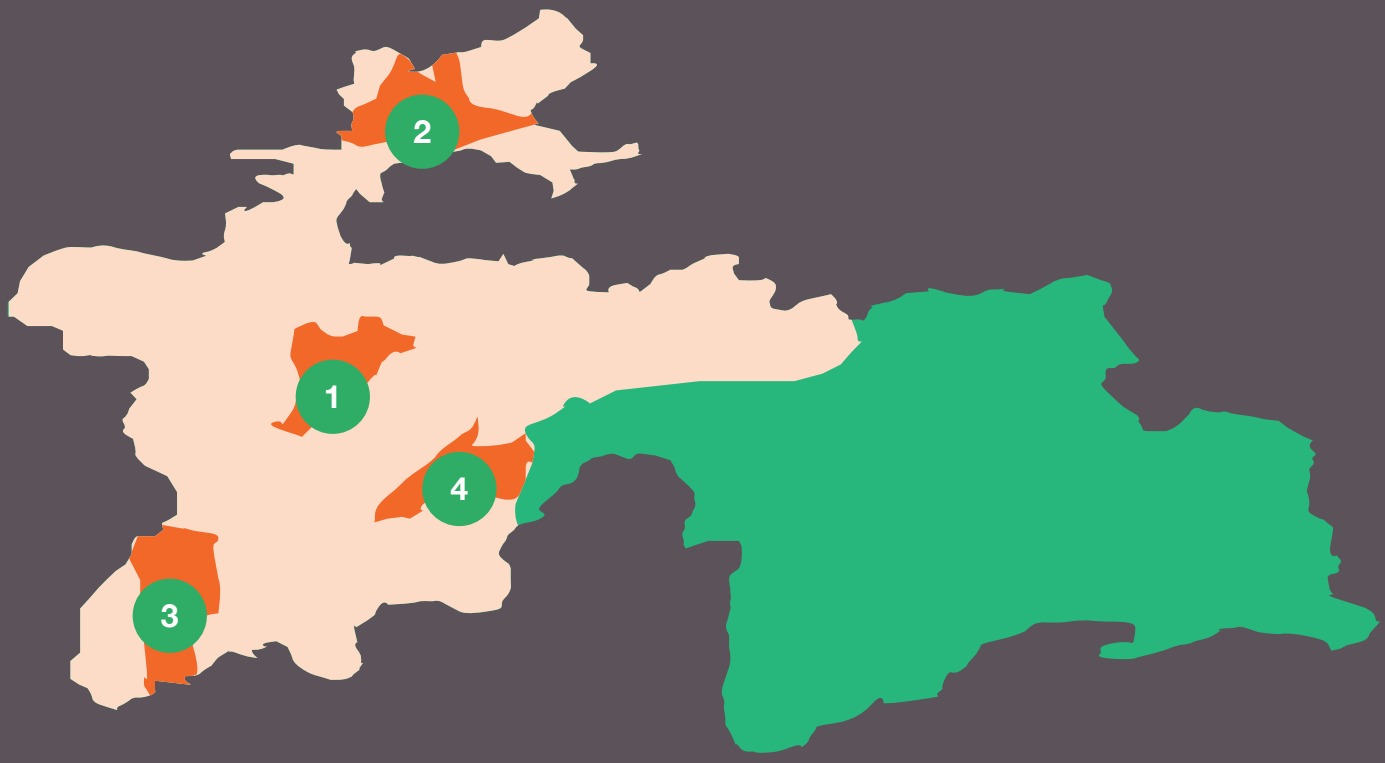
Context

Tajikistan is a landlocked country located in the southern part of Central Asia. It covers an area of 143,000 sq km, with mountains representing 93% of Tajikistan's territory. Over the last decade, Tajikistan has been gradually recovering from an economic downturn. The overall real GDP growth rate in recent years has been at 6-7%, supported by relatively high productivity in the mining sector and growth of agriculture, as well as growing money transfers from migrant workers. Depending on the altitude, the average annual temperatures in Tajikistan vary from 17°C to -6°C. Variation in rainfall is complex, but Tajikistan is classified as an arid and semi-arid country. Up to 75% of annual rainfall can occur during the cold season.

Methodology

The study in Tajikistan follows a lighter implementation of VC-ARID, combining key informant interviews and a small producer survey. Eighty livestock producers and traders have been surveyed across four districts (Vahdat, B. Ghafurov, Qabodiyon, Khovaling) during the period of June-August 2017 (see Figure 15 - source: Rakhimov et al. (2018).

Figure 15. Tajikistan map and pilot areas



1: Vahdat district (District of Republican Subordination, central Tajikistan)

2: B. Ghafurov district (Sughd province, northern Tajikistan)

3: Qabodiyon district (Khatlon province, southern Tajikistan)

4: Khovaling district (Khatlon province, southern Tajikistan)

Source: Adapted from Rakhimov et al., 2018.

Step 1: Mapping the value chain

Agriculture is a strategic industry for Tajikistan, providing employment for over 60% of the population and accounting for 21% of GDP. More than 66% of the population live in rural areas, which makes their income directly or indirectly dependent on agricultural activities. According to national data, the overall value of agricultural production in 2015 was 70% higher compared to 1991, including 52% growth in livestock production. In 2015, livestock accounted for 32% of the total income from agricultural products. Therefore, the livestock sector is a strategically important industry for the country, providing food security and being a direct source of income for more than 4 million people in rural areas. Following an increasing demand for the consumption of meat, production increased by 45% between 2011 and 2016. The livestock sector has clear potential for growth that must be considered in the context of climate change to remain sustainable.

In Tajikistan, livestock farming is an activity in which most of the tasks are carried out by men who usually make decisions about production, such as the purchase and sale of livestock or the provision of inputs (such as feed for the cattle). Another key characteristic of the livestock sector in Tajikistan is the role of informal communication channels. Herders rely on this informal network to keep updated on price changes, weather events or market quality. The key stakeholders of the livestock sector are the relevant government ministries and departments that regulate development policy, followed by district and provincial authorities, which ensure proper implementation of policy locally. What makes the livestock value chain so unique in this country is the presence of public authorities at each stage of the production process. Indeed, relevant institutions such as the Ministry of Agriculture, Ministry of Power and Water Resources, Environmental and State (administrative unit) committees play a large role in the livestock sector's development. In Tajikistan, the government determines the location for herders' activities, implementation of services, and the number of people 'accredited' to be herders, so there is a relatively high degree of government control in terms of land use and economic activities.

Step 2: Assessing climate risks at each level of the value chain

The herders are the actors most vulnerable to climate change in the beef value chain, but they also appear to be key actors for the proper functioning of the value chain. In addition to producers, this study captured impacts and private adaptation to climate change for processors in the value chain.

Recent years have been characterised by irregular rainfall in Tajikistan. Many respondents reported experiencing prolonged rainy periods in spring and water shortages during summer and autumn. This trend is confirmed by observed data and by the conclusions of the Third National Communication (3NC) under UNFCCC (2014). For example, rainfall in 2017 was 130-140% above the normal level. Increased rainfall is associated mostly with a growing intensity of rain and a decreased number of rainy days. Almost all producers (95%) said that climate change had affected their activities. An absolute majority of respondents mentioned droughts and heatwaves as major risks. Indeed, there were serious droughts in 2000-2001, 2008, 2009, 2010 and 2014, caused by rising ambient temperatures and insufficient availability of water. The responses are in line with 3NC (2014) data which indicates that 2000-2014 was the hottest period in the history of instrumental monitoring in Tajikistan.

To mitigate against negative effects of climate change on production, farmers identified many services that could be improved. For instance, all of the respondents reported the unsatisfactory state of pastures due to high degrees of degradation, low hay yields and the development of ravines. Although efforts have been made concerning the supply of uninterrupted water for livestock, access to the resource remains inadequate for farmers who still need to buy additional water between seasons. Most respondents report availability of veterinary services in pilot districts but highlight problems with quality, promptness, and prices for such services.

There is a network of credit organisations to support the development of agriculture in most of the surveyed villages, but the use of these services remains limited. The main reason cited for this is the high interest rates. Rather, it appears that growth in livestock production in these areas is funded by profit from agricultural activities, wages, and money transfers from migrant workers. There are obvious problems with the provision of information about potential risks of climate extremes to the public and to producers. Most respondents are unhappy with the quality and timeliness of such information.

Processors cite the shift towards more intense and seasonally variable rainfall as the main climate risk, affecting the development of their business. Many respondents mentioned cases of meat product spoilage due to warm winter weather combined with limited availability and interruptions in the power supply. To mitigate against the negative impacts of climate change; 37% of respondents said that they had changed the process and conditions of meat processing; 33% said that they had improved transportation methods; and 10% re-trained to do other business alongside livestock. More than 20% of respondents said that they did not take any mitigation measures, the reason for which was the lack of necessary knowledge and skills. Despite climate and financial challenges inherent in the development of the meat business, none of the processors stopped their operations or found an alternative method of income generation. At worst, they instead reduced the quantity of their production.

Step 3: Identifying adaptation and private sector investment options for climate-resilient value chain transformation

Implement holistic management of natural resources that takes into account climate change impacts

Improvement of the state of pastures and water resources is crucial to enhance resilience of the livestock sector. Several actions to promote better pastures could be undertaken, from the inventory of the current grazing areas to their restoration. In order to support the regeneration of pastures, the definition of a precise calendar and identification of the time at which grazing activity is less harmful for specific areas would optimise the use of existing natural resources. This should also be supported at the local level by infrastructure and regulations that support movement of livestock. Governmental authorities have an important role to play in the definition and implementation of sustainable norms for pasture use and water access.

Improve meat quality and support access to terminal market

Livestock productivity and food safety have to be a priority to preserve and support the production of meat. It includes improving selective breeding and hybridisation, reducing the numbers of small ruminants, improving livestock feeding practices and access to veterinary services. Another important aspect is better integration of meat products into national and foreign markets. As a landlocked country, Tajikistan faces difficulties in reaching main business hubs. National livestock production currently flows to domestic consumers only, with no export alternatives. This reveals high potential for the relevant agricultural institutions to restore and build connections with border countries. At the national level, extended infrastructure is also necessary to create connections between settlements, terminal market and production areas.

Support vertical integration in the value chain for better resilience and efficiency

The livestock sector has to move away from subsistence activity towards economic development. Most of the farmers identify livestock farming as a source of subsistence instead of a business and profitable activity. In addition, transformation cannot be achieved without a more efficient processing sector within the context of climate change. Local authorities may support the resilience of the processing sector by strengthening their power supply, creating small workshops for meat processing, installing large stationary cold storage for meat or introducing new standards and norms that would improve meat quality.

Financial services and information is key to adaptation

As a minimum, the provision of financial support and information support needs to be extended along the value chain. Agricultural institutions may achieve this goal by taking part in sustainable land management networks, considering preferential finance terms and affordable loans, or improving the system of weather forecasting, modelling and early warning. Pilot projects on livestock insurance have been conducted and the results of should be carefully considered in the context of building the resilience of the sector. These discussions could rely on the experience of the national index-based insurance implemented in Mongolia as well as East Africa.

Step 3

Conclusions from VC-ARID Step 3

High

There are clear opportunities for climate-resilient economic development in SALs

Sectors where production is rooted in SALs are vulnerable and exposed to climate risk but there is inherent adaptive capacity that is the basis of climate-resilient economic development. Across all the value chains studied, combinations of horizontal (for example promotion of the tourism-related sector and creation of jobs in services industries such as financial and animal health that support the cotton and livestock sectors) and vertical integration (for example improved quality of livestock and cotton products and transformation of beef and raw cotton into premium cuts and textiles) offer opportunities for increasing productivity within sectors but also diversification into related sectors, such as tourism in the cases of Kenya's northern and southern rangelands. However, to be sustainable and inclusive, adaptation options must be socially acceptable as well as economically viable and climate resilient.

The VC-ARID studies demonstrate that there are options for investing in transformation in these adaptive value chains in SALs, which can create employment and revenue and realise growth in the future.

High

In SALs, transformation within existing climate-resilient sectors can avoid maladaptation

In all the value chains, actors reported turning to alternative sources of subsistence and income, for example in Pakistan farmers responded to climate shocks by shifting from cotton to cash crop production. In Kenya and Senegal, herders relied on agricultural production or waged employment to cope with drought impacts. While these strategies are rational responses by individuals and households to manage the risks they face, these may also be maladaptive where they lead to longer term shifts (for instance land use change and environmental degradation or depletion of groundwater resources) (Cochrane and Cafer, 2017).

Taking future climate change into consideration, these impacts may be even greater in the short and long term. Furthermore, the diversification of livelihoods away from production activities that support social-ecological systems and local economies in SALs towards alternatives may be less socially acceptable, environmentally sustainable or economically viable under a changing climate. For example, shifting extensive livestock production towards more sedentary, intensive production of livestock or irrigated crops can be maladaptive. Not only this, but it can erode the characteristics of those systems that constitute the adaptive capacity of communities and economies in SALs if these lead to erosion of customary institutions and norms, are not connected to markets or increase demand on scarce natural resources, particularly water. As stated in the previous point, investments within climate-resilient sectors offer greater potential for climate-resilience economic development. As such, livelihoods and local economic development programmes should be cognisant of this risk, support the elements of existing adaptive capacity in SALs and avoid potentially maladaptive outcomes.

The potential for maladaptive outcomes exists not only at the household level but also poses risks at the sector and national economy levels. For example, investments in long-lived infrastructure in areas of high climate risk, such as SALs, can lock communities and local economies into maladaptation where they incentivise patterns that undermine the system, such as urbanisation (Jones et al., 2015; Carabine et al., 2015). On the other hand, where local and national governments invest in sectors that are more climate-resilient, for instance extensive livestock rather than water resource-intensive cash crop production, these can potentially constitute adaptation investments with associated benefits for drawing down finance and meeting international agreement obligations.

High

The formal private sector is not incentivised to invest in adaptation. Medium to large private sector actors look to producers and/or policy-makers to take adaptation action

The findings from all value chain studies suggest that the formal private sector is not actively investing in adaptation either at production, processing or sectoral levels. For example, while textiles firms in Faisalabad clearly recognise the cost of climate-related shocks on their supply chains, they do not see the need to invest in protecting these. Rather, they expect producers to bear the risks of climate change and look to the public sector or international markets to provide solutions. Similarly, meat processors in Nairobi are well aware of the impacts of drought on their businesses operations and potential for growth, yet they do not invest directly in smoothing supply. In both cases, key informants indicated willingness to invest if the regulatory environment demanded it.

Therefore, adjustments to the regulatory environment are needed to incentivise and draw down investment. However, private and public actors are generally not cognisant of the role the private sector can play in plugging the investment gap. For example, in these value chains, the private sector can provide a demand and a guaranteed market for quality products, even without direct investment. Public investment should be directed towards creating the enabling environment.

High

Private adaptation plus adaptation planning are required for climate-resilient and inclusive economic development

Most adaptation options require relatively low public investment but significant policy change. At the same time, the private-sector is not incentivised to invest so there is an issue of the enabling environment. Medium- to large-sized private-sector actors look to producers and/or policy-makers to take adaptation action and are not cognisant of the role they can play in plugging the investment gap. For example, Small- and Medium-Sized Enterprises (SMEs) provide a demand and a guaranteed market for quality products but no investment in production. Across the case studies, adjustments in the regulatory environment are needed to incentivise and draw down investment. Therefore, public investment should be directed towards creating an enabling environment for private/public adaptation investment.

Moreover, on quality issues, regulation is a key factor. Vertical integration or regulated monopoly are often the optimal way to support upgrading of quality in the value chain. That it is why it is essential for public authorities to implement solid adaptation plans. If contracts are not enforced or if information is asymmetric, public-private partnership or horizontal competition is not sufficient to drive improvements in quality. Each economic actor has a role to play in this option.

High

In SALs, national adaptation action is required, but the local and regional levels are also important for governance and climate-resilient economic development

PRISE has explored climate-resilient economic development through the lens of the state and the national level. However, it has also recognised that in terms of geography, economic activity or the communities that inhabit them, national borders do not delineate SALs. While this is not a characteristic unique to SALs, this is a key difference to sectors and systems that do fall more neatly within national administrative boundaries. Furthermore, climate change itself is a challenge that transcends national governments and requires action across scales. VC-ARID has been designed to incorporate these scales of analysis and identify options for adaptation and investment at local, national and regional levels.

Indeed, VC-ARID has revealed in all cases that action is required at local (or production) level where there is inherent adaptive capacity within communities and local economies; at national level where the public sector needs to create the enabling environment for adaptation investments; and at regional level where there are challenges to be addressed (for instance drought impacts or food security) or opportunities to harness (such as international trade).

For instance, actors in all value chains have identified early warning systems as important. These are present in almost all cases with national-level investment, but they are not often appropriately targeted at local

communities with the provision of relevant information (as demonstrated in the levels of satisfaction recorded in the VC-ARID studies). In particular, early warning systems are not always well designed to anticipate drought-induced crises, as they are designed in line with agricultural system parameters and do not incorporate the characteristics of drought and SALs. The pastoralist crisis in the Sahel in 2010 and in the Horn of Africa in 2011 are cases in point, and both have influenced the activities of value chain actors in the Senegal, Burkina Faso and Kenya studies.

Regional policy frameworks and coordination are necessary to address the scale of drought phenomena, which have direct and indirect effects. Drought impacts are not geographically restricted to the areas where hydrological drought occur and are 'tele-connected' across regions. For instance the 2005 food crisis in Niger was precipitated by price shocks that originated due to drought in Nigeria. Early warning and drought management systems should monitor both production and prices, with particular attention on sentinel markets in the region (Araujo Bonjean et al., (2010); Araujo et al., 2012).

An example of frameworks trying to address these issues at regional scale include the Intergovernmental Authority for Development in the Horn of Africa (IGAD) and the Drought Disaster Resilience and Sustainability Initiative (IDDRSI), which addresses natural resources, markets, livelihoods, disaster risk management and peace and security coordinated across institutions in member states. Another is the Nouakchott Declaration in the Sahel, which addresses the mobility of pastoralists across the region. As a result, the PRISE programme in 2017-2018 is convening stakeholders in a regional dialogue between regional bodies in the Horn of Africa and Sahel for cross-regional learning on key value chains, policy frameworks and services for drought-prone areas.

High *From climate-resilient economic development towards transformation*

The findings of the VC-ARID studies have led to the proposal of a new definition of climate-resilient economic transformation that takes into account the important elements of territory, climate risk, variability and informality:

The full range of evolutions undertaken by the economy and society towards sustainable development. This is characterised by a shift towards sectors that boost inclusive and adaptive growth and gains of productivity within sectors. This increase in productivity must be attained without putting extensive pressure on natural assets and without generating negative environmental spillover that cannot be internalised.

This definition offers the opportunity to set forth a broader definition of socioeconomic transformation in Agenda 2030, with real examples of how to empower people, ensure inclusiveness and equality, and mainstream climate adaptation while delivering national and sectoral economic development objectives.

Reflections on VC-ARID

VC-ARID has been received by stakeholders at national and international levels as an innovative approach to considering adaptation. The integrated approach providing adaptation solutions at the sectoral/value chain level is innovative in a context where adaptation activities are often not anchored in a systemic approach and as such can lead to maladaptation.

The focus of VC-ARID methodology on specific characteristics of SALs has revealed important dynamics:

Production in semi-arid lands

The semi-arid lands 'hotspot' focus of VC-ARID allowed research teams and stakeholders to focus on marginal areas, which would not otherwise be chosen as research priorities because they are typically viewed as less important areas for production. Most development analysis traditionally takes a sectoral approach, but by starting with a hotspot approach it was possible to take particular sectors and blend this with a territorial approach that takes into account the specific characteristics of semi-arid lands. This has enabled a cross-sectoral overview, which is essential for climate-resilient economic development.

The VC-ARID approach combines the hotspots and territorial approaches with a sectoral focus (see Figure 2). Thus VC-ARID ensures an analysis that is tailored to the context, not only resulting in more appropriate options for climate-resilient economic development but also in building trust and shifting narratives with stakeholders. Part of this shift has been the recognition that production in semi-arid lands can be the basis of viable businesses with private sector investment, where they have previously been viewed only as vulnerable subsistence livelihood activities.

Climate risk

The particular focus on identifying climate risks at each step of the value chain, as well as across the sector overall, has allowed us to distinguish between coping, adaptive and maladaptive responses. It has also allowed us to test perceptions of climate change versus observations and to distinguish between private and planned adaptation options.

Seasonality

Beyond long-term climate change and extremes, exploring volatility and constraints for production, trading and markets between seasons in a normal year has allowed us to identify opportunities that can smooth supply and demand, and therefore prices, for example the fattening of livestock during lean months to increase overall quality.

Gender

In value chains where roles for women and youth initially appear to be limited, risks and opportunities can be hard to understand. Focusing specifically on gender in exploring the value chain actors, adaptation responses and opportunities, has revealed not only that inequalities exist in terms of rights and financial inclusion, but where adaptive capacity can already be harnessed. For example in the Kenya beef value chain, actors tend to be predominantly male, with livestock ownership by women at less than 4%. However, the gender-sensitive methodology revealed that joint ownership is the most common form (65%) and care of animals is almost 50:50 between women and men. While in just over half of cases men control the income from sales, these dynamics are important to understand as banking of livestock assets is one of the most important private adaptation decisions in case of shocks and stresses. Furthermore, the surveys show that producer

households experience a mix of idiosyncratic and covariate shocks, which when experienced together increase vulnerabilities. Women are key to dealing with idiosyncratic, household-level shocks. So while women may not be visible in the value chain, their decision-making plays a role and can be harnessed in terms of sectoral transformation.

Informality

The flexibility provided by informal systems and processes is key to managing climate-related and other risks in SALs. For example, mobility (inputs or people), labour (employment or alternative activities) and capital (ability to draw on assets through access to markets) all play important roles in people's responses to shocks and stresses and decisions to adapt.

Unprecedented opportunities for comparison and insight

The VC-ARID methodology can be applied to any value chain where climate change should be considered and particularly those rooted in arid and semi-arid lands or other climate change hotspots. VC-ARID has been replicated by seven research teams in five countries, offering unprecedented opportunities for comparison between semi-arid regions of the world and providing significant insights on appropriate methodological approaches for analysing these systems, as well as ways to harness them for private sector investment through appropriate risk management. These findings have contributed to an emerging paradigm about semi-arid lands that is framed more around development opportunities and adaptation than poverty, vulnerability and household resilience.

A method for analysis and engagement across scales that is necessary for climate-resilient economic development

The VC-ARID methodology has enabled stakeholder engagement across multiple scales, incorporating a wide range of actors that do not typically coordinate around climate and development action. Decentralised institutions and national sector representatives have had the opportunity to exchange experiences on adaptation in their respective countries. Because of the comparability of the approach, VC-ARID has also provided the opportunity of regional/cross-scale exchanges. The interactions of private and public actors in these sectors across the regions confirmed the importance of coordinated action across national governments and decentralised/devolved bodies, but also the necessity to align action with regional policies. Coordination is especially important around issues of natural resource management, trade (for instance the free movement of goods and people) and crisis management (for instance food security/human security) where many institutions are responsible.

Finally, it is important to stress the central objective of VC-ARID to define and promote investments supporting economic development that is both resilient to climate change and inclusive. VC-ARID is anchored in a context of sectoral, territorial or national economic development. It places the analysis at different scales than poverty reduction or resilience-building efforts, which focus on individuals or households as the units of analysis. While VC-ARID strives to advance the socioeconomic development of individuals and private actors, it is designed to support a more comprehensive adaptation process making a clear distinction between options that promote subsistence at the household level and those that drive economic development at the sectoral and territorial levels. The case of livelihood diversification versus value chain transformation for providing income is an example where the two approaches can lead to very different and contradictory results.

An appropriate tool for targeting socioeconomic development investments that is equitable and climate-resilient

Because VC-ARID recognises different scales of analysis relevant to socioeconomic development (household, territorial, sectoral and national), it can provide a tool for decision-making. VC-ARID can be used by private actors (for example individuals, SMEs, producer organisations) but also by local authorities, which are seeing a trend towards decentralisation and devolution in SALs, and national governments. The combination of sectoral analysis with a territorial approach makes VC-ARID a specific and tailored tool but also a method that can be applied in other contexts where these factors are important to socioeconomic development and

transformation.

In this sense, VC-ARID can also be used to design robust and efficient targeting for adaptation investments and programming. Indeed, as the method allows targeting at several levels, it can address one of the main challenges of current adaptation programmes: working across different scales (Dupar, 2016).

The complex balance that climate and development planners face is the implementation of interventions that are specific to the local context while maintaining the potential for comparison to prioritise investments, benchmark the approach or assess results, and for scaling up and out of interventions. VC-ARID has demonstrated that it can be a method for effective adaptation measurement and can thus support prioritisation and evaluation of adaptation projects and investments.[17]

At the same time, the flexibility of VC-ARID allows it to be adapted and tailored to the areas and sectors for which it is applied. It has also been demonstrated that the key to achieving these dual objectives is the inclusion in the methodology of iterative engagement with stakeholders on several scales.

[17] VC-ARID's characteristics for adaptation planning have been recognised by participants of the Adaptation Metrics conference on 27 September 2016. An outcome of the conference in Morocco was an official submission of the Kingdom of Morocco at the UNFCCC conference, highlighting the importance of a value chain approach in the context of adaptation metrics: https://unfccc.int/resource/docs/2016/apa/eng/inf02a01.pdf.

References

PRISE references

Akouwerabou, D., Bako, P., Sombie, I. and Yerbanga, A. (to be published 2018). *Impact du changement climatique, options d'adaptation et opportunités d'investissement dans le secteur du coton – Chaine de valeur coton au Burkina-Faso.* PRISE Working Paper. Ouagadougou: University of Ouagadougou.

Batool. S. and Saeed, F. (to be published 2018). *Climate change impact, vulnerability and adaptation assessment of cotton value chain in Pakistan.* PRISE Working Paper. Islamabad: Sustainable Development Policy Institute.

Bedelian, C., Moiko, S. and Said, M. (to be published 2018). *Harnessing opportunities for climate-resilient economic development in semi-arid lands: adaptation options in the beef value chain in Kajiado County, Kenya.* PRISE Working Paper. London: Overseas Development Institute; Nairobi: Kenya Markets Trust.

Dia-Ndiaye N., Diop, W., and Beye, A. (to be published 2018). *Impact du changement climatique, options d'adaptation et opportunités d'investissement dans le secteur de l'élevage au Sénégal – Chaine de valeur lait au Sénégal.* PRISE Working Paper. Dakar: IED Afrique.

Jones, L., Carabine, E. and Schipper, E.L.F. (2015). *(Re)conceptualisation maladaptation in policy and practice: towards an evaluative framework.* PRISE Working Paper. London: Overseas Development Institute.

Rakhimov, S.H., Kayumov, A., Asozoda, N., Faizulloyev, F. and Mustayeva, N. (to be published 2018). *Tajikistan: Planning adaptation measures for livestock farming sector in the context of value chain.* PRISE Working Paper. Dushanbe: Regional Environment Center for Central Asia.

Waguru Ndiritu, S. and Said, M. (to be published 2018). *Harnessing opportunities for climate-resilient economic development in semi-arid lands: adaptation options in the beef value chain in Laikipia County, Kenya.* PRISE Working Paper. Nairobi: Kenya Markets Trust.

Other sources

African Union Interafrican Bureau for Animal Resources (AU-IBAR) (2015). *Livestock Development Strategy for Africa (LiDeSA) 2015-2035.*

African Union (AU) (2014). *Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods.*

Araujo Bonjean, C., Brunelin, S. and Simonet, C. (2010). *Prévenir les crises alimentaires au Sahel : des indicateurs basés sur les prix de marché.* Agence Française de Développement. Document de travail 95.

Araujo, C., Araujo-Bonjean, C. and Brunelin, S. (2012). 'Alert at Maradi: Preventing Food Crises by Using Price Signals'. *World Development, Elsevier,* Vol. 40(9), pp. 1882-1894.

Banuri, T. (1998). *Pakistan: Environmental Impact of Cotton Production and Trade.* Winnipeg, Canada: International Institute for Sustainable Development.

Behnke, R. and Muthami, D. (2011). *The contribution of livestock to the Kenyan economy.* IGAD LPI Working Paper 03-11. Addis Ababa, Ethiopia: IGAD Livestock Policy Initiative.

Carabine, E., Jouanjean, M.-A. and Tsui, J. (2015). *Kenya's ending drought emergencies policy review: scenarios for building resilience in arid and semi-arid lands.* London: Overseas Development Institute.

Carabine, E., Lemma, A., Dupar, M., Jones, L. and Mulugetta, Y. (2014a). *The IPCC's Fifth Assessment Report: What's in it for Africa?* London: Climate and Development Knowledge Network.

Carabine, E., Lemma, A., Dupar, M., Jones, L. and Mulugetta, Y. (2014a). *The IPCC's Fifth Assessment Report: What's in it for South Asia?* London: Climate and Development Knowledge Network.

Carabine, E., Lwasa, S., Buyinza, A. and Nabaasa, B. (2017). *Enhancing climate change development programmes in Uganda: Karamoja livestock value chain analysis for resilience in drylands*. London: Overseas Development Institute.

Carabine, E., Wainwright, J. and Twyman, C. (2014). 'Narratives of a Drought: Exploring Resilience in Kenya's Drylands'. *Advances in Intelligent Systems and Computing,* AISC, Vol. 229, pp. 307-317.

Catley, A., Lind, J. and Scoones, I. (2013). 'Development at the margins: pastoralism in the Horn of Africa'. In: Catley, A., Lind, J. and Scoones, I. (eds.) *2013 Pastoralism and Development in Africa: dynamic change at the margins,* New York: Routledge, p 328.

Cochrane, L. and Cafer, A. (2017). 'Does diversification enhance community resilience? A critical perspective'. *Resilience,* Vol. 6(2), pp. 129-143.

Comité Français pour la Solidarité Internationale (CFSI) (2013). 'Le Sénégal en pleine montée de lait', *Alternatives Économiques,* No. 327 bis, (pp. 10-11).

de Haan, C. (ed.) (2016). *Prospects for Livestock-Based Livelihoods in Africa's Drylands.* World Bank Studies. Washington, DC: World Bank.

De Souza, K., Kituyi, E., Harvey, B., Leone, M., Murali, K.S. and Ford, J.D. (2015). 'Vulnerability to climate change in three hot spots in Africa and Asia: key issues for policy-relevant adaptation and resilience-building research'. *Regional Environmental Change,* Vol. 15(5), pp. 747-753.

Dupar, M. (2016). 'How to tailor adaptation programme'. [online] *Climate & Development Knowledge Network.* Available at: https://cdkn.org/2016/11/feature-tailor-adaptation-programmes/?loclang=en_gb

Government of Pakistan (2016). Economic survey of Pakistan 2015-2016. Ministry of Finance as cited in Rehman, A., Jingdong, L., Chandio, A.A., Hussain, I., Wagan, S.A. and Memon, Q.U.A. (2016) 'Economic perspectives of cotton crop in Pakistan: A time series analysis (1970-2015) (Part 1)', *Journal of the Saudi Society of Agricultural Sciences*.

IPCC (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Field, C.B., Barros, V., Stocker, T.F., Dahe, Q., et al. (eds.). New York (USA) and Cambridge (UK): Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC) (2014). *Climate Change 2014: Synthesis Report.* Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland: IPCC.

Kimani, S.K., Esilaba, A.O., Njeru, P.N.M., Miriti, J.M., Lekasi, J.K. and Koala, S. (2014). 'Improving Livelihoods in Semi-arid Regions of Africa Through Reduced Vulnerability to Climate Variability and Promotion of Climate Resilience'. In: Leal Filho, W., Esilaba, A.O., Rao, K.P.C. and Sridhar, G. (eds.), *Adapting African agriculture to climate change,* Climate Change Management Series, pp. 25-33.

Livestock Value Chain in Karamoja: An Opportunity for Climate-Resilience Economic Development (2017). [Film]. Uganda. Arjun Kohli for the Overseas Development Institute, Kenya Markets Trust, and the Karamoja Development Forum. [online] https://vimeo.com/218421316.

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Desertification Synthesis.* World Resources Institute. Washington, DC. Available at: https://www.millenniumassessment.org/documents/document.355.aspx.pdf.

Lankoandé, G.D., Maradan, D., Sanon, K., Thiombiano, T., and Zein, K. (2011). 'Analyse Économique du secteur du coton – liens pauvreté et environnement'. Burkina Faso Ministère de l'Environnement et du Cadre de Vie: Ouagadougou. Available at: https://www.unpei.org/sites/default/files/dmdocuments/Burkina%20Faso%20-%20Evaluation%20Economique%20-%20Cotton%20study.pdf

Neely C., Bunning, S. and Wilkes, A. (eds.) (2009). *Review of evidence on drylands pastoral systems and climate change: implications and opportunities for mitigation and adaptation.* Land and Water Discussion Paper. Rome: Food and Agriculture Organization of the United Nations.

Sebego, M. (2010). *Les causes des contre-performances de la filière coton au Burkina Faso: Une analyse en modélisation VAR non contraint.* Document de travail. Ouagadougou. Ministère de l'Economie et des Finances du Burkina Faso (MEF-BF)/ Direction de la Prévision et des Analyses Macroéconomiques (DPAM).

Siddiqui, R., Samad, G., Nasir, M. and Jalil, H.H. (2012). 'The Impact of Climate Change on Major Agricultural Crops: Evidence from Punjab, Pakistan'. *The Pakistan Development Review,* Pakistan Institute of Development Economics, Vol. 51(4), pp. 261-276.

SWAC-OECD/ECOWAS (2008). *Livestock and regional market in the Sahel and West Africa: Potentials and challenges.* Paris: Sahel and West Africa Club/OECD.

Tanner, T. and Horn-Phathanothai, L. (2014). *Climate Change and Development.* Oxon: Routledge.

Third National Communication under UNFCCC (3NC). (2014). *State Hydrometeorology Agency of the Environmental Committee of the PRoT*. Dushanbe. Available at: http://unfccc.int/resource/docs/natc/tjknc3.pdf

Weingärtner, L., Simonet, C. and Caravani, A. (2017). *Disaster risk insurance and the triple dividend of resilience.* ODI Working Paper 515. London: Overseas Development Institute.

Research for climate–resilient futures

This work was carried out under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA), with financial support from the UK Government's Department for International Development (DfID) and the International Development Research Centre (IDRC), Canada. The views expressed in this work are those of the creators and do not necessarily represent those of DfID and IDRC or its Board of Governors.

www.prise.odi.org