WORLD BANK GROUP

STRENGTHENING FINANCIAL RESILIENCE TO DROUGHT:

A Feasibility Study

For An Index-Based Drought Risk Financing Solution For Pastoralists In Senegal

ILRI | INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Global Index Insurance Facility
MANAGED BY WORLD BANK GROUP

USAID FROM THE AMERICAN PEOPLE

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

Rights and Permissions

This report was edited by: Victor Mlambo

Cover design and layout: Cubedifference

Cover Photos Credits

Photo credit: EAP Photo Collection/ World Bank

Acknowledgement

The study has been funded by the Global Index Insurance Facility (GIIF) and by the Financial Resilience Program, supported by USAID.

The Financial Resilience Program (FRP) is a World Bank partnership with the United States Agency for International Development (USAID) to enhance the capacity of policy makers for improved financial resilience of vulnerable rural households and businesses to climate shocks and natural disasters. The FRP provides technical assistance to governments in the development and implementation of policy to help rural populations and businesses prepare for—and recover more quickly from—the impacts of climate shocks, disasters, and crises; and develops and shares knowledge to inform practitioners and policymakers globally.

The Global Index Insurance Facility is a dedicated World Bank Group program that facilitates access to finance for smallholder farmers, micro-entrepreneurs and micro-finance institutions through the provisions of catastrophic risk transfer solutions and index-based insurance in developing countries. Funded by the European Union, the governments of Germany, Japan and the Netherlands, GIIF has facilitated approximately 9.6 million contracts, covering close to 48 million people, primarily in sub-Saharan Africa, Asia and Latin America and the Caribbean. The program is part of the International Finance Corporation's Financial Institutions Group department.

The authors wish to thank all the government officials and representatives of the international development organizations, private sector companies, local associations and rural communities who agreed to be interviewed as key informants or stakeholders.

The authors also wish to thank peer reviewers: Diego Arias Carballo (Lead Agriculture Economist) Antoine Bavandi, (Senior Financial Sector Specialist) and James Muli Sinah, (ETC- Agrifinance and insurance Specialist) as well as Charles Stutley and Ramiro Iturrioz for their review and guidance throughout.

Table of Contents

Figures

Tables

List of Acronyms

ACF	Action Against Hunger
ADENA	Association pour le Développement de Namarel et Villages Environnants
ADID	Association pour le Développement Intégré de Dahra
AfDB	African Development Bank
AGRHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
ANACIM	Agence Nationale de l'Aviation Civile et de la Météorologie
ANSD	Agence Nationale de Statistique et de la Démographie
ARC	African Risk Capacity
ASAL	Arid and Semi-arid
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters
CEP-MEPA	Cellule des Études et de la Planification, Ministère de l'Élevage et des Productions Animales
CHIRPS	Climate Hazards Group Infra-red Precipitation with Station
CILSS	Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel
CIMA	Conférence Interafricaine des Marchés d'Assurances
CIRAD	French Agricultural Research Centre for International Development
CNAAS	Compagnie Nationale d'Assurance Agricole du Senegal
CNCAS	National Credit Agricole Fund of Senegal
CORAD	Rural and Agro-pastoral Cooperative for Development
CSA	Food Security Commission
CSE	Centre de Suivi Ecologique
CV	Contingent Valuation
DIRISHA	Drought Index Insurance for Resilience in the Sahel and Horn of Africa
DRDRs	Direction Régional du Développement Rural
DRFI	Drought risk Financing and Insurance
DFS	Digital Financial Services
EM-DAT	Emergency Events Database
EOS	End of Season
EWS	Early Warning Systems
GDP	Gross Domestic Product
GIE	Groupement d'intérêt Économique
GIIF	Global Index Insurance Facility
GOK	Government of Kenya

HOA	Horn of Africa
HSNP	Hunger Safety Net Programme
IBDRFI	Index-Based Drought Risk Financing and Insurance
IBLI	Index-Based Livestock Insurance
IFA	Insurance for Assets
IFC	International Finance Corporation
ILRI	International Livestock Research Institute
IG	Inclusive Guarantee
IGAD	Inter-governmental Authority on Development
IPAR	Initiative Prospective Agricole et Rurale
ITCZ	Inter-Tropical Convergence Zone
IU	Insured Unit
KLIP	Kenya Livestock Insurance Programme
LSO	Livestock Safeguard Operation
MAP	Mean and Annual Precipitation
MFIs	Micro-finance Institutions
MNO	Mobile Network Operators
MODIS	Moderate Resolution Imaging Spectroradiometer
NGDI	The Next Generation of Drought Index
NGS	Number of Growing Seasons
NDVI	Normalized Difference Vegetation Index
NGOs	Non-governmental organizations
NSPS	National Social Protection Strategy
NUSAFIII	Northern Ugandan Social Action Fund
OSB	Opération de Sauvegarde du Bétail
OXFAM	Oxford Committee for Famine Relief
PARM	Platform for Agricultural Risk Management
PPP	Public-Private Partnership
PPZS	Pôles Pastoralisme et Zones sèches
PRAPS	Regional Support Project for Pastoralism in the Sahel
PRNIA	National Food Insecurity Response Program
QUIIC	Quality Index Insurance Certification
R4	Rural Resilience Initiative
RBM	Réseau Belital Maroobé

RESOPP	Network of Farmers and Pastoralists of Senegal
RFE	Rainfall Estimate
RNU	National Unique Registry
SIIPE	Satellite Index Insurance for Pastoralists
SIPSA	Information System on Pastoralism in the Sahel
SMS	Short Messaging Service
SNCA	National Food Security Council
SPAI	Pastoral Warning and Information System
SOS	Start of Season
TLU	Tropical Livestock Unit
TWG	Technical Working Group
UAIs	Unit Areas of Insurance
UNCDF	United Nations Capital Development Fund
USAID	United States Agency for International Development
USD	United States Dollar
WBG	World Bank Group
WFP	World Food Programme
XOF	West African Communauté Financière Africaine Franc

Authors

Francesco Fava[1,2], Rupsha Banerjee[1], Njoki Kahiu[1,4], Mame Mor Anta Syll[1], Felix Lung[3], Nathan Jensen[1], Yihenew Zewdie[1], Tenin Fatimata Dicko[3] and John Plevin[3]

[1] International Livestock Research Institute (IRLI), Nairobi, Kenya

[2] University of Milan, Milan, Italy

[3] World Bank Group (WBG), Washington, USA

[4] Department of Plant and Environmental Sciences, New Mexico State University

Contacts:

1. Rupsha Banerjee (b.rupsha@cgiar.org)
2. Francesco Fava (francesco.fava@unimi.it)
3. John Plevin (jplevin@worldbank.org)
4. Tenin Fatimata Dicko (tdicko@worldbank.org)

Executive Summary

Why financial protection from drought shocks for pastoralists? The regional context

Livestock is fundamental to national economies and the welfare of households in Sahel countries. It is estimated that about 50 million people, the majority of whom are extremely poor, rely on pastoralism[1] for their livelihoods in the Sahel. Livestock is a key economic factor in west African countries, where it contributes 35, 39, 37 and 31% to the gross domestic product (GDP), in Burkina Faso, Mali, Niger and Senegal, respectively.

The Sahel is very prone to droughts and shifting climatic patterns. Drought costs in the Sahel region are extremely high, especially for pastoralists. Between 1970 and 1990, there was a prolonged period when rainfall was well below average resulting in a series of major droughts, famines and huge livestock losses due to insufficient drinking water, diseases and starvation, caused by lack of forage and grazing resources. Post 1990, average rainfall increased but the area is still affected by periodic drought shocks and climatic extremes. This has contributed to the huge cost burden arising from (a) economic losses of livestock and livestock-based products, (b) loss of livelihoods for pastoralists whose animals die and (c) costs of humanitarian assistance.

In Senegal, the livestock sector contributes more than one third to agricultural GDP and most rural households are engaged in livestock rearing. Based on the national statistical agency's most recent data, the livestock sector contributed 38 and 3.6% to agricultural and national GDP, respectively, in 2018. The 5% average annual growth of the sector between 2016-18 has been roughly in line with the national GDP growth.

Drought is the main climate risk faced by Senegal in terms of numbers of affected people. The 2019 drought affected about 1 million people. Model estimates indicate that Senegal would need $26 million USD on average per year and a maximum of $140 million USD to respond to drought. In terms of livestock losses, estimated costs during drought events occurred in the 1970s-80s are in the range $14-32 million USD per year.

Index-based drought financing for pastoralists – how it works

Drought risk financing and insurance solutions have emerged as powerful tools to protect vulnerable communities against drought impacts. The key idea is to link prearranged financing solutions to credible response plans. This can make funding available faster after disasters, strengthen predictability and improve cost effectiveness. Among the various solutions available, index-based drought risk financing and insurance (IBDRFI) approaches are particularly suitable for smallholder farming and extensive pastoral systems. These instruments trigger payouts/financial responses based on an 'objective' index approximating the impact/loss. The majority of IBDRFI instruments targeting extensive rangelands currently operational in Africa are based on drought indices derived from satellite normalized difference vegetation indices (NDVI) data. Among these, the index-based livestock insurance (IBLI) products have been specifically designed to protect pastoralists in the face of drought.

Recent developments in earth observation (EO) missions, technologies and analytics are opening new opportunities for designing innovative indices for IBDRFI initiatives suitable for rangeland and extensive pastoral systems. Initiatives such as the World Bank Next Generation Drought Index (NGDI) aim to expand the range of options for designing IBDRFI solutions by developing a practical framework for a set of indices or indicators that will better monitor, anticipate and trigger financial responses to severe drought events.

1. Throughout this report, the definition of 'pastoralists' includes all the herders that (i) mainly depend on livestock (i.e. ruminants) for their livelihood, (ii) rely primarily on rangeland resources for feeding their livestock and (iii) use some degree of mobility as herd management practice. As such, our definition includes nomadic, semi-nomadic and semi-sedentary pastoral communities, including those that practice some cropping activities (i.e. agro-pastoralists)

The IBDRFI initiatives specifically designed to protect pastoralists in the face of drought shocks have so far been implemented in Africa with different modalities, including as retail micro-insurance products, macro-level insurance schemes for social livelihoods protection, or scalability mechanisms of social safety net programs. All these initiatives rely on similar EO technologies and indices (i.e. based on NDVI data) and are generally designed with anticipatory response principles, e.g. early drought detection for early action and impact mitigation. Micro-level retail IBLI schemes have been implemented in northern Kenya and southern Ethiopia, with private insurance companies involved in marketing, promoting and underwriting the scheme on a voluntary basis with individual pastoralists. Macro-level social livelihood protection insurance schemes are currently operational at a national level in eastern Ethiopia, Zambia and Kenya (through the Kenyan Livestock Insurance Program, KLIP). Scalability mechanisms of safety net programs have also been implemented in Kenya and Uganda, under the Hunger Safety Net Program (HSNP) and the Third Northern Ugandan Social Action Fund (NUSAF III), respectively. These social protection schemes can complement sovereign level products such as the ones being implemented by the African Risk Capacity (ARC).

Objective of the feasibility assessment

The feasibility study conducted by the International Livestock Research Institute (ILRI) and the World Bank aims to inform development and implementation policies to increase pastoralists' resilience in Senegal and the Sahel against severe drought shocks. It provides the background knowledge required to make informed decisions on whether investing resources in the design and implementation of an IBDRFI program can achieve the desired public policy objectives.

The feasibility assessment considers socio-economic (potential demand and value), technical (i.e. product design) and operational (supply chain) factors that are important for the design and implementation of IBDRFI solutions in Senegal.

The socio-economic feasibility analysis assesses the presence of necessary preconditions to justify the launch of an IBDRFI scheme (i.e. vulnerability of livestock to drought) and expected demand for the IBDRFI solutions from local institutions and pastoral and agro-pastoral households. It examines the relevance of the livestock sector, impact of drought on the national economy and pastoralists' socio-economic environment.

The technical feasibility analysis assesses whether key conditions for the technical design of an accurate index and trigger mechanism for drought impacts on pastoral areas are met. The feasibility factors considered include coverage of rangeland, rangeland vegetation cover/density and seasonality, which are critical, not only for the design of NDVI-based indices, but also for alternative EO drought indices. When conditions are not fully met, the assessment provides indications of the type of work required to design appropriate technical solutions to refine the product design for the specific context.

The operational feasibility analysis evaluates the conditions required for supplying IBDRFI solutions and supporting the development of an enabling environment (institutional, regulatory and social) for its large-scale and sustainable provision. Thus, it seeks to assess the existing financial and insurance infrastructure and services, policy and regulatory environment, potential distribution channels and the existing private and public stakeholders (insurers and financial service providers, pastoral associations, intermediaries and non-governmental organizations (NGOs) etc.) and their capacity in the financial sector.

A scenario analysis finally determines historical payouts and hypothetical costings of proposed IBDRFI structures. This analysis is purely illustrative and aims to show simple examples of how the technical product customization and the choices made on different programmatic options have fundamental cost-benefit implications. However, it should be noted that the proposed scenarios are not meant to be recommendations for a specific option nor to cover an exhaustive range of IBDRFI solutions. Thus, detailed analyses of alternative programmatic options and product design customizations need to be planned with local stakeholders at the early implementation stages for future initiatives.

The feasibility study is largely built on technical solutions, experiences and programmatic options implemented in east African countries, which were used as benchmarks for the assessment. As such, the IBLI product design[2] was used for the technical assessments, while IBDRFI programmatic options are based on the main ones tested thus far. Therefore, micro-level retail and macro-level social livelihood protection schemes that provide direct payouts/cash transfers to policyholders or beneficiaries were presented in the scenarios.

2. Henceforth, for simplicity IBLI is used as a generic term to indicate drought index-insurance products based on NDVI satellite imagery designed specifically for pastoralists. Across different programs, the product design often changes, although the underlying technical design principles are largely similar.

However, the feasibility conditions should be considered as widely applicable to alternative IBDRFI options that can and should be evaluated and tailored to the specific context based on the country policy priorities in drought risk management and social protection. During the program design phase, alternative drought index product design approaches might be considered, given that the Sahel pastoral regions have significant ecological and socio-economic differences to those prevailing in east Africa. More importantly, while alternative programmatic options, such as meso or sovereign level insurance are not discussed in detail in this report because of the lack of direct implementation experiences in pastoral areas, these models might need to be considered depending on the country's policy priorities and the local context.

Key findings of the feasibility assessment

Overall, the feasibility assessment, based on socio-economic, technical and operational conditions, indicates that Senegal's readiness for the implementation of an IBDRFI initiative targeting pastoralists is very high.

Table E.1 illustrates the key findings of this study with respect to the feasibility criteria considered.

The socio-economic assessment (Table E1, green) emphasizes the important role of the livestock sector to Senegal and the vulnerability of pastoralists to drought, particularly in the northern part of the country. It also indicates that there is potential demand for the product from pastoral communities. However, other relevant risks for the livestock sector (e.g. diseases, cattle rustling and bushfires) that largely affect agro-pastoralists need to be considered as part of a comprehensive social protection and disaster risk management strategy.

The technical assessment (Table E1, yellow) classifies 33% of the Senegalese land area as feasible (green) or feasible but needing review (orange) for the implementation of IBDRFI products for pastoralists (Figure E1). This could cover about 26% of the national livestock herd. These areas cover a vast portion of the Saint Louis, Louga and Matam regions. The areas needing further review are considered feasible from a technical point of view, but have more fragmented rangeland cover due to a higher proportion of crops or woody cover and ongoing land use changes. For this reason, it would be important for local stakeholders and experts to confirm the relevance of these areas for extensive livestock herding and to provide a more detailed assessment of the drought index performance.

The operational assessment (Table E1, grey) shows that:

- **Senegal has a conducive environment for implementing IBDRFI solutions based on legal and regulatory frameworks, public and private sector capacity, interest and experience.** The government of Senegal and Compagnie Nationale d'Assurance Agricole du Sénégal (CNAAS) have already had significant discussions on potential IBDRFI options targeting pastoralists including a public-private partnership (PPP) approach, demonstrating interest and willingness to support. The country also has strong capacity in the management and provision of remote sensing datasets and agro-meteorological services, e.g. Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM) and Centre de Suivi Ecologique (CSE) etc. Furthermore, the government of Senegal has been a participant in the drought risk pool of the ARC since 2014, which might offer the opportunity to develop a harmonized drought risk management framework in the country.
- **The capacity to deliver digital financial services (DFS) is still weak in the pastoral regions and this could become a barrier to effective implementation.** However, the good mobile money infrastructure and dynamism of the private sector actors and development organizations toward expanding their DFS portfolio and offering index-insurance brokerage services (e.g. Planet Guarantee and IBISA), offers the opportunity to overcome such barriers.
- **There is a dense network of pastoral and breeding associations in the pastoral regions that could play an important role in product distribution, awareness creation and bundled DFS offering.**

Table E.1. indicates that there are no critical areas that would require significant investments for IBDRFI implementation (red dots). Any new IBDRFI initiative in Senegal would require, however, to address the areas identified as medium readiness (yellow dots) including:

- better understand the risks faced by pastoralists and how they can be exacerbated by drought;
- carefully design awareness creation to stimulate informed demand and market development;
- better characterize rangeland composition and use in central and southern Senegal to potentially customize the product design and increase the area suitable for IBDRFI technical implementation;
- promote the development of more effective distribution channels using existing DFS infrastructures and pastoral associations' networks.

The scenario analysis carried out under the study provides illustrative costing scenarios for two alternative 5-year IBDRFI programmatic options aimed at providing a safety net to vulnerable pastoralists in the face of drought. Both scenarios are designed on the experiences of Kenya and Ethiopia, where ongoing initiatives have demonstrated positive impacts on pastoralists' welfare and income, private sector development and government budgets and contingent liability.

- **the global cost of supporting a microlevel retail scheme with 50% subsidies targeting to insure 25,000 pastoralists (from year 5) is estimated to be $5.6m, including $4.9 million subsidies and $0.75 million for program support activities.** This option should stimulate both demand for the insurance product while simultaneously increasing the incentives for insurance providers to invest in marketing and support chains, leading to broader access and longer-term sustainability. At the same time, this option can fail to meet its objectives if the private sector does not invest in the product delivery or on the complementary activities such as marketing and awareness creation, which are critical to creating a sustainable market and meeting the target coverage.
- **the global cost of a social protection program that provides insurance for 5 cattle equivalent for 50,000 pastoralists (from year 5) is estimated to be $19.3 million, including $16.8 million premium subsidies and $1.75 million for program support activities.** This option assures meeting target coverage levels but may not stimulate private investment in product marketing or awareness creation; it may not necessarily create access to insurance for those that do not receive the insurance transfer. The long-term fiscal sustainability poses a second important risk, as this scheme requires considerable medium-term budget allocation commitments by the government.

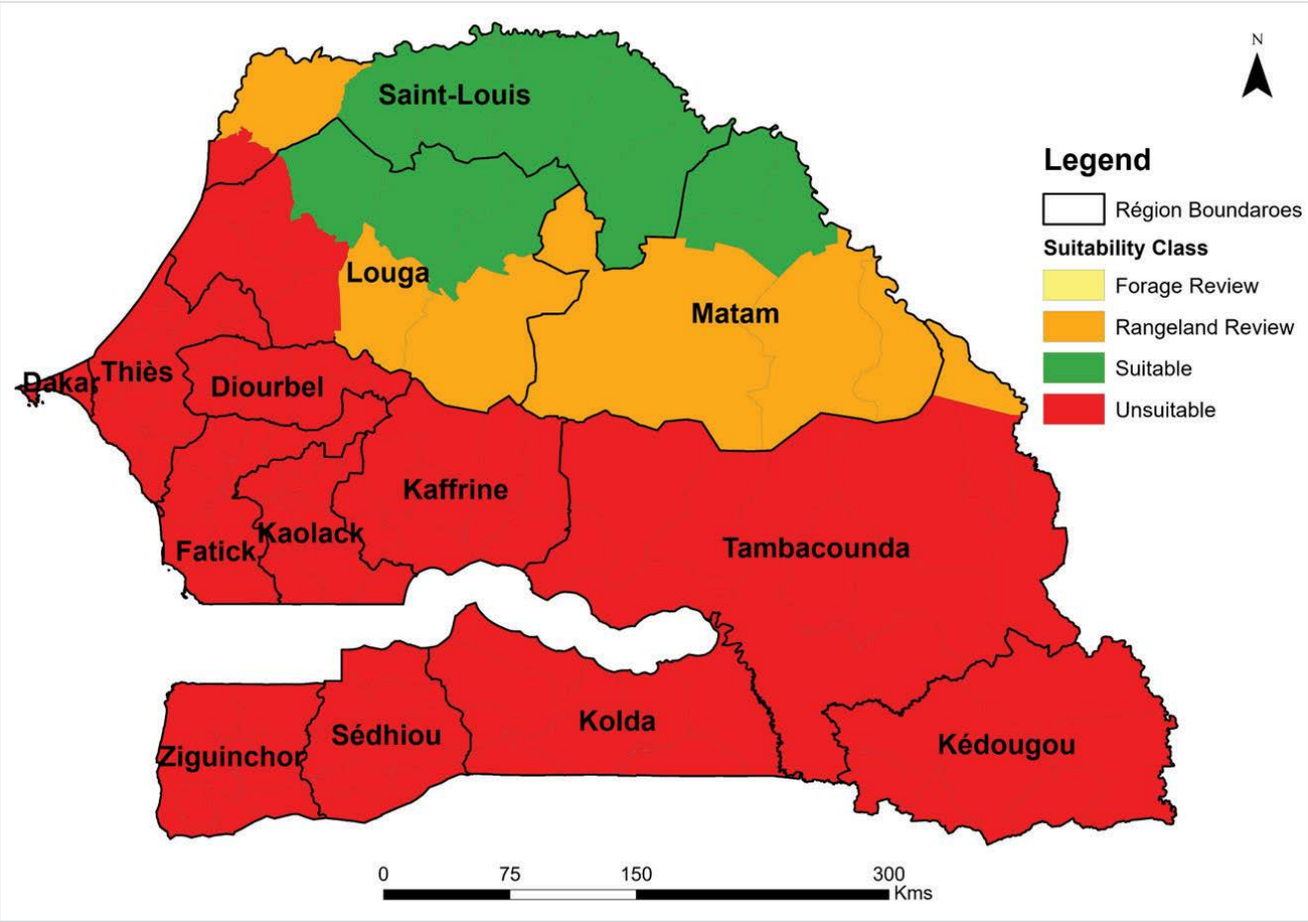
TABLE E.1 FEASIBILITY ASSESSMENT OF THE COUNTRY'S READINESS FOR IBDRFI PRODUCTS TARGETING PASTORALIST

			Justification
Socio-economic Feasibility	Importance of pastoral livestock to the local economy		The livestock sector represents 38 and 3.6% of the agricultural and national GDP, respectively. Pastoralism is the main Source of livelihood in the country's northern and north-eastern regions. The national livestock herd is 18.4 million, excluding poultry.
	Impact of drought on the livestock sector		Even though there are no detailed records on the cost of recent droughts (to the authors' best knowledge), estimates from models indicate that Senegal would need 26 million United States Dollars (USD) on average per year and a maximum of USD 140 million to respond to drought. Drought is the main risk faced by the country due to the large number of affected people. The 2019 drought affected about 1 million people. Estimates of livestock losses during drought events that occurred in the 1970s and 1980s are USD 14-32 million per year.
	Vulnerability of pastoralists to drought		Pastoralists are vulnerable to drought and indicated it as one of the main risks they face. However, evidence suggests that other issues, such as livestock rustling, disease and bush fires are also relevant. In terms of poverty, pastoralists are generally better off than agro-pastoralists, supporting the importance of considering complementary IBDRFI approaches that could cover the latter, especially for social protection purposes.
	Pastoralist demand for livestock insurance		Existing studies suggest that there is demand for index-insurance products (IBLI) from livestock keepers in northern Senegal. A qualitative study suggests, however, that the willingness to pay might be moderately low compared to the expected premium costs in a commercial program
	Pastoralist financial literacy		Pastoralist communities have been exposed to insurance and have some understanding of the concept. However, agricultural and index-insurance are largely unknown in the pastoral areas and their introduction would require investments in awareness creation.

			Justification
Technical Feasibility	Rangeland dominance	🟠	The cover of extensive rangeland areas used for livestock herding is dominant only in the northern parts of the country. Towards the south, the landscape is more fragmented by increased crop and woody plant cover, making the IBLI product design less optimal because the NDVI signal might be strongly affected by vegetation that is not used for grazing.
	Seasonality and signal intensity	🟢	The rangeland seasonality is well-defined and relatively homogenous across the country. In the northern region, the typical rangeland growing season lasts from July to November. The NDVI signal is also sufficiently strong to assess the inter-annual variability. These factors do not limit the feasibility of IBLI product design in the country.
	Overall feasibility of product design	🟢	The product design can be considered 'fully feasible' for 14.6% of Senegal's total land area and 'feasible but needing review' for another 18.3%. This covers the northern pastoral regions of Senegal. Overall, close to 30% of the national livestock herd falls in the areas suitable for implementation. Further analyses should be considered to evaluate the possibility of tailoring the product design such that a broader extent of the agro-pastoral areas could be also covered.
Operational Feasibility	Technical capacity on index calculation and quality assessment	🟢	Senegal hosts multiple institutions with experience in handling remote sensing data for rangeland monitoring (e.g. CSE) and supporting index-insurance initiatives, e.g. ANACIM. The availability of a network of biomass monitoring sites with historical records is a strong asset for product design.
	Legal and regulatory insurance environment	🟢	Senegal is part of Conférence Interafricaine des Marchés d'Assurances (CIMA), which already has regulations in place for index-insurance. Demand for Sharia compliance has not been reported
	Insurance market development	🟠	The insurance market development is relatively good in the agricultural sector, thanks to the activity of CNAAS and the growing role of brokers such as Inclusive Guarantee. Senegal is also part of the ARC drought risk pool.
	Interest from insurers in IBDRFI	🟢	CNAAS and other private sector actors are already exploring the possibility of launching IBDRFI products for livestock and demonstrated a keen interest in the current initiative.
	Effective distribution channels	🟠	Insurers' presence in pastoral areas is limited or absent and existing agricultural insurance initiatives do not yet utilize digital technologies. However, the growing digital financial services network and dense network of breeders and pastoralist associations in the pastoral regions offer opportunities to support cost-effective distribution channels if targeted investments are made.
	Existing pastoralist beneficiary registries	🟠	Senegal has a social registry, which already includes around 590,000 households (including 65% of all poor households). Even though its coverage in pastoral regions is unclear, it is expanding and aiming to cover all poor households in the country eventually.
	Finance available for premiums	🟠	CNAAS, a national company, already offers government funded 50% subsidies for agricultural insurance products. So far, there is no clear indication of government's willingness to finance large initiatives on livestock insurance under this IBDRFI feasibility study.
	Interest from government	🟢	The government has shown interest in IBDRFI initiatives targeting extensive pastoral systems and already has multiple initiatives for financing responses to shocks, including in the livestock sector.

🔴 = low; 🟠 = medium; 🟢 = high.

FIGURE E.1 TECHNICAL FEASIBILITY OF IBDRFI PRODUCTS IN SENEGAL



Source: Authors' own illustration.

Recommendations

Considering the limited scope of a feasibility study, the next steps toward implementing an IBDRFI initiative in Senegal would require in-depth engagement with country stakeholders and the planning of analytical studies to address knowledge gaps identified in this assessment. The details are provided in Chapter 6 of the main report.

Photo credit: EAP Photo Collection/ World Bank

Next Steps

Stakeholders' engagement and policy support

R1: Keep the momentum on the ongoing discussions with the government. The ongoing discussion on the IBDRFI initiatives for pastoralists should be moved forward to the implementation design stage, following similar examples of crop insurance already launched in the country (Figure E.2). As part of these efforts, it is important to set up policy dialogue to define the broad objectives that the government wants to achieve with IBDRFI initiatives (e.g. protect poorest or protect better-off pastoralists with more livestock assets or both) and to consider alternative IBDRFI design and programmatic implementation options at micro and/or meso and macro levels.

R2: Identifying the scope of initiatives to implement as part of the IBDRFI solutions. The policy dialogue should discuss the scope for initiatives on social livelihood protection in pastoral areas, such as a shock responsive safety net, as part of a broader country drought risk financing strategy. Should the government of Senegal and CNAAS decide to proceed to implementation, it is recommended that a board and technical working group (TWG) for the design phase of the initiative be established. The TWG should ideally include representatives of the relevant ministries, national/regional agro-meteorological institutions, NGOs and development organizations active in the pastoral regions, pastoral associations and private sector actors with interest and/or experience in IBDRFI. The terms of reference for the TWG should be designed to support decision-making by providing technical backstop mechanisms during the program design stage, scheme implementation structures, product design customization, quality assurance, monitoring and evaluation frameworks, awareness creation efforts and evaluation of suitability for specific target areas.

Follow up actions on some of the priority areas identified:

R3: Cost–benefit analysis

A cost-benefit analysis should be conducted to evaluate alternative programmatic IBDRFI options at micro, meso and macro levels. This should include the level of government financial support (e.g. in the form of premium financing and/or subsidies on the startup and implementation costs) especially program subsidies, based on clear indications of priorities from the TWG or interested parties.

R4: Distribution channels

Targeted investments on DFS infrastructure and service provision should be planned for establishing efficient and robust registration, delivery and distribution mechanisms. This study indicates that both the DFS service network and presence of insurance service providers still seem weak in the pastoral regions. There is significant potential to leverage ongoing initiatives such as the household registry platform by the World Food Programme (WFP), which is now targeting inclusion of all poor households and could be a key instrument for beneficiaries' registration in IBDRFI initiatives.

R5: Product design

- **A systematic review of ongoing pastoral development interventions in northern Senegal should be conducted to explore synergies and opportunities for bundling services.** Several stakeholders have indicated the importance of connecting IBDRFI payouts with other interventions aimed at supporting improved livestock production. These include market linkages and value-chain development, feed and fodder development, forage conservation and water management, animal health, as well as access to finance and credit.
- **Considering that so far, no IBDRFI products and programs for pastoralists in the Sahel have been implemented, it would be important to conduct technical studies to explore alternative drought index design options.** This should be followed up by multi-stakeholder review exercises to tailor and customize the index product to the local context. The product design study should be informed by initiatives such as NDGI, Quality Index Insurance Certification (QUIIC) and operational rangeland monitoring systems in the country/region (e.g. CSE and Centre Régionale de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle (AGRHYMET) systems). Similarly, existing regional surveillance systems, such as the one developed by Action Contre la Faim (ACF) in collaboration with CSE, might be considered as a platform for IBDRFI-related data services.

Next Steps

R6: Capacity development and learning

- **A capacity building and awareness creation strategy targeting institutional and private sector actors and pastoral communities should be planned from the early stages of implementation.** All stakeholders indicated that financial literacy is limited in pastoral areas and the knowledge around agricultural insurance mechanisms is minimal. Increasing financial literacy and the understanding of index insurance products among pastoralists would be a critical step in the early implementation of any IBDRFI initiative.
- **A monitoring and evaluation strategy should also be designed as part of a broader learning framework to ensure that appropriate mechanisms for quality assurance and impact evaluation are in place.** Senegal is at the forefront of research and development innovation in the western African context, with strong local capacity and an active presence of international organizations with experience in IBDRFI and pastoral development. This creates the opportunity to create a laboratory for learning and impact evaluation that could become a model for the region.

FIGURE E.2 PHASES IBDRFI SOLUTION IMPLEMENTATION[3]

-	CONCEPT
3-6M	FEASIBILITY ANALYSIS (NATIONAL LEVEL)
6M-1Y	IMPLEMENTATION DESIGN AND LAUNCH (SUB-NATIONAL LEVEL)
3-5Y	IMPLEMENTATION (PROOF OF CONCEPT AND CONSOLIDATION)
-	SUPPORT ACTIONS FOR GEOGRAPHIC SCALING/LONG TERM SUSTAINABILITY

The suggested timing (m = months and y = year) is purely indicative.

3. Shaded boxes indicate the stages already implemented in Senegal.

Photo credit: EAP Photo Collection/ World Bank

Glossary of IBDRFI Terminology

Agricultural Insurance	Insurance applied to agricultural enterprises. Types of business include forestry, crop, livestock and aquaculture insurance, but normally excludes building and equipment insurance, although these may be insured by the same insurer under a different policy.
Basis Risk	Basis risk is the difference between an index and the shock that the index is supposed to be a proxy for. A payout triggered by an index may be higher or lower than the beneficiary's losses, leading to overpayment or shortfalls, respectively.
Ex Ante Risk Mechanism	Action taken prior to a potential risk event. Advance preparations for disasters help avoid inefficient response coping decisions. If ex ante strategies are not in place, short-term coping strategies will be utilized that have no significant long-term benefits.
Ex Post Risk Mechanism	Risk management strategies developed in reaction to an event without prior planning. While ex post strategies have a role to play, risk management mechanisms can be more effective when introduced ex ante.
Exposure	The cover amount or sum insured for peril(s) at any one time. In crop insurance, exposure may fluctuate during the coverage period, in line with crop growth stages from planting to harvest completion.
Hazard	A physical or moral feature that increases the potential for a loss arising from an insured peril or that may influence the degree of damage.
Indemnity	The amount payable by the insurer to the insured, either in the form of cash, repair, replacement or reinstatement in the event of an insured loss. This amount is measured by the extent of the insured's pecuniary loss. It is set at a Figure equal to but not exceeding the actual value of the subject matter insured just before the loss, subject to the adequacy of the sum insured. For many crops, an escalating indemnity level is established, as the growing season progresses in line with crop growth stages.
Index-Based Livestock Insurance	Satellite index insurance for livestock holders. Index-based livestock insurance originated from Mongolia in 2006 with the launch of a micro-level livestock mortality index insurance cover based on a county-level livestock mortality index. In 2010, IBLI was launched in Kenya as a micro-level predicted drought-related livestock mortality index, combining satellite imagery (based on the NDVI) and county-level livestock mortality data. Subsequent micro-level and modified macro-level IBLI programs in Kenya and Ethiopia have used satellite NDVI as a proxy for forage availability in pastoral regions.
Index Insurance	Insurance that does not make indemnity payments based on an assessment of the policyholder's individual loss, but rather on measures of an index that is a proxy of actual losses. Two types of agricultural index insurance products are those based on area yields, where the area is some unit of geographical aggregation larger than the farm and those based on measurable weather events.
Insurance	A financial mechanism that aims to reduce the uncertainty of loss by pooling many uncertainties so that the burden of loss is distributed. Generally, each policyholder pays a contribution to a fund in the form of a premium, commensurate with the risk they introduce. The insurer uses these funds to pay the losses (indemnities) suffered by any of the insured.
Insurance Agent	The person who solicits, negotiates or implements insurance contracts on behalf of the insurer.
Insurance Broker	The person who represents the insured in finding an insurer or insurers for a risk and negotiates the terms of the insurance contract. A broker may also act as an agent (i.e. for the insurer) for the purposes of delivering a policy to the insured and collecting premiums from the insured.
Insurance Policy	A formal document including all clauses, riders and endorsements, which express the terms, exceptions and conditions of the contract of insurance between the insurer and the insured. It is not the contract itself but evidence of the contract.
Insured Peril	The cause of loss stated in the policy, which on its occurrence entitles the insured to make a claim.
Loss Adjustment	Determination of the extent of damage resulting from occurrence of an insured peril and settlement of the claim. Loss adjustment is carried out by the appointed loss adjuster who works on behalf of the insurer.
Loss Ratio	The proportion of claims paid (or payable) to premiums earned. A loss ratio is usually calculated for each class of business in which an insurer participates. Analysis of loss ratios can be useful in assessing risks and designing appropriate insurance structures.
Macro-Level	The economic level at which countries and large donor agencies working with these countries experience risk of weather-induced humanitarian crises or economic instability caused by price volatility.
Meso-Level	The economic level at which banks, micro-finance institutions, producers, traders, processors and input providers experience risk due to the vagaries of weather and price.
Micro-Level	The economic level at which individual farm households experience risks due to shocks such as adverse weather events, price fluctuations or disease.

Premium	The monetary sum payable by the insured to the insurers for the period (or term) of insurance granted by the policy. The premium is calculated as the product of the premium rate and amount of insurance. It is also the cost of an option contract, paid by the buyer to the seller.
Premium Rate	The price per unit of insurance. Normally expressed as a per cent of the sum insured.
Reinsurance	When the total exposure of a risk or group of risks presents the potential for losses beyond the limit which is prudent for an insurance company to carry, the insurance company may purchase reinsurance i.e. insurance of the insurance. Reinsurance has many advantages including (i) balancing the financial results of the insurance company over a period, (ii) limiting the exposure of individual risks and restricting losses paid out by the insurance company and (iii) increasing an insurance company's solvency margin (per cent of capital and reserves to net premium income), hence the company's financial strength. The reinsurer benefits from profits of the insurance company, but also contributes to cover losses, the net result being a more sTable loss ratio over the insurance period.
Risk Aggregation	The process of creating a risk-sharing arrangement, which pools risks, thereby reducing transaction costs and giving small households or other participants a stronger bargaining position.
Risk Management	Care to maintain income and avoid/reduce loss or damage to a property resulting from undesirable events. Risk management involves identifying, analyzing, quantifying risks and taking appropriate measures to prevent or minimize losses. Risk management may involve physical mechanisms such as vaccinating animals or improving the management of grazing lands. It can also involve financial mechanisms, e.g. hedging, insurance and self-insurance (carrying sufficient financial reserves so that a loss can be sustained without endangering the immediate viability of the enterprise).
Risk Mitigation	Actions taken to reduce the probability or impact of a risk event or to reduce exposure to them.
Risk Retention	Risk retention is the process whereby a party retains the financial responsibility for loss in the event of a shock.
Risk Transfer	Risk transfer is the process of shifting the burden of financial loss or responsibility for risk-financing to another party through insurance, reinsurance, legislation or other means.
Risk Coping	Strategies employed to cope with a shock after its occurrence. Some examples of risk-coping strategies include the sale of assets, seeking additional Sources of employment and social assistance.
Risk Financing	The process of managing risk and the consequences of residual risk through products such as insurance contracts, catastrophe bonds, reinsurance or options.
Risk Layering	The process of separating risk into tiers that allow for more efficient financing and management of risks. High probability low-consequence events may be retained by households to a certain extent. The market insurance layer is characterized by the ability of the market to manage risks through insurance or other contracts. Low-probability high-consequence events characterize the market failure layer and at this layer of risk, government intervention may be necessary to offset the high losses.
Risk Pooling	The aggregation of individual risks for the purpose of managing the consequences of independent risks. Risk pooling is based on the law of large numbers. In insurance terms, the law of large numbers demonstrates that pooling large numbers of roughly homogenous, independent exposure units can yield a mean average consistent with actual outcomes. Thus, pooling risks allows an accurate prediction of future losses and helps determine premium rates.
Scalable Safety Net	A social protection program that can increase its caseload and/or its intensity of support in response to catastrophic events.
Shock	An unexpected traumatic event such as death in the family or loss of land and livestock, which can be caused by catastrophic weather events or another unexpected phenomenon. Price shocks occur when the price of commodities changes dramatically due to changes in local or global supply and demand, affecting the livelihoods of households dependent on this commodity either for income or caloric intake. Economic shocks can occur at the micro, meso and macro levels and can have long-term consequences for the economic well-being of actors at each level.
Social Safety Net	Various services usually provided by the government that are designed to prevent individuals or households from falling below a certain level of poverty. Such services include free or subsidized health care, childcare, housing and welfare etc.
Subsidy	A direct or indirect benefit granted by a government for the production or distribution (including export) of a good or to supplement other services. Generally, subsidies are thought to be production and trade distorting and cause rent-seeking behaviour, resulting in inefficient use of resources.
Underwrite	To select or rate risks for insurance purposes.

1. Introduction

1.1 Background

This report was prepared for the project entitled 'Feasibility analysis for a pre-arranged drought risk financing and insurance (DRFI) solution for livestock in the Sahel', conducted by ILRI and the WBG. The aim of the project was to assess the feasibility of implementing financial protection solutions against drought in the pastoral regions of four Sahelian countries (Burkina Faso, Niger, Mali and Senegal) and to discuss the most effective implementation modalities (as part of wider drought risk management and pastoral development initiatives) with local stakeholders (public and private sector).

Among the various DRFI solutions, index-based approaches are particularly suitable for smallholder farming and extensive pastoral systems. Index-based drought risk financing (IBDRFI) instruments trigger payouts/financial response based on an 'objective' index approximating the impact/loss. Indices can be based on ground measurement networks (e.g. meteorological and crop yield data) or by EO satellite data (e.g. rainfall estimates, vegetation indices and soil moisture).

The study was conducted against the background of ongoing discussions to scale-up regional or national-level IBDRFI initiatives in the Sahel and Horn of Africa (HOA) as part of a comprehensive agenda to increase the resilience to climatic shocks of pastoralists (see Footnote 1). For the last decade, IBDRFI solutions for pastoralists have been implemented and scaled up in east Africa (Kenya and Ethiopia) using different modalities, including micro-insurance, macro-level social livelihood protection, scalable safety nets and sovereign-level insurance programs. The positive impacts and overall success of these initiatives have attracted growing demand and interest from African governments and development organizations keen to explore the possibility of introducing similar approaches across other pastoral regions on the continent. In addition to the countries targeted by this project, feasibility and pilot studies have been conducted or are ongoing in Djibouti, Somalia, Sudan, Uganda, South Africa and Zambia.

This report presents the main findings and recommendations of the feasibility of implementing an IBDRFI solution for pastoralists in Senegal. This study was conducted from March 2020 to February 2021 by a joint team of ILRI and WBG experts, by combining literature review, in-country data collection, key informant interviews with local public and private sector stakeholders and dedicated technical analysis using satellite imagery and risk modelling approaches.

The objective of the feasibility assessment in Senegal is to inform the government of Senegal, private sector stakeholders and development institutions about the potential of launching IBDRFI initiatives in the country as a contribution towards sustainable solutions that cushion pastoral households against the impacts of severe drought shocks. The study also provides the background knowledge required to make informed decisions on whether investing resources in the design and implementation of an IBDRFI program can achieve the desired public policy objectives.

The feasibility study investigated the context, needs, challenges and potential solutions for implementing IBDRFI initiatives targeting pastoralists in Senegal. Therefore, the following three main areas were analyzed:

1. **The socio-economic context and potential demand for IBDRFI products (socio-economic feasibility, Chapter 2).** From a national perspective, extensive livestock production systems are an important component of the rural economy, making IBDRFI solutions for pastoralists a worthwhile investment. From a development and demand perspective, livestock assets are important to rural households' livelihoods and welfare, such that their protection is critical for resilience building. These conditions are also important in understanding the type of IBDRFI solutions that would be more relevant (i.e. commercial micro-insurance, social livelihood protection coverage and social safety nets etc.).
2. **The technical design of a satellite-based drought index for extensive rangeland systems (technical feasibility, Chapter 3).** A simple, robust, low-cost index design resulting in an accurate IBDRFI product is a critical pre-condition for implementation. Satellite-based indices have been proven to be reliable indicators of the impact of droughts on forage resources. The assessment therefore evaluates the geographic extent of the area where the technical design of an accurate satellite IBDRFI index would be possible. The feasibility factors considered include rangeland coverage, rangeland vegetation cover/density and seasonality, which are critical for the design of EO drought indices.

3. **The operational conditions for an IBDRFI scheme (operational feasibility, Chapter 4).** Designing and implementing an efficient supply chain for IBDRFI solutions in extensive pastoral areas is challenging and often requires substantial initial investments. The assessment of existing infrastructure and networks for financial services delivery, institutional and private sector capacity and interest, existing legal and regulatory frameworks and technical and financial constraints is therefore essential to determine the level of investment required to launch the initiative.

In addition, this study provides a simple scenario analysis to illustrate the historical payouts and hypothetical costings of typical IBDRFI structures (scenario analysis, Chapter 5). This analysis aims to provide the Senegalese government, private sector and development institutions with an overview of the costs and benefits of the proposed insurance scheme based on multiple scenarios. This is done for illustrative purposes only, with the aim of demonstrating how the technical product customization and different programmatic options have fundamental cost/benefit implications. As such, it should be noted that the proposed scenarios are not meant to be recommendations for specific options, nor do they represent an exhaustive range of IBDRFI solutions. Thus, a detailed analysis of alternative programmatic options and product design customization needs to be planned with local stakeholders at the early stages of implementation for future initiatives.

Findings from the different components of the study are summarized (Section 6) in a set of recommendations for the next stage of implementation. It should be noted that the scope of this assessment is limited to the determination of whether important requirements for the development and introduction of an IBDRFI initiative for pastoralists are met and to further provide recommendations for the subsequent planning and preparatory stages of implementation.

The feasibility study is largely built on technical solutions, experiences and programmatic options implemented in east African countries, which were used as benchmarks for the assessment. As such, the IBLI product design[4] was used for the technical assessments, while IBDRFI programmatic options were based on the main ones tested thus far. Therefore, micro-level retail and macro-level social livelihoods protection schemes that provide direct payouts/cash transfers to policyholders or beneficiaries are presented in the scenarios.

However, the feasibility conditions should be considered as widely applicable to alternative IBDRFI options that can and should be evaluated and tailored for each specific context according to the country's policy priorities in drought risk management and social protection. During the program design phase, alternative drought index design approaches might need to be considered, given that the Sahel pastoral regions present significant ecological and socio-economic differences to those prevailing in east Africa. While alternative programmatic options, such as meso or sovereign-level insurance are not discussed in detail in this report because of the lack of direct implementation experiences in pastoral areas, these models might need to be considered.

1.2 Index-based drought risk financing solutions for pastoralists

Drought risk financing and insurance refers to mechanisms that aim to reduce adverse socio-economic or ecological impacts of potential crises. This can include early financing to prevent and reduce the risk profile or preparing for and responding to a shock. Drought risk financing and insurance is becoming an integral part of climate risk management frameworks as a key component of financial protection strategic planning for low and middle-income countries.

Multiple DRFI approaches exist, including market-based instruments (e.g. insurance schemes, catastrophe bonds and swaps), contingent financing (e.g. credit) and budgetary tools (i.e. dedicated reserve funds or contingency budgets). These approaches are all designed to increase financial resilience to climate-related crises, linking the response actions to predefined mechanisms for timely release of financial resources. In this way, they aim to ensure rapid and cost-effective preparation, assistance, recovery and/or reconstruction efforts.

Different IBDRFI solutions for pastoralists have been developed and implemented from 2010 in east Africa, including micro-level retail insurance products, macro-level social livelihoods protection coverage, scalable safety nets programs and sovereign-level drought risk financing solutions (see Appendix 1 for differences between micro and macro-level products).

- A micro-level retail insurance product (IBLI), has been sold and scaled-up by local insurance companies across northern Kenya and southern Ethiopia from 2010 and 2012, respectively.

4. Henceforth, for simplicity IBLI is used as a generic term to indicate drought index-insurance products based on NDVI satellite imagery, designed specifically for pastoralists. Across different programs, the product design often changes, although the underlying technical design principles are largely similar.

- Macro-level social livelihoods protection programs have been implemented in Kenya from 2015, under the Kenya Livestock Insurance Program (KLIP), launched by the government of Kenya (GoK) with technical support from the WBG and ILRI. In Ethiopia the program was launched in 2018 under the Satellite Index Insurance for Pastoralists in Ethiopia (SIIPE) program and implemented by the WFP and the regional Somali government. In 2020, the WFP, International Fund for Agricultural Development and the Ministry of Fisheries and Livestock launched a similar scheme (currently at pilot stage) targeting 5,000 livestock keepers in Zambia.
- Scalability mechanisms of safety net programs have since been implemented in Kenya under the Hunger Safety Net Programme (HSNP) and in Uganda, under NUSAF III. In 2015, the GoK implemented a flexible scalability mechanism of the HSNP, an unconditional cash transfer program in the arid and semi-arid (ASAL) counties, which expands rapidly to cover additional households if droughts occur. Similarly, the NUSAF III program was launched in 2016 in Uganda as a social safety net that includes a scalable public works mechanism, allowing it to rapidly increase financial assistance to affected people when droughts occur.
- A sovereign-level drought risk financing solution for rangelands currently offered in east Africa and the Sahel was piloted by the ARC in collaboration with ILRI in Kenya.

Besides the operational options just listed, alternative IBDRFI programmatic implementation schemes in the pastoral context might also be promising considering the lessons learnt from implementation in east Africa and the context-specific policy objectives (ILRI 2021). For example, while never tested in the extensive pastoral regions, the potential for meso-level insurance may hold the greatest promise. This entails selling policies to risk aggregators such as pastoralist cooperatives, rural finance institutions or livestock services organizations (e.g. veterinary, drug and feed supplements suppliers). Meso-level distribution also offers the potential of de-risking lending to pastoralists and thus boosting investments in pastoral value chain upgrades. Box 1.1 presents an overview of micro, meso and macro-level distribution approaches.

Currently, there are several major parallel initiatives in east Africa assessing the feasibility of regional scaling up of IBDRFI solutions for pastoral communities, which should provide useful insights into the design and planning of an IBDRFI program in Senegal and the Sahel. In 2020-21, the Foreign, Commonwealth and Development Office of the government of the United Kingdom funded a study under the Drought Index Insurance for Resilience in the Sahel and Horn of Africa (DIRISHA) to scale up IBDRFI solutions for pastoralists in the eight Inter-governmental Authority on Development (IGAD) countries. This study was implemented by an ILRI research team and the findings were published in the second quarter of 2021. In addition, the African Development Bank (AfDB), the WBG and the European Union intend to launch a major investment program (estimated at USD 15 billion) in the HOA. The intended investment pillars include (i) regional infrastructure networks, (ii) trade and economic integration, (iii) building resilience and (iv) strengthening human capital. The third pillar includes the development of a regional pastoralist livestock insurance scheme. Insurance would be the entry point to enhance the financial inclusion of pastoralists (through promotion of savings and access to credit) to strengthen their resilience to drought by protecting their livestock assets, which in turn protects their livelihoods. Ultimately, the delivery of insurance products with complementary programs designed to improve pastoral production systems would increase productivity and incomes (WBG 2020a). These two initiatives should provide useful insights relevant to the design and implementation of IBDRFI products and programs in Senegal and other Sahel countries with large pastoral communities (ILRI 2021).

Photo credit: EAP Photo Collection/ World Bank

Box 1.1 Applications of index insurance at different levels of aggregation

Micro-level (direct):

Policyholders are individuals, e.g. farmers, market vendors or fishers, who hold policies and receive payouts directly. These policies are often sold at the local level and retailed through a variety of channels, including micro-finance institutions, farmers' cooperatives, banks, NGOs and local insurance companies. Premiums are either paid in full by clients or subsidized (or both).

Meso-level (indirect):

Policyholders are risk aggregators such as associations, cooperatives, mutuals, credit unions or NGOs, whereby a reinsurer makes payments to the risk aggregators, that then provide services to individuals.

Macro-level (indirect):

Policies are held by governments or other national agencies, within the international/regional reinsurance market. Payouts can be used to manage liquidity gaps, maintain governmental services or finance post-disaster programs and relief efforts for predefined target groups. Beneficiaries of these programs can be individuals. These schemes can be operationalized through regional risk pools.

Source: Schaefer and Waters (2016)

1.3 The IBLI product design

All IBDRFI solutions for pastoralists currently operational in Africa rely on similar EO technologies and general principles. Satellite indicators of forage condition (i.e. the NDVI, Box 1.2) are elaborated to derive an index of forage production in a given area and to calculate payouts using a predefined payout function and trigger mechanism. The normalized difference vegetation index is a low-cost, accessible and widely used satellite indicator of drought. There is well-documented evidence of a strong relationship between rangeland biomass and NDVI for ASAL rangelands. The NDVI has been successfully used to measure the effect of progressive drought conditions on forage and grazing availability over time (Fava and Vrieling 2021).

Among those solutions, the IBLI index design used in this study for technical analysis, was developed for anticipatory action and livestock asset protection in times of severe droughts that lead to forage scarcity.[5] The forage deficit estimated by the satellite index was used as an early indicator of drought conditions that negatively impact forage availability, livestock health and ultimately pastoralists' livelihoods (Appendix 2). As the satellite data provide near real-time assessment, payouts are triggered at the end of the rainy period (i.e. the most critical period for pastoralists to plan herd management) in the event of a drought. These payouts can support pastoralists to make informed and financially backed tactical decisions to better protect their livestock assets and thus cope with the shock. Pastoralists can purchase fodder and animal feed supplements on time to keep core breeding animals alive, well before major livestock losses are incurred. Studies in east Africa suggest that anticipatory responses are significantly more cost-effective in protecting assets and livelihoods than humanitarian aid in later stages of the crises (USAID 2018).

The IBLI product design is specifically tailored for pastoralists in extensive pastoral systems where mobility is an important herd management practice and livestock depend on rangeland resources. The insurance coverage is offered to relatively large geographical units (unit areas of insurance/UAIs) where the wet season grazing areas are located. The UAIs are designed in collaboration with local pastoral communities to reflect typical short-range livestock grazing and mobility patterns during the wet season. The product is currently not designed for transhumance corridors or long-distance dry season grazing areas.

5. It should be noted that satellite NDVI is sensitive to multiple factors affecting the vegetation, including some perils other than drought, e.g. floods, fires and pests etc. The IBLI index is, however, designed to specifically target drought effects on vegetation and minimize the impact of other factors, which might affect the NDVI signal. As such, while the NDVI might also be used to design multi-peril insurance coverage, this was not the case for the IBLI design in this study.

Box 1.2 Satellite NDVI information box

The NDVI is a relative indicator of green vegetation cover or vigour obtained by measuring the difference between visible and near infra-red light reflectance. Higher NDVI values indicate denser cover or healthier vegetation and vice versa. In the context of operational NDVI-based IBDRFI products for pastoralists, NDVI is used as a proxy for forage availability, since during a normal wet year/season, vegetation has higher NDVI than during a drought year/season.

While alternative satellite indices of drought exist, such as satellite rainfall estimates and soil moisture products, NDVI is currently the most widely used operational systems indicator for drought early warning, monitoring and index insurance in African rangelands. This is because of the well-established relationship between NDVI and vegetation condition, which is in turn directly related to forage resources available for livestock.

Recent developments in EO missions and technologies are opening up new opportunities for designing innovative indices of IBDRFI initiatives, including for rangelands and extensive pastoral systems (Fava and Vrieling 2021). Alternative EO-derived indicators (e.g. rainfall estimates, evapotranspiration, soil moisture) or drought indices provide a wide range of options to design new products (Fava and Vrieling 2021). Initiatives such as the NGDI aim to expand the range of options for designing IBDRFI solutions by developing a practical framework for a set of indices or indicators that will better monitor, anticipate and trigger financial responses to severe drought events. Others, such as the University of California Davis/USAID QUIIC, aim to establish effective approaches for IBDRFI product assessment and to define minimum quality standards. These efforts are expected to allow the development of innovative indices, tailored to specific needs, co-generated with stakeholders and validated according to high scientific standards.

1.4 Impacts and lessons learned from implementation

The IBDRFI initiatives implemented by ILRI in Kenya and Ethiopia thus far have produced valuable implementation lessons and evidence for governments and pastoral communities. Key impacts are summarized in Figure 1.1. They have also provided proof of concept for different implementation schemes tailored to the needs of the specific countries, ranging from commercial insurance programs with various premium subsidy levels to fully subsidized macro-level social livelihoods protection programs targeting the most vulnerable pastoralists. This has created strong demand for IBDRFI instruments from several countries across the region and increased interest from development partners based on this demand.

Photo credit: EAP Photo Collection/ World Bank

FIGURE 1.1 SUMMARY OF IMPACTS OF IBDRFI SOLUTIONS IMPLEMENTED UNDER KLIP

1. Protect Gov. budget		Risk-transfer to the private sector	• Premium Payment reduces public financial burden in case of drought • PredicTable and budgeted expenditures allow better reSource allocation and harmonization with complementary initiatives	10 million USD payouts since inception made by the private sector
2. Expand markets		Public investment on subsidies and infrastructure	• Public sector premiums guarantees regular profit. • Investment in infrastructure facilities and crowds-in additional services. • More awareness on the product increases the potential for retail sales.	IBLI coverage expanded from 3 to 8 countries Number of IBLI policies increased from 4k to over 20k
3. Protect vulnerable	Good Seasons	Reduced drought risk	• Intensification: Increased investments in higher-returns production strategies. • Strategic livestock sales when prices are high. [1] • Increased investments in veterinary services. [1] • Reduced precautionary savings. [1],[2]	Greater income [1,2]
	Drought Seasons	Reduced income loss during drought	• Less reliance on determental coping strategies during drought. • Less distress selling of productive assets.[?] • Less "skipping" meals during drought.[?] • Maintained investments in human capital.	Improved post drought economic and welfare outcomes.
		Payments in anticipation of drought	• Early action to mitigate the impact of drought • Destocking in anticipation of price and reSource shocks. • Early purchase of inputs to sustain remaining herd during the coming drought.[4]	

Sources: [1]Jensen et al. 2017; [2]Matsuda et al. 2019; [3]Janzen and Carter 2019 and [4]Taye et al. 2019 in Fava et al. (2021).

The IBDRFI solutions for pastoralists are still evolving in response to lessons learnt and growing demand from new countries. While there are consolidated operational implementation experiences in east Africa, new programs can utilize the vast knowledge capital accumulated over the last 10 years to further improve the existing solutions, tailoring them to the local context and pastoral systems and supporting their harmonization into broader risk management, resilience building and pastoral development policy frameworks.

Evidence from multi-year impact evaluation surveys on the retail micro-insurance IBLI programs in Kenya and Ethiopia shows that these programs generated considerable social and welfare benefits for pastoralists who insured their livestock (Figure 1.1, Block 3: Protect vulnerable). During good years, insured households respond to their insurance coverage by increasing investments in livestock, veterinary and vaccination services, selling more livestock and reducing their herd size (Jensen et al. 2017; Matsuda et al. 2019). These changes in production strategies result in positive impacts on indicators of well-being, such as increased household income per adult equivalent and reduced reliance on costly ex ante risk-reducing strategies such as distress selling of livestock or skipping meals (Janzen and Carter 2018; Jensen et al. 2017; Matsuda et al. 2019).

Analyses of the use of payouts from pastoralists in Kenya and Ethiopia indicate that payouts influenced the decision-making of pastoralists on coping strategies. These payouts were used for both livelihood protection and purchasing of livestock inputs. Using data from a survey of over 1,000 KLIP beneficiaries in Marsabit and Isiolo after the 2016-17 drought, a study examined how beneficiaries changed their coping strategies in anticipation of payments and how they spent those funds once they were received. A large majority (70%) of respondents reported using part of the payouts for human food consumption, while others used the payouts for forage/fodder, water and veterinary services expenses for their livestock (Taye et al. 2019).

The experience of KLIP has provided evidence that the establishment of a PPP model for implementing IBDRFI is effective in transferring risk to the private sector while crowding-in private sector capacity and stimulating market expansion. The PPP model was preferred for KLIP because private sector-only implementation proved difficult to scale-up whilst maintaining private sector appetite for retail coverage due to the high costs of distribution and the relatively low uptake. The PPP assisted in developing a new model for implementing IBDRFI solutions. Lessons learned from the implementation of KLIP are summarized as follows:

- Government leadership and direct investment in IBDRFI initiatives are possible and can be effective when there is strong partnership with the private sector and roles and incentive structures are clearly defined. A mechanism for long-term public commitment ne eds to be established to guarantee the stability of the scheme.
- Subsidies for scaling up and consolidating the scheme are important and instrumental, but they also need to be associated with smart targeting mechanisms and private sector incentives for market development and expansion.
- Awareness creation and capacity strengthening at all levels are fundamental and require sufficient resources for such schemes to achieve sustainability.
- Impact assessments require investment, planning and preparation. It is, therefore, recommended that a rigorous impact study and cost-benefit analysis of the program be included during the design phase to ensure that lessons learnt are documented and evidence is gathered.
- The introduction of an anticipatory logic in the IBLI and KLIP index design (for early drought detection and livestock asset protection) has been a fundamental step in improving the value and cost-effectiveness of the scheme.
- Accurate insurance product design is critical to create trust and achieve desired impacts but currently the data infrastructure for product quality assessments and comparisons is weak, if not absent. Therefore, there is an urgent need for the establishment of robust, transparent actionable strategies and methodologies for quality assessment of index insurance products.
- Engaging with local and international stakeholders and tailoring the IBDRFI product to the specific agro-ecological and socio-economic contexts and evolving environmental conditions is necessary not only during the program design phases but throughout the entire program implementation cycle.
- Effective implementation is just as important as the technical design. It is important to ensure that any premium collection and payment infrastructure designs are robust prior to the launch of similar schemes. Leveraging off existing financial service infrastructure is crucial in ensuring that development impact is achieved, trust is built and the scheme is sustainable.
- Scaling up IBDRFI initiatives requires strong coordination efforts and harmonization of the different drought risk management instruments to optimize their finance mechanisms, targeting approaches, data and management infrastructure.

However, lessons learnt so far show that there are still significant challenges to be addressed in implementing IBDRFI in extensive pastoral regions, particularly in terms of financial sustainability and effective product distribution. The micro-level insurance retail schemes still face significant challenges such as low adoption rates and high marketing and distribution transaction costs. These challenges make the products unattractive for private insurance companies unless they are significantly subsidized. In addition, the macro-level and safety net schemes for social livelihoods protection face challenges around the long-term commitment of government budgets and efficiency of the distribution model.

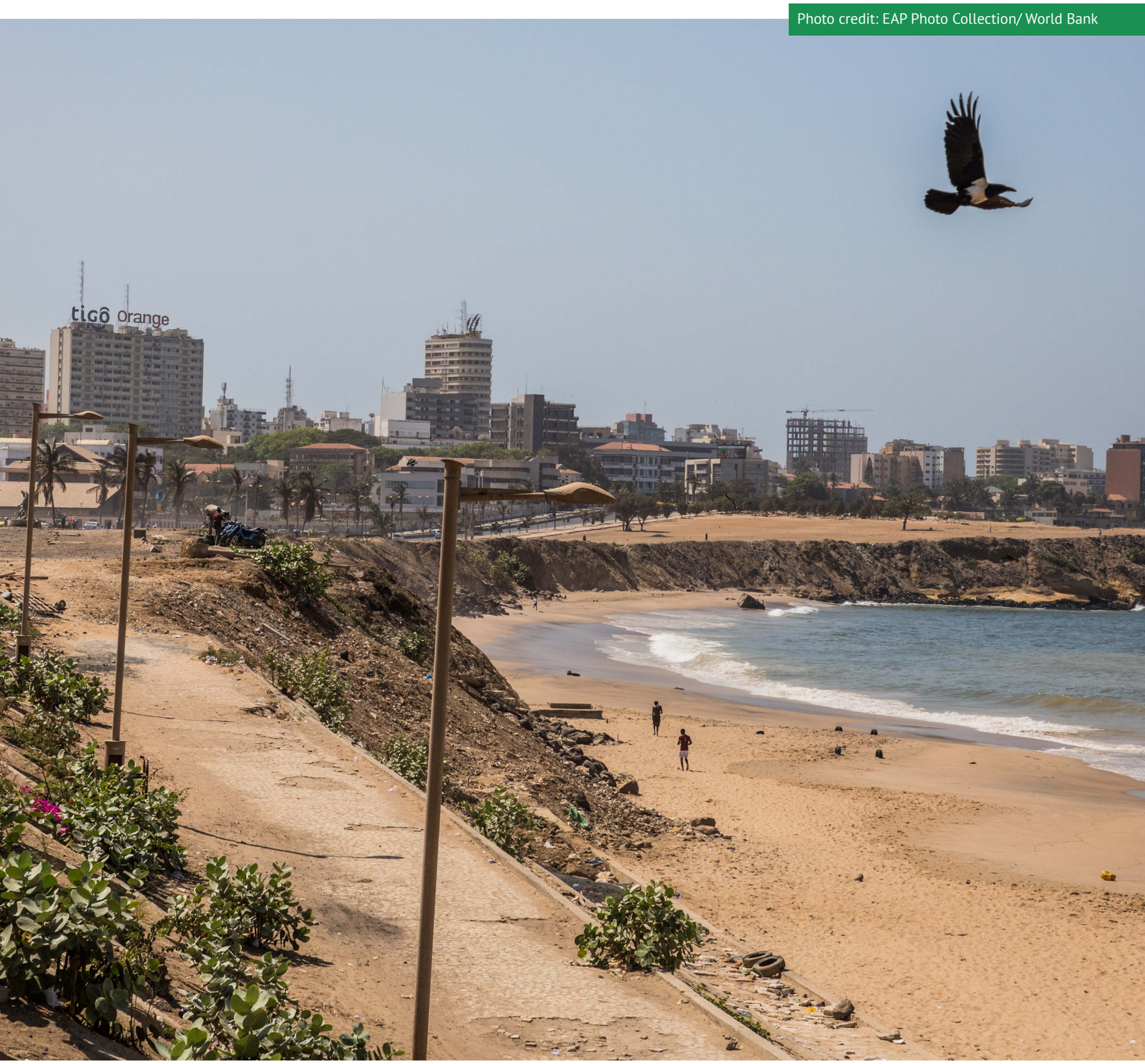
A recent study conducted under the DIRISHA program clearly shows that there is need to identify new low-cost distribution channels for IBDRFI in east Africa (ILRI 2021) and that meso-level channels might represent a feasible option. This is likely to apply equally in Senegal and other parts of the Sahel. Over the past decade, the micro-level IBLI programs in Kenya and Ethiopia have operated at a financial loss because of the very high administration and operating costs of implementing insurance with individual pastoralists, who often reside in very remote areas. The unit costs of promotion, awareness and education, policy issuance and premium collection from individual pastoralists exceeded the premiums generated from each micro-level policy sale. For micro-level IBLI programs to operate at a commercial profit, they will require new and more cost-effective ways of marketing and delivering cover to clients.

The experiences of IBLI and KLIP in Kenya and Ethiopia demonstrate the need for parallel investments in resilience building and market development for pastoral communities. Insurance by itself cannot build drought resilience and protect livelihoods. Insurance is only one of many essential elements of a comprehensive risk management framework.

On one hand, building resilience requires broader investments in risk information (e.g. probabilistic drought risk assessments), risk reduction (e.g. improved natural reSource management practices) and preparedness building (e.g. live animal offtake markets). On the other hand, index-based insurance requires certain elements to function well. Not only is there a need for more concerted financial literacy and insurance training for pastoralists, but also systems for targeting and registering pastoralists require improvement. Strengthening of private sector markets for fodder and feed supplements and provision of veterinary services are also required as without these, pastoralists receiving payouts are unable to use the money to sustain their livestock (ILRI 2021).

Overall, evidence from operational insurance programs suggests significant benefits can be derived from IBDRFI instruments, both in terms of establishing mutual benefits between the public and private sector and delivering positive outcomes for the welfare and livelihoods of pastoralists during crisis and non-crisis periods. There is still need for better understanding of the short- and long-term impacts of these programs on individual, community and environmental outcomes. Investments in robust monitoring and evaluation infrastructure and rigorous impact assessment studies are important to assess and increase the product value to ensure the development of tailor-made initiatives for resilience building of pastoral communities.

Photo credit: EAP Photo Collection/ World Bank



2. Socio-economic assessment

This section aims to review the main socio-economic conditions that may justify IBDRFI initiatives in Senegal. It examines the relevance of the livestock sector and the impacts of drought shocks to the national economy and the pastoralists' livelihoods. The prevailing socio-economic environment, in terms of the importance of livestock for livelihoods and welfare, vulnerability to drought shocks and impacts of drought and other shocks on livestock assets, is also assessed. The analysis was conducted through a combination of desktop reviews and key informant interviews with stakeholders in the country (see Appendix 3).

2.1 General socio-economic context

Senegal is a growing agriculture-based economy, but poverty remains a serious challenge. Senegal's economy has maintained strong economic growth over the last 10 years, averaging 5.1% per year between 2010-19. Agriculture is still the backbone of the economy as 52% of the population lives in rural areas, where crop farming and livestock rearing are the main Sources of livelihoods. Agriculture contributes about 15% to the national GDP and is estimated to provide 29% of total employment. Given that most producers are subsistence farmers, the total number of people working in agriculture is likely to be much higher, with some estimates of total employees in agriculture as high as 77% (CIA 2021). Table 2.1 presents an overview of selected key economic and agricultural indicators in Senegal. A large share of the population is poor, with half of the population estimated to be living below the national poverty line in 2011.

TABLE 2.1 SELECTED ECONOMIC AND AGRICULTURAL INDICATORS IN SENEGAL

Indicator	Value	Period
Population (million)	16.3	2019
Rural population (%)	52.3	2019
Annual GDP growth (%)	5.1	2010-19
GDP/capita (USD million)	1,447	2019
National poverty (% of total)	46.7	2011
Agricultural GDP (% of total GDP)	14.8	2019
Agricultural employment (% of total)	29.4	2020

Source: (WBG 2021)

2.2 Importance of livestock to the national economy

The livestock sector contributes more than one third to the agricultural GDP and most rural households are engaged in livestock rearing. The national statistical agency's most recent data shows that the livestock sector contributed 38 and 3.6% to the agricultural and national GDP, respectively. The 5.0% annual growth of the sector during 2016-18 mirrored that of national GDP. As per the latest general census data from 2013, around 28% of all households and 60% of farming households are engaged in livestock rearing. An estimated 24% of the total population (equivalent to 3.5 million people) in Senegal were estimated to be nomadic pastoralists or agro-pastoralists in 2015 (Table 2.2).

TABLE 2.2 SELECTED LIVESTOCK SECTOR INDICATORS IN SENEGAL

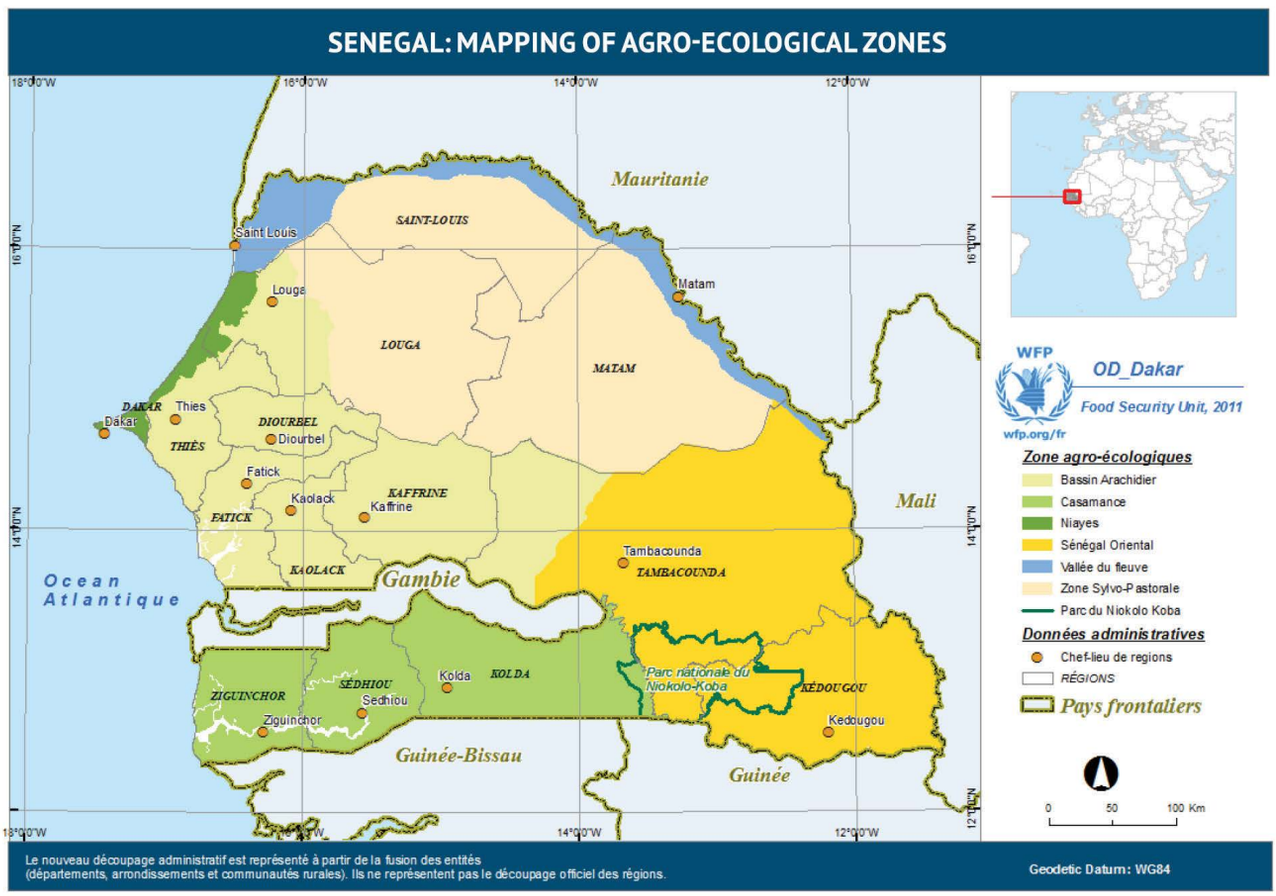
Indicator	Value	Period	Source
Livestock sector's contribution to national GDP (% of total)	3.6	2018	ANSD 2019
Livestock sector's contribution to agriculture GDP (% of total)	38.3	2018	ANSD 2019
Households rearing livestock (% of total)	28.2	2013	ANSD 2014
Farming households rearing livestock (% of total)	60	2013	ANSD 2014
Pastoralists (nomadic pastoralists and agro-pastoralists) (% of total population)	23.8	2015	UNECA 2017

Administratively, Senegal is divided into 14 regions, which are further sub-divided into 45 departments and 103 arrondissements. Livestock production systems in Senegal can be divided into nomadic pastoral, agro-pastoral and intensive and semi-intensive systems.

1. ***Nomadic pastoralism:*** Extensive livestock rearing on communal grazing lands that is mostly practiced by herders of the Fulani ethnic group living in the silvo-pastoral zone in the northern and north-eastern regions of Senegal, also known as 'the Ferlo'. The Ferlo stretches over an arid and semi-arid area of about 70,000 km2 over parts of the departments of Saint-Louis, Louga, Matam and the margins of Tambacounda.
2. ***Agro-pastoral systems:*** Extensive livestock rearing coupled with sedentary crop farming that can be found in the 'groundnut basin' ('Bassin Arachidier'), the Senegal river valley ('Vallée du fleuve'), the South east of the country ('Sénégal Oriental') and the south ('Casamance').
3. ***Intensive and semi-intensive livestock rearing systems:*** Essentially focus on poultry farming and are concentrated in a narrow coastal band (1,800 km2) in the northwest of the country called 'the Niayes', stretching from Dakar to Saint Louis. Many other economic activities take place in this area (PARM 2016). Figure 2.1 shows these main agro-ecological zones.

Photo credit: EAP Photo Collection/ World Bank

FIGURE 2.1 AGRO-ECOLOGICAL ZONES OF SENEGAL

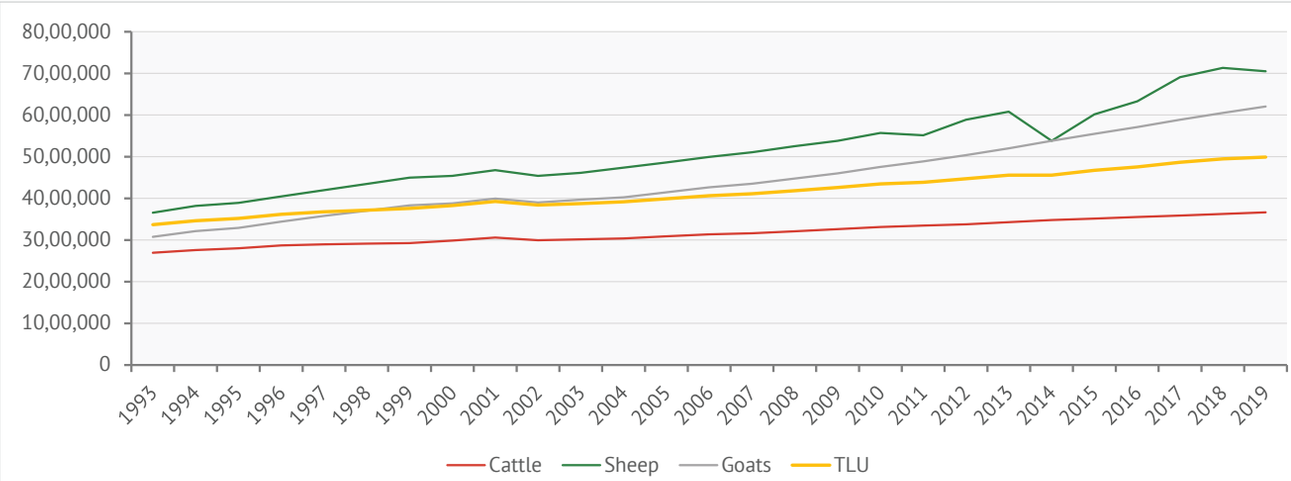


Source: WFP (2014b)

In 2019, there were an estimated 18.4 million livestock (excluding poultry) in Senegal. As per the Food and Agricultural Organization of the United Nations (FAO) data, the national herd is comprised of sheep (38%), goats (34%), cattle (20%) with the remaining 8% composed of horses, donkeys, pigs and camels. Overall, livestock numbers have grown consistently over the years, with tropical livestock units (TLUs)[6] growing by 30% over the last 20 years (2000-19). However, the average annual ruminant herd growth was only 1.1-2.4%. In 2002, the number of cattle, sheep and goats decreased by 2.1, 2.9 and 2.4%, respectively, following erratic rainfall patterns. The livestock Figures reported by the FAO (Figure 2.2) are in line with data collected and presented by the national Ministry of Livestock and Animal Production (Cellule des Études et de la Planification, Ministère de l'Élevage et des Productions Animales) (CEP-MEPA 2017). Notably, the overall long-term composition of the national herd has changed significantly from the 1970s. Bovines accounted for almost 50% of the national herd in the 1970s but only make up 25% currently {PARM 2016}

6. Tropical livestock units allow comparisons of nutritional requirements across livestock species. Using ILRI's classification for the Horn of Africa, 1 adult cow weighing on average 250 kg is deemed to be equivalent to 1.0 TLU. In terms of nutritional requirements, a camel is equivalent to 1.4 TLUs and sheep and goats are equivalent to 0.1 TLU. It is noted that different institutions use different TLU conversion factors. For example, Houerou and Hoste (1977) use the following conversion factors for pastoral / nomadic herds: 1 cow = 1 TLU; cattle in a herd = 0.7 TLUs; sheep = 0.1 TLUs; goats = 0.08 TLUs and camels = 1.25 TLUs.

FIGURE 2.2 TOTAL NUMBER OF SELECTED LIVESTOCK SPECIES IN SENEGAL (1993 TO 2019)



Source: FAOSTAT (2020)

There is no data on nomadic and agro-pastoralist total population sizes and their respective livestock distributions. A review of literature revealed that agro-pastoralists owned the majority of livestock in Senegal in the 2000s, approximately 67 and 62% of bovines and small ruminants, respectively (PARM 2016, citing Niang and Mbaye 2013). As agro-pastoralists tend to be concentrated in the central and southern Senegal regions and are relatively less mobile than nomadic pastoralists, a larger concentration of livestock populations is expected in these areas. However, the national statistics agency, Agence Nationale de Statistique et de la Démographie (ANSD) estimated that in 2012, more than 50% of ruminants were in the silvo-pastoral zone of northern and north-eastern Senegal (the Ferlo) (Table 2.3).

Photo credit: EAP Photo Collection/ World Bank

TABLE 2.3 SIZE OF LIVESTOCK HERD BY MAIN LIVESTOCK ZONES IN SENEGAL (2012)

Livestock zone	Cattle	Sheep	Goats	Camels
Niayes	211,696	410,074	271,400	-
Southeast	794,830	504,494	620,332	-
Silvo-pastoral	1,646,573	3,274,391	2,746,172	4,794
Groundnut basin	725,897	1,698,110	1,400,211	-

Source: PARM 2016, citing CEP-MEPA (2015)

2.3 Pastoral livelihoods, challenges and issues

Pastoral and agro-pastoral households are among the poorest and most vulnerable in Senegal. Most households (75%) whose livelihoods depend mainly on livestock are located in the two poorest quintiles.[7] Households that mainly depend on livestock rearing also belong to the groups most affected by food insecurity. In 2013, the WFP assessed that 24% of these households were moderately food insecure while 3% were severely food insecure (WFP 2014b).

Pastoralists in Senegal traditionally follow a subsistence lifestyle with little involvement in trade but there are signs of change. Agro-pastoralists have traditionally produced animal products mainly for self-consumption, which would be supplemented with crop products. Only a small portion of livestock is marketed (WBG 2015). Despite its substantially large livestock sector, Senegal still depends on meat imports to meet demand. In 2016 alone, Senegal produced more than 242,000 tonnes of meat and still imported another 8,900 tonnes (CEP-MEPA 2017). The involvement of pastoralists in livestock trade seems to be changing, with most livestock owners including those in remote nomadic pastoralist systems becoming dependent on markets. While this can boost their livelihoods, it also exposes them to market-related risks such as market quarantines due to disease outbreaks and market shocks leading to plummeting livestock prices (WBG 2015).

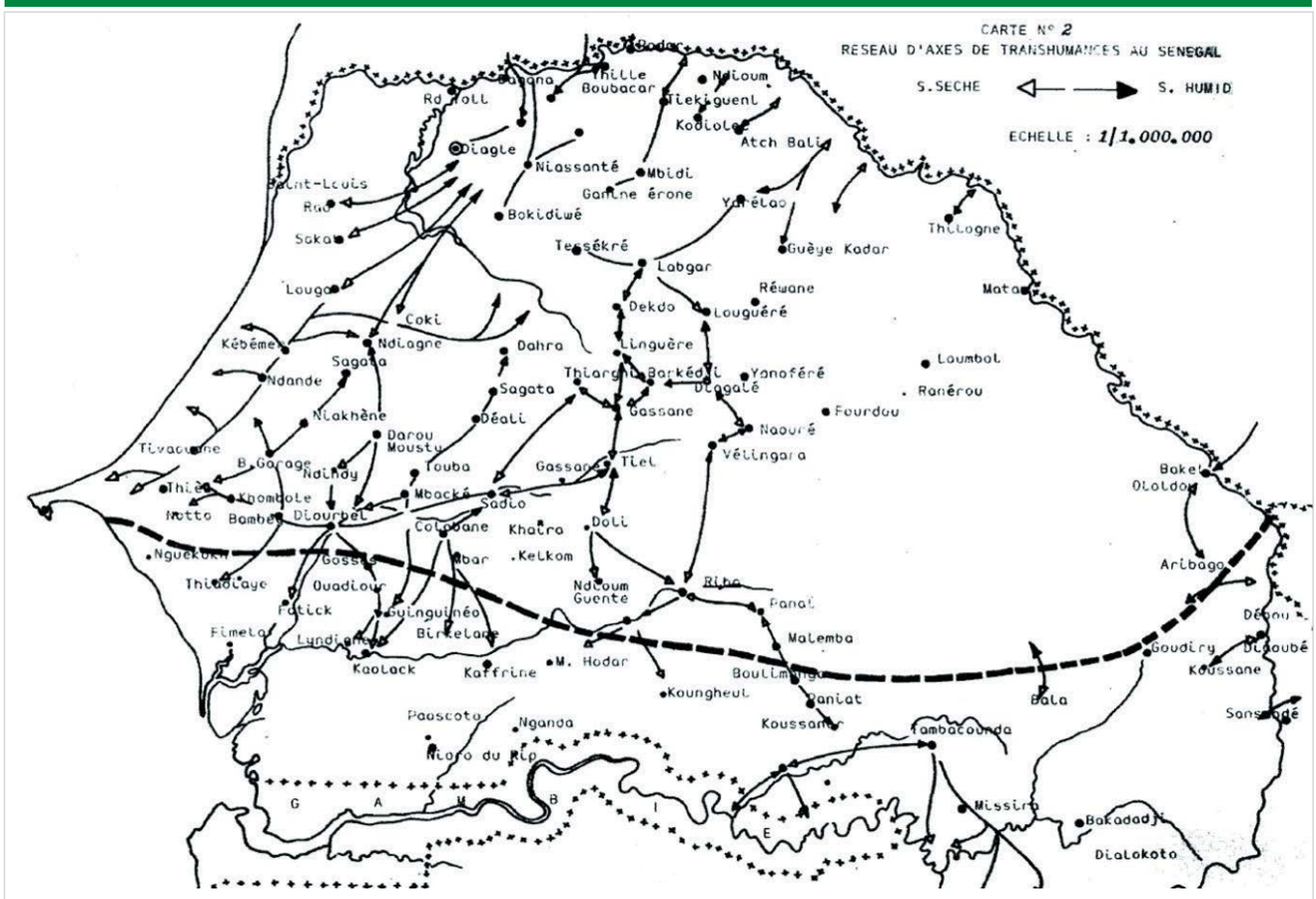
Pastoral livestock rearing involves varying degrees of seasonal mobility to access scarce natural resources on communally managed parcels of land or open-access systems in northern Senegal and Mauritania. Seasonal livestock migrations, especially north-south, are an important herd management strategy for nomadic pastoralists in Senegal although local mobility patterns might be considerably different and less generalizable than regional ones (Figure 2.4; Turner et al. 2016). Over the years, transborder transhumance from Mauritania into Senegal and Mali has been on the increase (Touré et al. 2012). Mobility patterns can be coarsely separated into three typologies: (i) sedentary management, which refers to the grazing of livestock around a single encampment year-round (≈ 0-5 km radius), (ii) local seasonal movements in multiple directions (sometimes referred to as 'la petite transhumance') between encampments to escape flooding (movements on/off floodplain) or cropped fields or to access higher quality pasture or water (≈ 5-40 km distance) and (iii) long-distance seasonal movements (sometimes referred to as 'la grande transhumance'), generally oriented to the south during the dry season and back to the north during the wet season to take advantage of seasonal gradients in forage quality (≈ 40-250 km distance) (Turner et al. 2016).

A large proportion of the livestock owned by nomadic pastoralists remains in the rangelands in northern Senegal and Mauritania during the wet season and then moves south. The rainy season typically lasts from June to mid-September. In regular years, pastoralists tend to stay with their animals in the northern rangelands until November or December before migrating south in search of markets to sell livestock or towards central and southern regions to purchase crop residues. As represented in Figure 2.3, most of the migratory movement occurs between the Ferlo and the groundnut basin in central Senegal. There have been many attempts at capturing and quantifying livestock herd movements using different methodologies but given data constraints and the complexities of pastoral transhumance, no definitive mapping has emerged (Jahel et al 2020).[8]

7. Poverty was assessed by calculating an index which considered both the possession of goods and living conditions (WFP 2014b).

8. Jahel et al. (2020) provides a good overview of the latest literature on the issue, citing e.g. census and network-based approaches that have been used in an attempt to map livestock movements.

FIGURE 2.3 MIGRATORY MOVEMENTS OF PASTORAL HERDS BETWEEN NOVEMBER TO JANUARY



Source: Leclerc and Sy (2011)

Pastoralism has been constantly evolving in Senegal over the last 30 years in response to environmental, socio-economic and political challenges. Before the major droughts in the mid to late 1970s, most of the pastoralists were subsistence oriented, relying on a combination of herding and rain-fed agriculture. The herd mainly consisted of cattle for milk and a few sheep and goats (Sutter 1987). Following these drought years, many pastoralists did not find cultivation worthwhile thus focused more on livestock rearing (especially sheep) and increased commercialization of their activities (Adriansen 2008). However, this shift was short-lived due to pressure on pastoral lands, security issues and governmental policies, which drove pastoralists to more sedentary livelihoods (PARM 2016) as detailed in the paragraphs below.

Nomadic pastoralists in Senegal have been subject to many challenges that reduce their access to grazing lands. Over the years, grazing lands have become increasingly scarce. Contributory factors include both human and livestock population growth and associated pressures on grazing lands, soil degradation, deforestation, local conflicts, increasing climate variability and growing croplands (PARM 2016). The government has also adopted initiatives towards 'modernizing' traditional nomadic pastoral lifestyles over the last 20 years[9] through legal and political initiatives aimed at creating 'pastoralist units' to limit migration or to support the spread of sedentary agriculture and agro-businesses (Ancey and Monas 2005).[10]

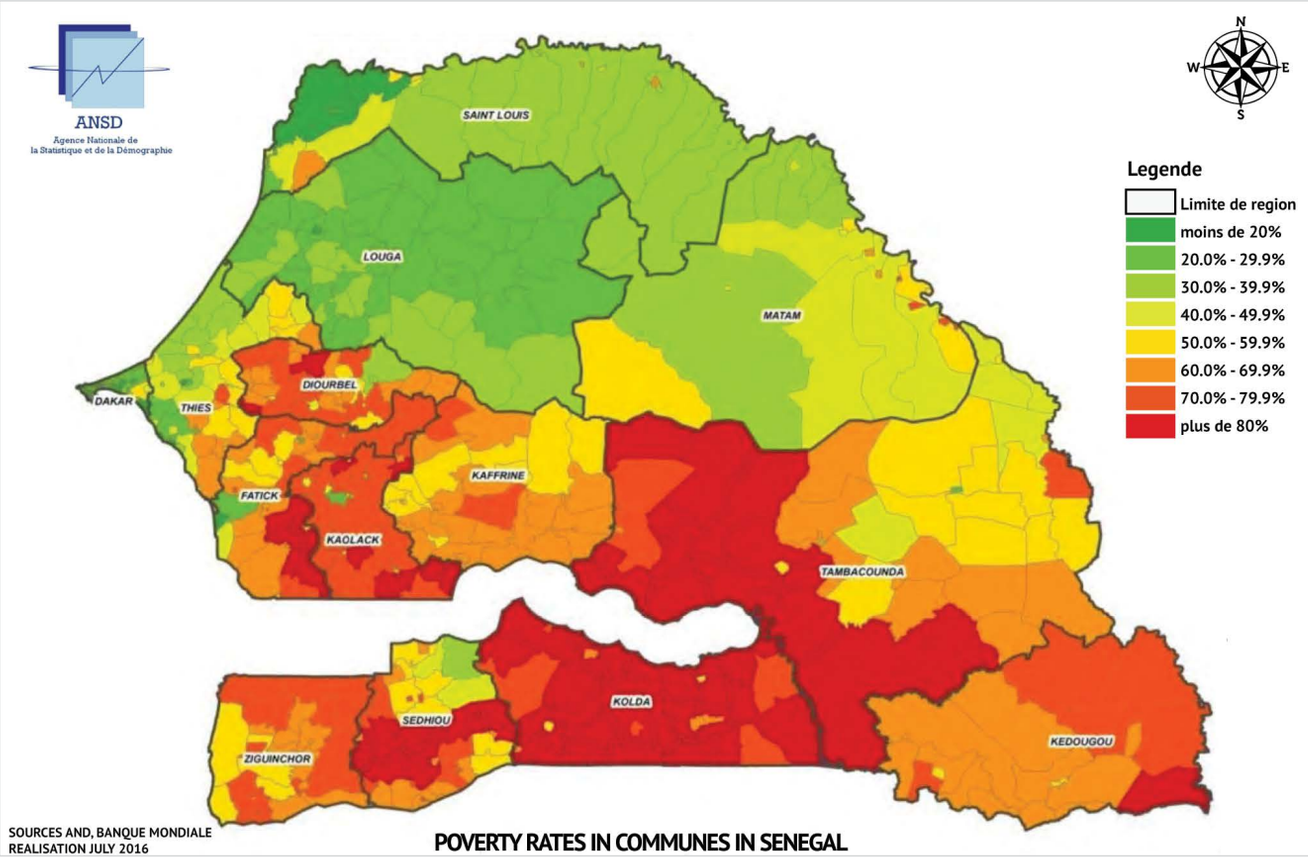
9. For example, President Wade famously said in 2006, "The image of hungry and kosher cattle wandering around looking for hypothetical pastures and water points must forever disappear from the Senegalese agricultural landscape," ("L'image de bovins faméliques et cachectiques errant à la recherche d'hypothétiques pâturages et points d'eau à jamais doit disparaitre du paysage agricole sénégalais") (Ancey and Monas 2005).

10. The most important relevant legal and policy projects include the 'Loi d'orientation agro-silvo-pastorale,' (2004); the 'Nouvelle Initiative sénégalaise pour le développement de l'élevage,' (2005), the creation of 'Centres d'impulsion pour la modernisation de l'élevage', the creation of the 'Fonds d'Appui à la Stabulation, (FONSTAB) (2007) and the 'Plan National de Développement de l'Elevage, (PNDEL) (2013).

Many pastoralists have therefore abandoned the nomadic lifestyle and become sedentary, thus further increasing pressure on the land. Nomadic pastoralists that do not have sufficiently large herds to buffer potential shocks are particularly exposed. Food-secure households have an average of 8.4 TLUs compared to 5.1 TLUs for food-insecure households (WBG 2015). The latter households are potentially forced to give up the traditional nomadic lifestyle and become sedentary. Indeed, a retrospective study (Weicker 1993) using data from 1953 and 1979 showed that the total area of cultivated croplands more than tripled in size. The conversion of agro-pastoralist lands into crop lands reduces room for the migratory pastoralist lifestyle. Local institutional leaders also report that pastoral mobility frequently conflicts with sedentary agriculture. An example that is often cited is Podor in northern Senegal, which has attracted the interest of sedentary farmers, much to the disapproval of pastoralists in the area.[11] In addition, the drive towards increased rice production through irrigation as espoused by the 'Plan for an Emerging Senegal', is likely to worsen farmer-pastoralist conflicts.[12]

Agro-pastoralists are among the most vulnerable population groups in Senegal. Transitions into agro-pastoralism are generally a product of the described pressures, particularly limited access to grazing land. Thus, while nomadic pastoralists in Senegal are often recognized to be relatively resilient and less vulnerable, agro-pastoral households generally possess fewer livestock and occupy lands on the fringes of pastoral areas, with particularly low rainfall. They are thus exposed to the risks associated with rainfall variability but have limited opportunities to migrate their livestock herds in response. Agro-pastoral households are thus among the poorest and most vulnerable population groups in Senegal (WBG 2015). This is also reflected in the national geographic distribution of poverty, which is more concentrated in central and southern Senegal, i.e. home to most agro-pastoralist households, as opposed to the north where most nomadic pastoralists reside (Figure 2.4).

FIGURE 2.4 SENEGAL POVERTY INCIDENCE



Source: ANSD (2016)

11. Interview with Mr Aliou Samba BA, President of the Senegalese Branch of Réseau Billital Maroobé (RBM on 5th January 2021.

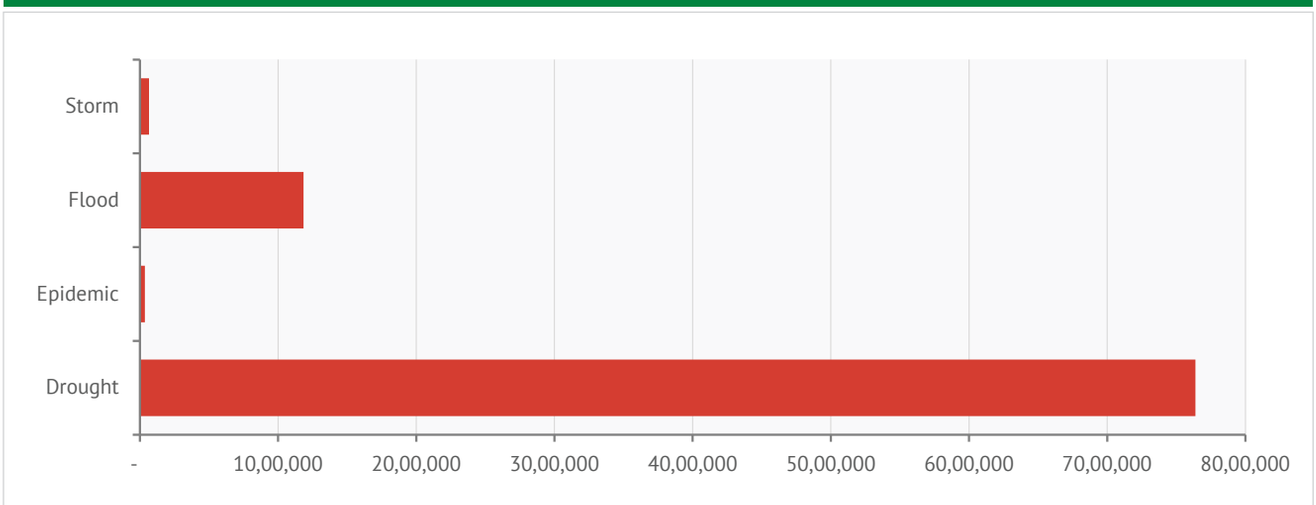
12. Interview with Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) representatives.

Pastoralism in Senegal should also be seen from the perspective of events and developments in the Sahel region where pastoralist-centric legislative instruments have often been promoted. For instance, Sahelian countries have adopted several bilateral agreements that enhance cross-border transhumance between the countries. This process is also backed by various autonomous pastoral organizations in the Sahel region. There are, however, several factors that militate against the unfettered movement of pastoralists and their herds. For example, pastoral communities in the north-eastern region of Senegal, who are used to migrating to Mali during the dry spells are abandoning this practice because of the on-going conflict in that country.

2.4 Cost of drought shocks on the livestock sector

Senegal is exposed to a variety of different climate shocks, of which droughts have the most adverse impacts. According to the emergency events database (EM-DAT), during the last half of the century Senegal has experienced a total of over 40 major natural and weather-induced disasters and riverine floods accounted for most of these. In addition, the country has also faced droughts, epidemics (such as cholera and yellow fever), convective storms and insect infestations. However, as Figure 2.5 shows, droughts tend to have the most devastating impact, having affected close to 8 million people in Senegal since 1970. Given that EM-DAT often underestimates the difficult-to-quantify impacts of droughts, the actual Figure is likely to be much higher.

FIGURE 2.5 NUMBER OF SENEGALESE PEOPLE AFFECTED BY DISASTER TYPE (1970 TO 2019)

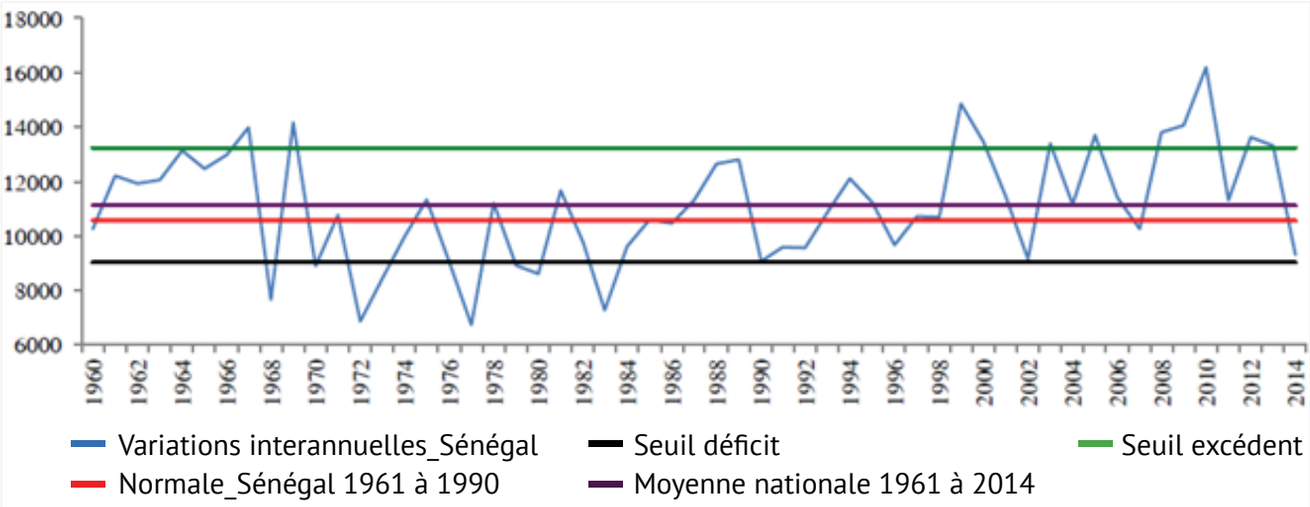


Source: EM-DAT database

Major droughts tend to occur every five years on average. Figure 2.6 shows total rainfall over time as analyzed by the Platform for Agricultural Risk Management (PARM). Major droughts were experienced in 1968, 1972, 1977, 1983, 1990, 1996, 2002, 2007 and 2014. For their analysis, PARM defined a major rainfall deficit (drought) as occurring when annual total rainfall was below one standard deviation of the long-term mean (note that this is different from the Seuil deficit threshold shown in the graph). It should be noted that these are national Figures, which do not necessarily represent local drought conditions accurately (PARM 2016). For example, like elsewhere in the Sahel, the year 2011-12 was a significant drought year in Senegal, leading to a widespread food security crisis (WFP 2014). PARM also calculated the return periods for severe rainfall deficits and excess rains[13] in the main livestock production zones of Ferlo, the southeast and Niayes. For all these regions, both severe rainfall deficits and excesses were estimated to occur about once every 6 to 6.5 years (Table 2.4).

13. Return period refers to the average time interval for severe rainfall deficits or excesses to occur, recorded as one standard deviation above or below the long-term mean.

FIGURE 2.6 MAJOR DEFICIT AND EXCESS RAINFALL YEARS IN SENEGAL



Source: PARM (2016)

TABLE 2.4 RETURN PERIODS OF MAJOR DEFICIT AND EXCESS RAINFALL YEARS IN LIVESTOCK PRODUCTION ZONES OF SENEGAL

Zone	Major rainfall deficit*[14] year, return period	Major rainfall excess year, return period
Ferlo	6.3	6.5
South-East	6.2	6.5
Niayes	6.5	6.6

Source: PARM (2016)

Quantification of the impact of drought crises on governmental budgets has not been undertaken but modelled estimates indicate an average drought response cost (in the form of food security needs) of USD 26 million per year. This is the result of a modelling exercise conducted by the International Food Policy Research Institute (Clarke and Vargas Hill 2013), which unfortunately was not specific to the livestock sector. The same study estimated a maximum modelled drought response cost of more than USD 140 million from 1983 to 2011.

Based on drought events in the 1970s and 1980s, PARM estimated the financial impact of droughts on the livestock sector ranged from 13.4 billion west African Communauté Financière Africaine Franc (XOF) (XOF = USD 1 at date) to XOF 17.3 billion (USD 32.4 million) per year. Pasture and forage becomes unavailable when there is no rainfall and animal mortality increases, reducing the size of livestock herds. For the severe drought years of 1972-74 and 1983-84, PARM recorded drought-inflicted livestock deaths and assessed the average annual cost of droughts in the livestock sector to be approximately XOF 11.2 billion (USD 21 million) (Table 2.5). It should be noted, however, that there may be some important caveats to this analysis.[15]

14. Major deficit rainfall years are defined as total annual rainfall at least one standard deviation below the 1960 to 2014 average, while major excess rainfall years exceed this average by at least one standard deviation.

15. This analysis was not conducted by the authors and it may be subject to important caveats: (i) the data are more than 40 years old and it seems unlikely that projections for 2021 and beyond are valid, given that the size of the national herd has since roughly doubled and the national herd composition has changed significantly, (ii) from the documentation available, the methodology employed by PARM to arrive at the estimated average annual losses due to drought is not entirely clear and (iii) as part of this analysis and from the documentation available, it could not be verified whether the calculated monetary values have been time-adjusted to be relevant in 2021.

TABLE 2.5 DROUGHT-RELATED LIVESTOCK LOSSES IN SELECTED DROUGHT YEARS IN SENEGAL

Year	Cattle		Sheep		Goats		Total
	Number lost	Financial value (XOF billion)	Number lost	Financial value (XOF billion)	Number lost	Financial value (XOF billion)	
1972	266,573	6.7	-	-	195,468	0.7	
1973	628,929	15.7	78,316	0.47	329,098	1.1	
1974	-	-	347,867	2,1	459,674	1.6	
1983	429,205	10.7	325,180	2.0	160,268	0.5	
1984	462,536	11.6	409,298	2.5	201,983	0.7	
Total		44.7		7.0		4.5	56.2

Source: PARM (2016)

2.5 Impact of drought and other risks on livestock production

Drought-induced forage scarcity is identified as an important risk for pastoralists due to its negative impacts on livestock production and livelihoods. Interviews with pastoral institutional leaders[16] revealed that pastoralists face (i) a combination of risks arising from too low/intermittent rainfall (drought), (ii) too much rainfall (floods) and (iii) insect infestations, including locusts and grasshoppers. However, results of a preliminary empirical assessment undertaken by the Initiative Prospective Agricole et Rurale (IPAR) (Syll et al. 2019) indicate that rainfall deficits and forage scarcity are recognized by pastoralists as the main shocks they face.

16. Interview with Mr Aliou Samba BA, president of the Senegalese branch of Réseau Billital Maroobé (RBM), a network of regional pastoral associations on the 5th January, 2021.

Photo credit: Visiter Bordeaux From Pixabay

Livestock mobility offers an opportunity to exploit dryland areas with insufficient precipitation for crop growing and access to crop residues in regions where cropping is feasible. However, this production strategy is also extremely vulnerable to drought. Droughts can impact livestock-owning households by reducing their income from milk and livestock sales, while also causing massive losses to household wealth and productive capital stock. For example, during a recent drought in 2017, low rainfall resulted in depletion of forage in pastoral regions, directly causing cattle deaths and indirectly causing increases in conflict and food insecurity (Action Against Hunger 2018).

While livestock deaths are the most obvious consequences of drought, local institutional leaders emphasize the hidden effects of drought such as reduced fertility and calving rates. This not only reduces the size of the pastoralists' productive capital stock but also deprives women pastoralists of income they would otherwise generate through the sale of milk. Furthermore, droughts also cause adverse social and psychological impacts, including family dislocations. Droughts and the resultant livestock decimation also disproportionately affect the youth (also called 'Tefanké') in the community, who are itinerant traders that buy animals in the villages and at weekly markets for resale in different local markets.

Pastoralist livestock production in Senegal is also subject to several other production risks. These include:

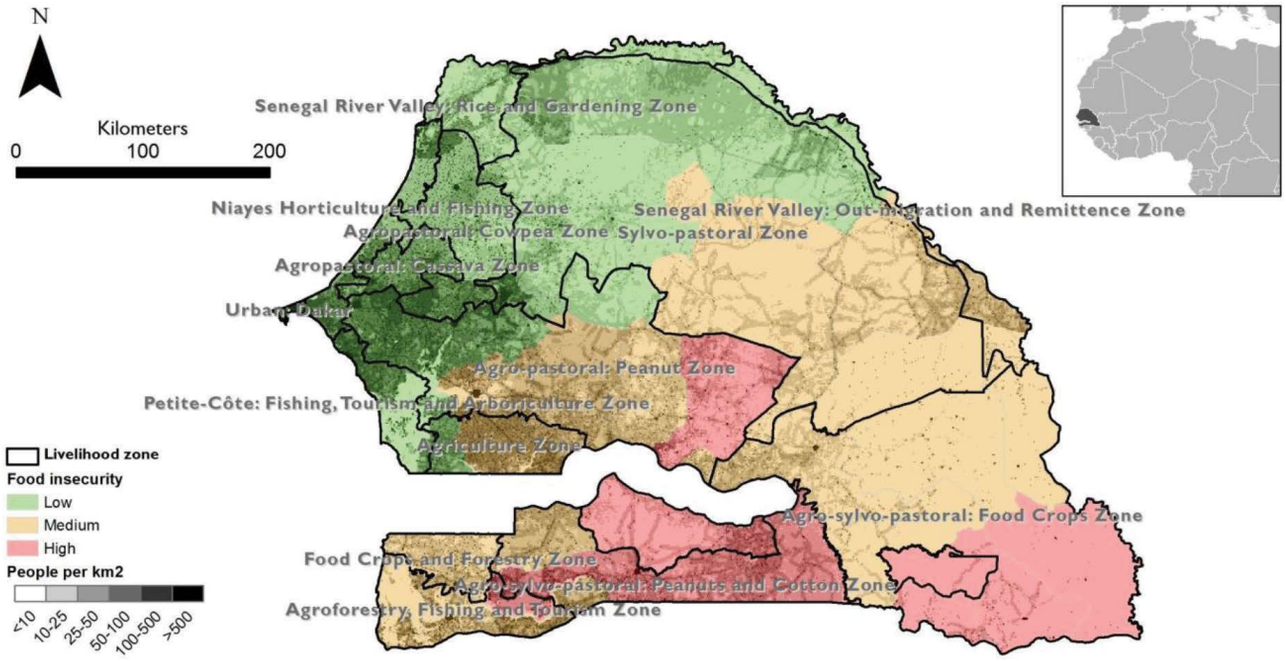
- **Diseases:** Key diseases affecting livestock producers in Senegal include Rift Valley Fever, foot and mouth disease and contagious bovine pleuropneumonia. In its 2016 livestock sector risk assessment, PARM estimated that livestock diseases accounted for average losses amounting to a staggering XOF 414 billion (USD 756 million) per year. Of all the identified production risks for pastoralists, these are the largest losses suffered annually by the livestock sector. Conversely, in interviews conducted for this study and for the World Bank's 2015 agricultural risk assessment (WBG 2015), diseases were rarely mentioned as a major risk for livestock producers. Possible explanations for this might have to do with the interviewers' focus on shocks or with the producers' perception of livestock diseases as part of 'business as usual', as opposed to droughts which occur infrequently but when they do, present significant challenges.
- **Bushfires:** These occur every year in Senegal, particularly in the eastern and southern regions of the country. The Centre de Suivi Écologique (CSE), a natural reSource monitoring centre operated jointly by the government and technical partners, estimates that fires are mostly started voluntarily, either by farmers or criminals. They pose a serious risk to pastoralists as they obliterate valuable biomass and thus potential animal pasture. The CSE monitors the occurrence of bushfires and publishes annual results in regular bulletins.[17] During the period 2002-12, the CSE estimated that fires destroy 791,332 ha per year, on average. Of the destroyed land, 59% (466, 885 ha) was from bushfires (PARM 2016). The World Bank estimates that bushfires can destroy as much as 6 per cent of the potential dry season grazing area and 3.8 million tonnes of biomass per year, on average (WBG 2015). However, it should be noted that bushfires are mainly concentrated in the southern part of the country.
- **Locust infestations:** These directly affect pasture availability, thus significantly affecting grazing lands for ruminants. Fortunately, locust invasions are a relatively rare occurrence in Senegal. For the locust infestation of 1988, associated livestock losses were estimated at XOF 4.3 billion (USD 7.9 million).

In summary, the evidence showing severe impact of droughts on pastoral livelihoods is mixed. The highlights are:

- **The impact of droughts on pastoral livelihoods is clearly significant.** Pastoral leaders frequently report droughts as one of the most important or even the most important risk faced by pastoralists. Highlights from the PARM analysis are (i) large-scale droughts tend to occur about once every five years and can lead to significant livestock losses, (ii) rainfall variability is expected to increase in future due to climate change and (iii) households dependent on livestock holdings are among the most vulnerable in Senegalese society.
- **Agro-pastoralism, rather than pastoralism, seems to be the most food insecure livelihood. Risks other than droughts are also important for the livestock sector.** Different data Sources stress that it is mostly agro-pastoralists, not nomadic pastoralists, who are among the poorest and most vulnerable people in Senegal. The WFP food security analysis also shows that it is not the nomadic pastoral areas in the northern 'Ferlo' area that are most exposed to food insecurity, but the agro-pastoral households located in central and southern Senegal (Figure 2.8). The PARM livestock sector risk assessment (summarized in Table 2.9), shows that the Senegalese livestock sector is exposed to other risks, including livestock diseases and bushfires. This suggests that complementary instruments might need to be considered as part as comprehensive disaster risk management and livelihoods protection strategies at a national level.

17. These ' Suivi des feux au Sénégal' bulletins are published annually on the website of the CSE (https://www.cse.sn/index.php/publications/veille-environnementale/suivi-des-feux-de-brousse/category/10-suivi-des-feux-de-brousses).

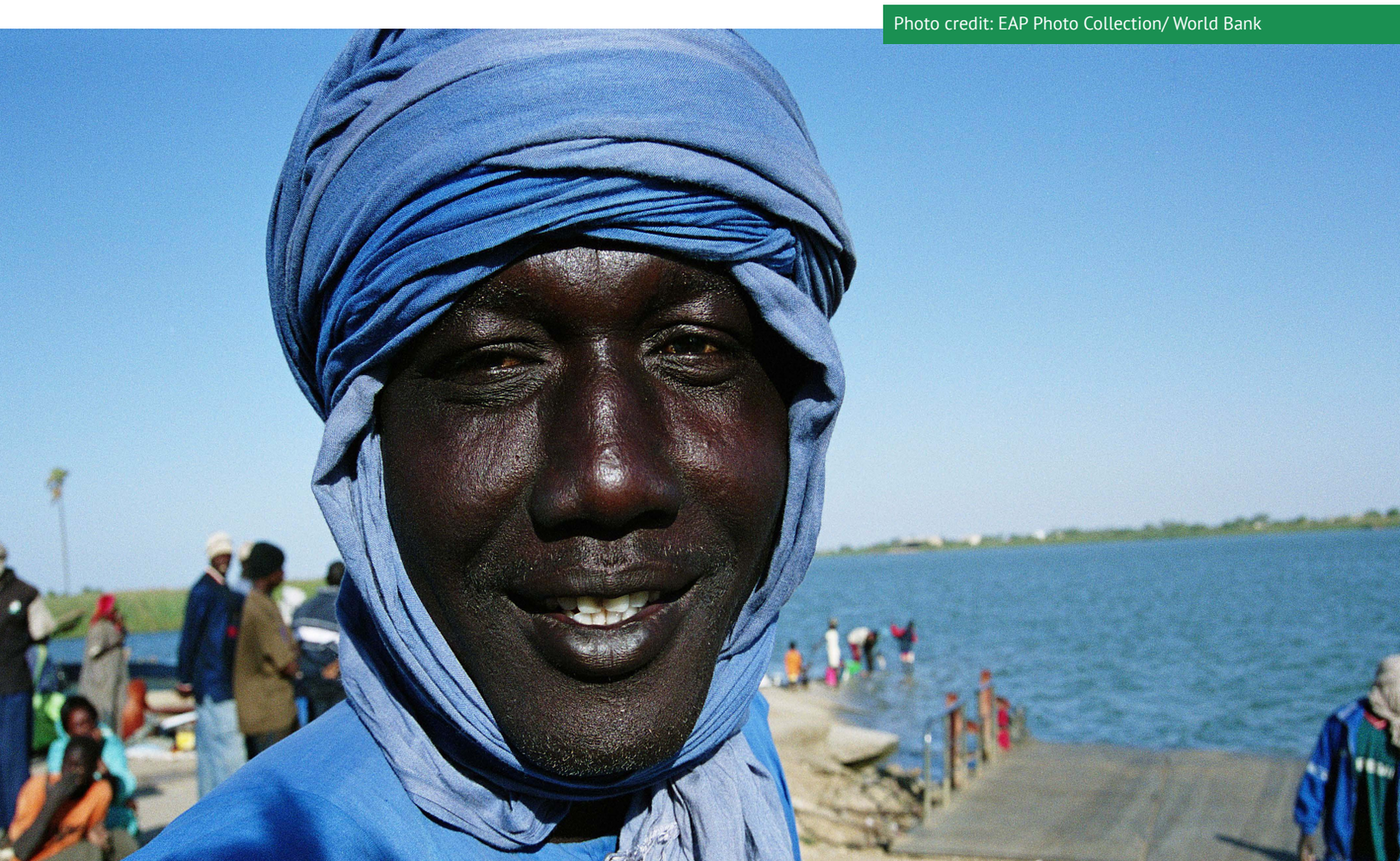
FIGURE 2.7 FOOD INSECURITY IN SENEGAL BASED ON - FOOD INSECURITY PREVALENCE, POVERTY INCIDENCE, AND GLOBA CHRONIC MALNUTRITION INDICATORS



Food insecurity is shown in this map through three proxies: prevalence of food insecurity, poverty incidence and global chronic malnutrition as measured by the CFSVA (2009/2010).
A department is considered to have high food insecurity when prevalence of food insecurity is >20%, poverty incidence is >60% and GCM is >30%.
A department is considered to have medium food insecurity when prevalence of food insecurity is 15-20%, poverty incidence is 40-60%, and GCM rates are 20-30%.
A department is considered to have low food insecurity when prevalence of food insecurity is <15%, poverty incidence is <40%, and GCM rates are <20%.

Source: WFP (2014)

Photo credit: EAP Photo Collection/ World Bank



2.6 Pastoralists' demand for livestock insurance

The Initiative Prospective Agricole et Rurale and BRACED conducted a qualitative study to gauge the potential interest and willingness of pastoralists to pay for an index-insurance product (IBLI design) covering drought impacts on livestock (Mame Mor et al. 2019). The study was conducted in 2018 on 300 pastoral and agro-pastoral livestock keepers in the departments of Podor, Dagana, Ranérou, Linguère and Koumpentoum. To assess the willingness of livestock keepers to pay, a contingent valuation (CV) approach was used. The CV approach involves the selection of a representative sample of the population and assessing their willingness to give up or pay for specific goods through questionnaires.

Most livestock keepers (80%) indicated that insurance products would be valuable to them and demonstrated a basic understanding of insurance principles, but poor knowledge of the range of agricultural insurance products. A more nuanced view was shared around the level of trust in the broader insurance system, with about 56% indicating they were sufficiently confident and the rest expressing little or no confidence in insurance. The study did not investigate the specific reasons behind this lack of confidence in insurance.

The study identified drought (i.e. rainfall deficit) as the most important risk to cover through insurance. Livestock rustling and livestock diseases ranked second and third, respectively. Of note, while livestock rustling was indicated as the primary risk, less interest was indicated in a related insurance product.

Once the concept had been explained, there was a preference towards index-based insurance and specifically towards a product associating rainfall deficit to forage availability. During group discussions with pastoralists and pastoral breeder's associations, strong consensus was expressed on the potential value of an index-insurance product covering forage availability. However, questions were raised on how such a product would be implemented, especially considering herd mobility.

The willingness to pay analysis indicates that 50% of breeders are ready to pay XOF 3,000 (about USD 6) to insure 1 head of cattle and 25% of the breeders were willing to pay up to XOF 10,000 (about USD 18) for total sum insured of XOF 100,000 (about USD 180). The results of the analysis should be cautiously relied upon since they are largely based on qualitative information. However, the results suggest that there is reasonably strong interest in livestock insurance and relatively good capacity to cover the insurance premium by pastoralists.

Photo credit: Daniella Van Leggelo-Padilla / World Bank

Key takeaways from Chapter 2: Socio-economic assessment	
Economic importance	The livestock sector is an important economic sector in Senegal, contributing 38 and 3.6% to agricultural and national GDP, respectively in 2018. Around 24% of the population (more than 3 million people), are estimated to be nomadic pastoralists or agro-pastoralists.
Cost and impact of droughts on pastoral livelihoods	No recent data are available on livestock-related drought costs. A modelling analysis at country level indicates an average drought response cost of between USD 26 -140 million (maximum) per year. The livestock-related drought cost in the 1970s and 1980s was estimated to range from USD 14-34 million per year.
Production systems	The two main livestock production systems are nomadic pastoralism and agro-pastoralism. Nomadic pastoralists are concentrated in the silvo-pastoral zone in the country's northeast, termed the 'Ferlo', while the agro-pastoralists tend to be concentrated in central and south-eastern Senegal. Fueled by population growth, land pressures and government policy, agro-pastoralism is on the rise even though there is no reliable data on the size of this sub-group versus that of nomadic pastoralism.
Vulnerability	Households dependent on livestock belong to the poorest, most vulnerable and most food-insecure households in Senegal. Agro-pastoralists tend to be significantly worse off than nomadic pastoralists, which is also reflected in the national distribution of poverty and food insecurity.
Pastoralists' demand for livestock insurance	As per the 2018 IPAR and BRACED study, there is general interest in livestock drought insurance and willingness to pay for this cover by pastoralists.

3. Technical assessment

This section illustrates the results of the technical feasibility assessment, aimed at evaluating the possibility of designing an IBDRFI product for the extensive pastoral areas of Senegal. An IBLI product design was used for the assessment (Appendix 2). However, the feasibility analysis could also inform the development of alternative drought indices based on NDVI or other EO satellite indicators of drought. The datasets and methodology used are described in Appendix 2.

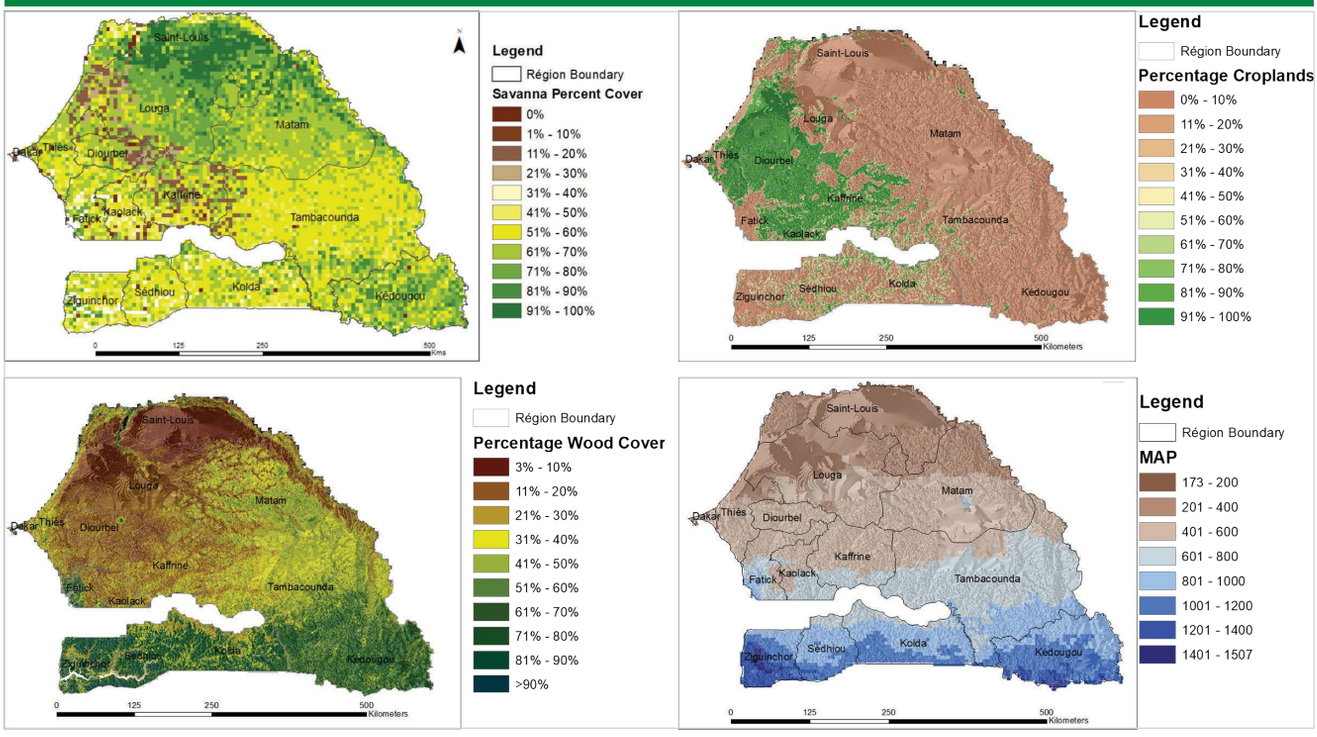
3.1 Agro-ecological characterization and rangeland distribution

Senegal is characterized by a single rainfall season with a strong north to south gradient in temperature (decreasing) and precipitation (increasing). Extremely dry climate is observed in the northern part of the country towards the arid Sahara desert. The climate gets wetter moving southwards with a northeastern to southwestern gradient (Figure 3.1d). The inter-annual rainfall patterns are strongly influenced by the movement of the inter-tropical convergence zone (ITCZ), peaking in August (Rian et al. 2009). The region suffers frequent and recurrent droughts due to the variations in latitudinal movements of the ITCZ from one year to another, causing large inter annual variability in rainfall (Nicholson 2001; Rian et al. 2009).

Two major bioclimatic regions are present in Senegal, the Sahelian and Sudanian regions dividing the country into two almost equal halves (CILSS 2016; Patrice et al. 2017). These regions show transitions in climate and land use in a north-south direction. The Sahelian region is a semi-arid belt in the northern half of the country running from east to west, with a mean annual precipitation (MAP) of 150 to 600 mm (Funk et al. 2015). The Sudanian region covers the southern half of Senegal. The region is wetter than the northern region with MAP ranging from 600 to 1 500 mm (CILSS 2016), benefitting from a relatively longer wet season typically lasting from May to December/January.

Pastoralism and agro-pastoralism are the main livelihoods in the Sahelian region, which is dominated by savannah ecosystems (Figure 3.1a). The vegetation is broadly characterized by open grasslands often mixed with relatively low woody plant species in the north while toward the east/southeast, the woody cover gradually increases (Figure 3.1a and 3.1c). This region also has some important wetlands, particularly the Senegal delta, which forms part of River Senegal, the second longest river in west Africa after the Niger. In the Sudanian region, the vegetation becomes denser, with savannas becoming open woodlands due to the higher annual precipitation. This is the region where croplands dominate (Samasse et al. 2020). Croplands are concentrated in the west, where more than 80% of the population lives (CILSS 2016) (Figure 3.1b). Dense woody cover is dominant in the south, due to the presence of woodlands and gallery forests (Figure 3.1c).

FIGURE 3.1 AN ILLUSTRATION OF RANGELAND COVER (A), CROPLAND COVER (B), WOODY COVER (C) AND MEAN ANNUAL PRECIPITATION (MAP) (D)[18] IN SENEGAL



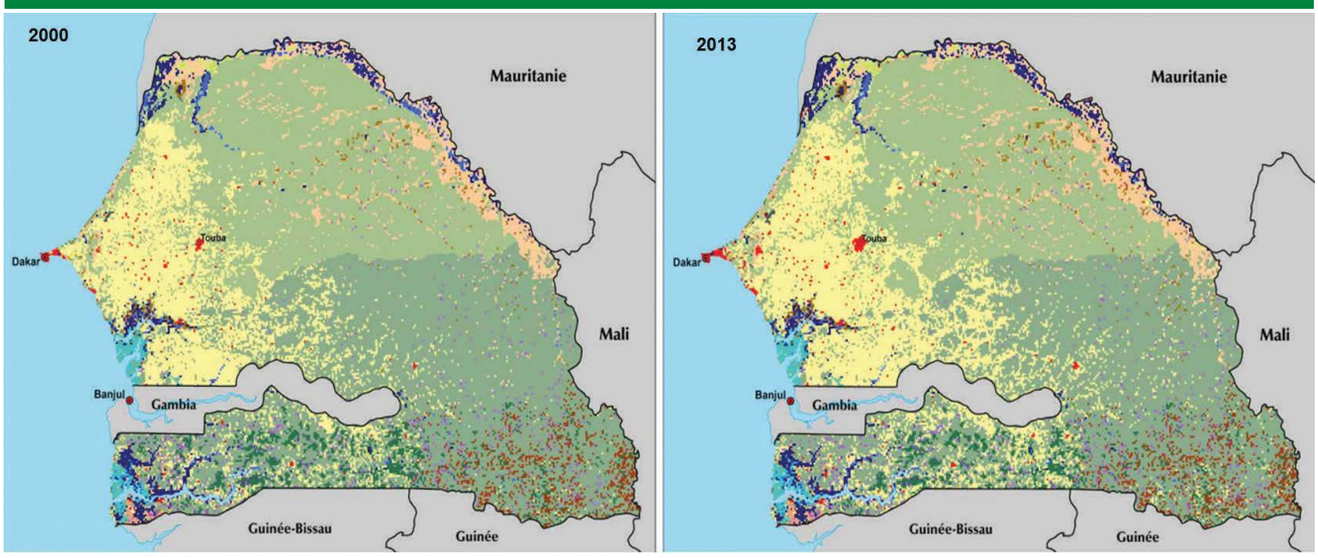
Source: Author's own illustration

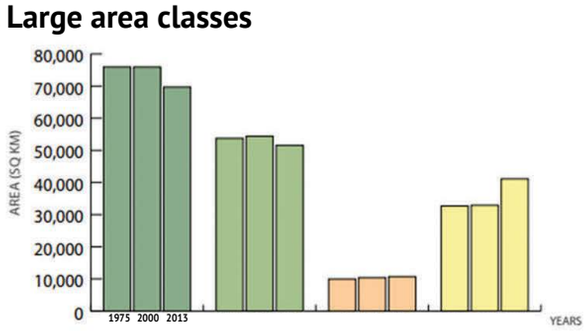
Land use/cover change has been a major challenge in Senegal, leading to loss of natural vegetation within savannas and woodlands (Figure 3.2). The expansion of agricultural lands is responsible for most of the land use/cover changes in the last few decades at the expense of woodlands, pastoral and protected areas. An increase in cultivated lands has been the most significant land use change in Senegal, with total cultivated areas increasing by slightly above 20% from 1975 to 2013 (CILSS 2016; Cotillon 2017; Tappan et al. 2016) and showing a general progression from west to east (Wood et al. 2004). The most dramatic and largest conversions into cultivated land occurred between 2000 and 2013 (Figure 4.2). These changes were most pronounced in central Senegal and Casamance, a region that lies south of the Gambia along the Casamance river. In contrast, reduced commercial value of some farmlands (particularly in the peanut basin) forced farmers to move to other more profiTable ventures in the 1980s and 1990s, (Cabral et al. 2017). The abandoned farms have reverted into grasslands, which may be considered an increment in pastoral lands (CILSS 2016). It is noteworthy that while various classifications exist for ecological regions, land use/cover, rangeland and cropland distribution (CILSS, 2016; Fare et al., 2017; FEWSNET, 2015) disparities are evident.

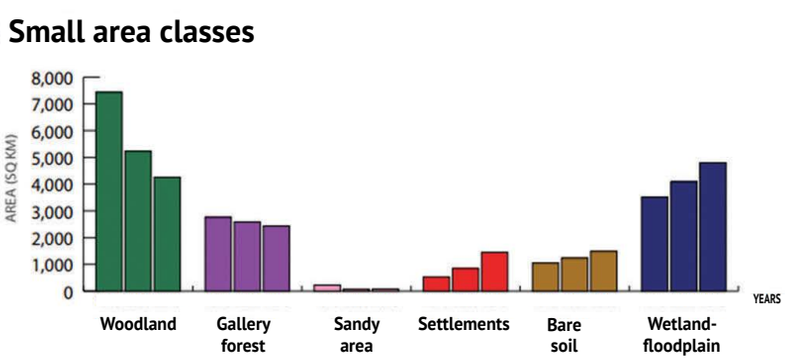
18. Derived from the Joint Research Centre cropland and rangeland masks used in the Anomaly Hot Spots of Agricultural Production (ASAP) early warning system and the woody cover from Anchang et al. (2020).

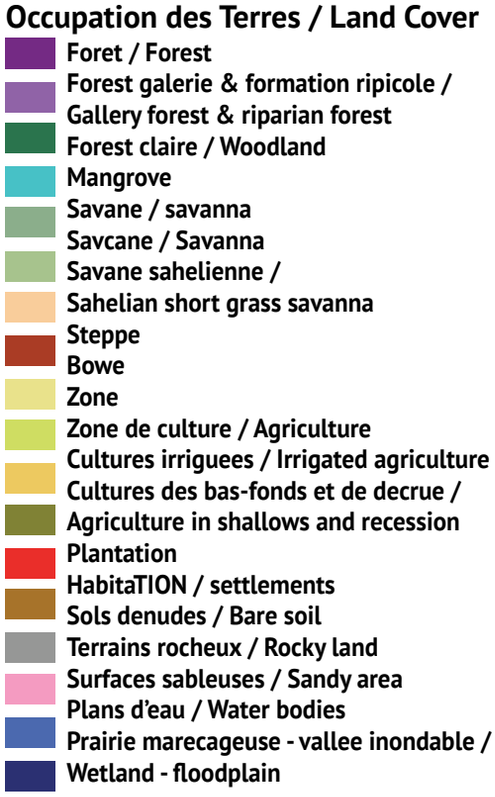
Photo credit: EAP Photo Collection/ World Bank

FIGURE 3.2 LAND COVER/USE CHANGES IN SENEGAL









Source: CILSS (2016)

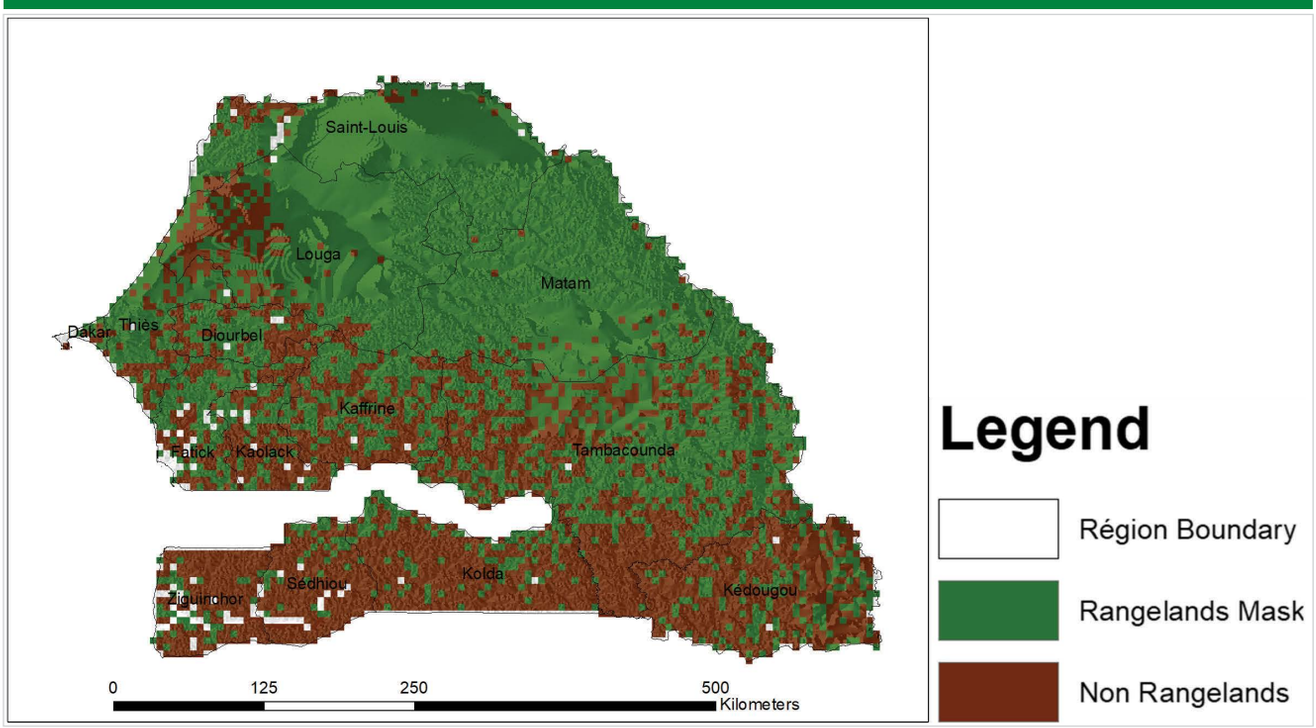
Natural and human-driven bush fires are recurrent phenomena in Senegal, especially in the southeastern part of the country within savanna ecosystems (Archibald et al., 2013; CILSS, 2016; Giglio et al., 2013; Kahiu et al., 2018). These are important as they maintain the structure of savanna biomes by keeping the tree layer/cover low, thus preventing forests from encroaching onto the grassland (Bond, 2001; Bowman et al., 2009). Controlled fires also allow the rejuvenation and resprouting of more nutritious grass for herbivores (livestock/wildlife). However, as illustrated in Section 2.5, bush fires are also a key risk for herders.

Recurrent droughts have also contributed to changes in vegetation characteristics and composition in Senegal. Senegal experiences recurrent droughts caused by low, erratic and variable rainfall, particularly in the northern and eastern regions of the country that lie within the Sahelian bioclimatic region (WFP 2014). Over the years, drought events coupled with overgrazing have led to the degradation of the savanna structure, vegetation cover and productivity, pushing them into steppe-like characteristics, while extreme cases have resulted in bare and unproductive land.

3.2 Assessment of feasible areas for IBDRF product design

Extensive rangelands, which are suitable for IBLI design dominate a large portion of the north of the country (Figure 3.3). The area suitable for NDVI-based IBDRFI products for pastoralists is limited in the west by the increase in croplands cover (Figure 3.1b) and in the south and southeast by the increase in woody cover (Figure 3.1c). Cropland-dominated areas are considered unsuitable, while savannahs with high woody cover need to be reviewed with local stakeholders to confirm if they are effectively used for extensive grazing.

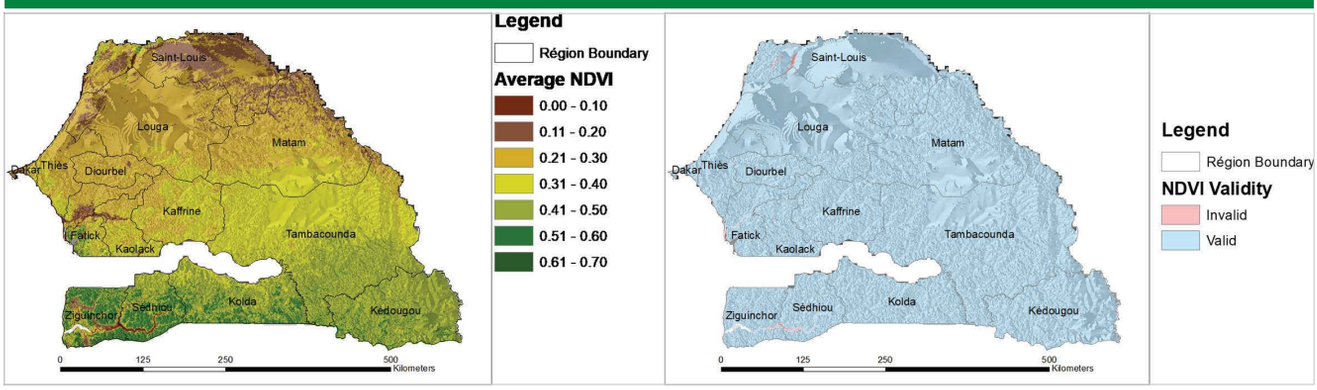
FIGURE 3.3 RANGELANDS' MASK GENERATED FOR SENEGAL



Source: Copernicus GLS (Appendix 3)

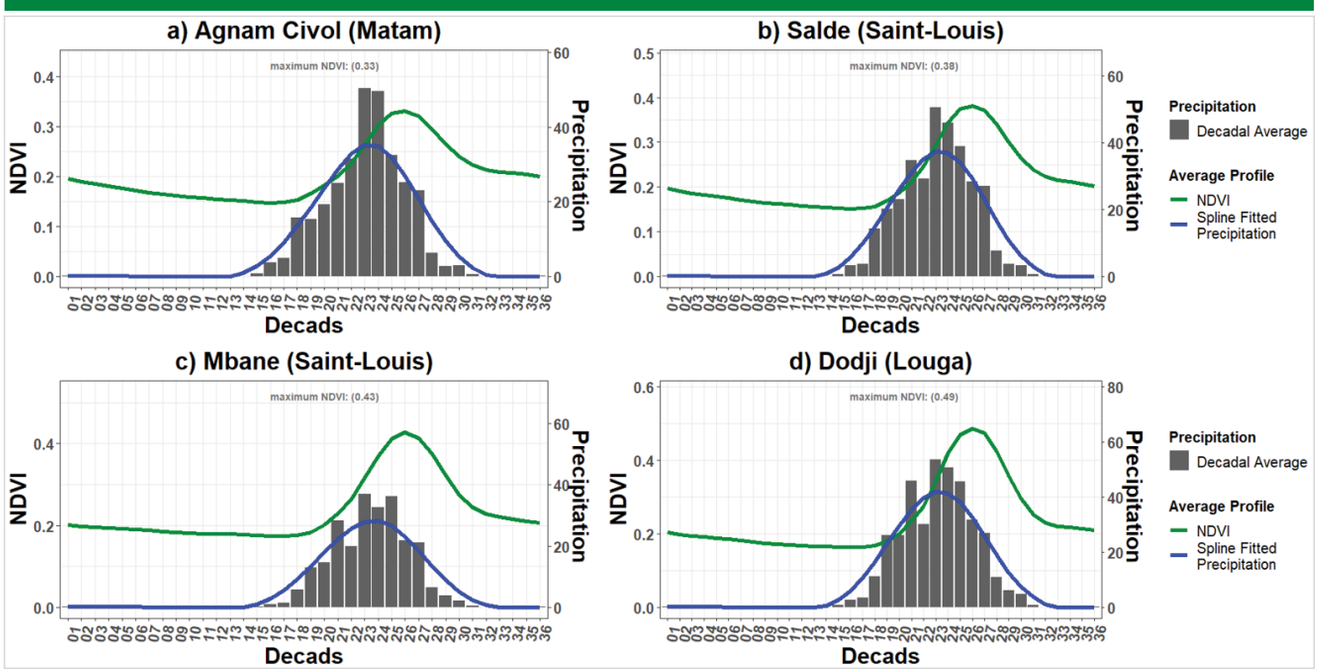
The NDVI intensity: The signal is sufficiently clear and strong for most of the rangeland-dominated ecosystems in Senegal. The average NDVI across the country shows high intensity (an indicator of forage availability), with a southward increase in response to higher precipitation (Figure 3.4a). As a result, the NDVI signal is sufficiently strong in most areas of Senegal (Figure 3.4b).

FIGURE 3.4 NDVI INTENSITY (A) AND A MAP AREAS WITH SUFFICIENTLY STRONG NDVI SIGNAL VALIDITY (B) IN SENEGAL



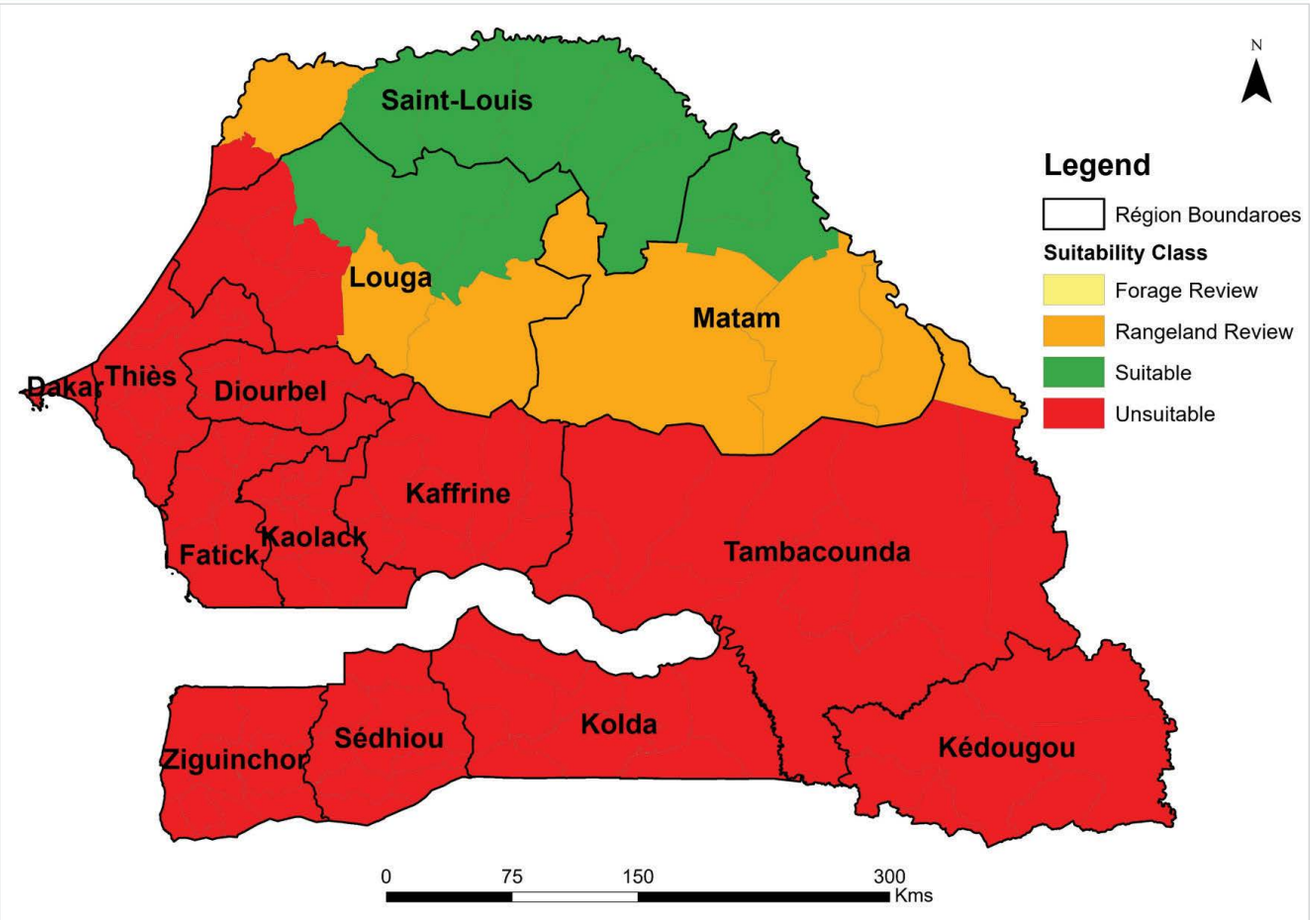
The rainfall and vegetation growth patterns in the rangeland dominated regions in Senegal show well-defined seasonality, allowing for clear definition of one distinct drought risk period. The pasture and rangeland vegetation growing season has a 1 month lag time with respect to precipitation onset. It runs from July to October/November, showing clear and geographically consistent patterns for the various rainfall stations/departments (Figure 3.5). This allows for forage availability risk period definition from July to November within the pastoral areas in Senegal. As also shown in Figure 3.7, NDVI decadal averages are quite consistent across northern Senegal, reflecting the vegetation growth over the season despite some variability in the intensity of the signal.

FIGURE 3.5 ANNUAL AVERAGE VEGETATION AND PRECIPITATION CLIMATOLOGY OF FOUR NORTHERN PASTORAL UNITS IN SENEGAL



The final classification of Senegalese administrative units into feasibility classes indicates that about 14.6% of Senegal's land area (marked in green) would be feasible for IBLI design, while 18.3% of the area (marked in orange) meets most of the suitability criteria but requires more work to ascertain rangeland extents (Figure 3.6). This includes the northern areas dominated by pastoralists, but also part of the region characterized by agro-pastoral livelihoods. The northern central part of the country in parts of Saint Louise, Louga and Matam regions are fully feasible, while the southern portion of these regions needs further analysis and review with stakeholders to confirm the extent, relevance and use of these pastoral areas before implementation. Unsuitable units dominate the southern parts of the country where crop production, forestry production, urban settlements and other economic activities are practiced.

FIGURE 3.6 TECHNICAL FEASIBILITY OF IBLI DESIGN IN SENEGAL

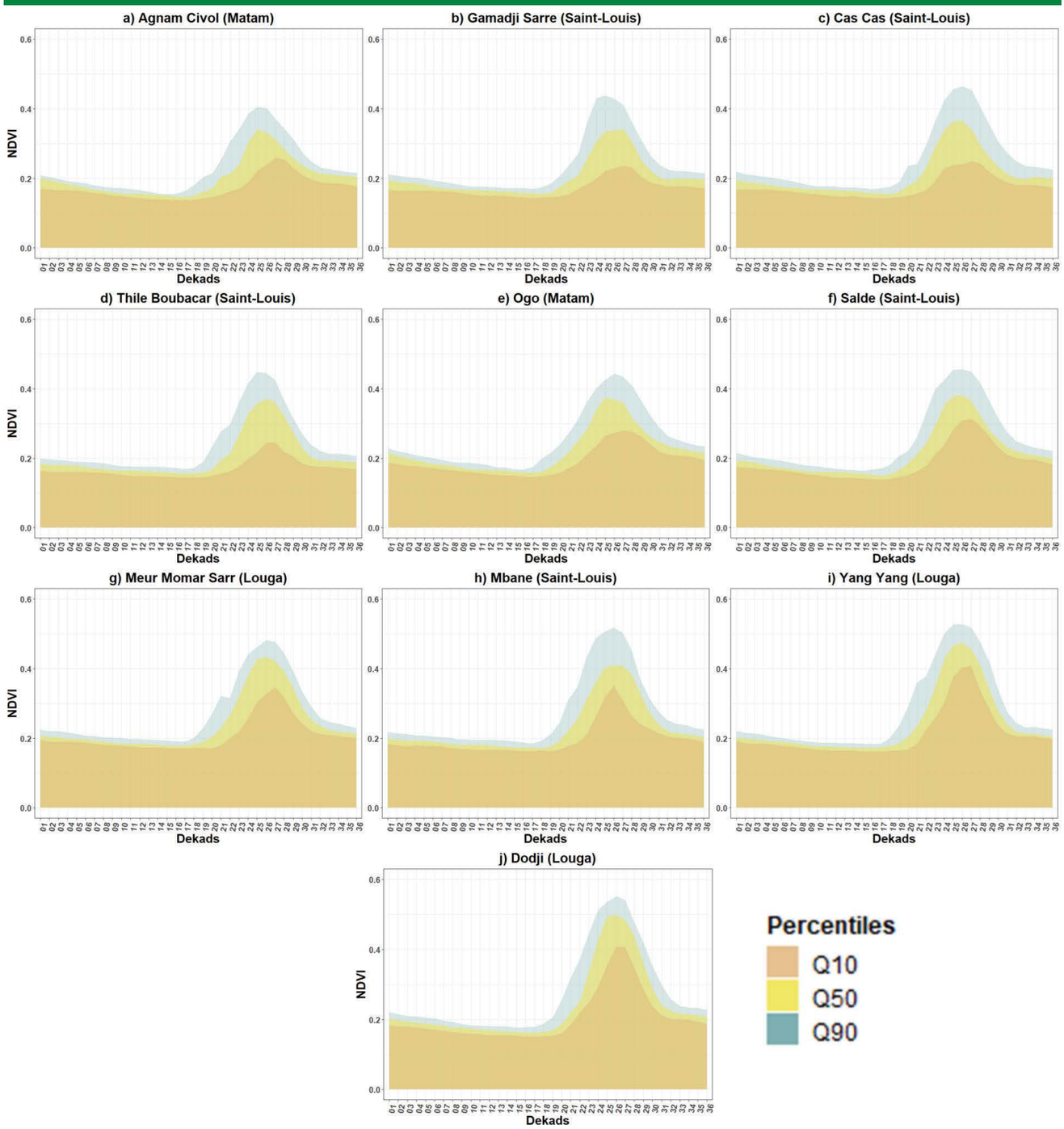


Source: Authors' own illustration

3.3 Characterization of the feasible units

The average vegetation growing season in the suitable units is relatively homogeneous, although there is small variation in intensity of the vegetation signal in response to the increase in precipitation in a north-eastern to south-western pattern. The NDVI intensity increases southwards with increase in precipitation as shown from Figure 3.7b (Gamadji Sarre, the most northerly driest administrative unit) to Figure 3.7j (Dodji, the most southerly wettest administrative unit). The inter-annual variability, however, is quite significant, with a tendency towards strong delay in the onset of the season during drought years.

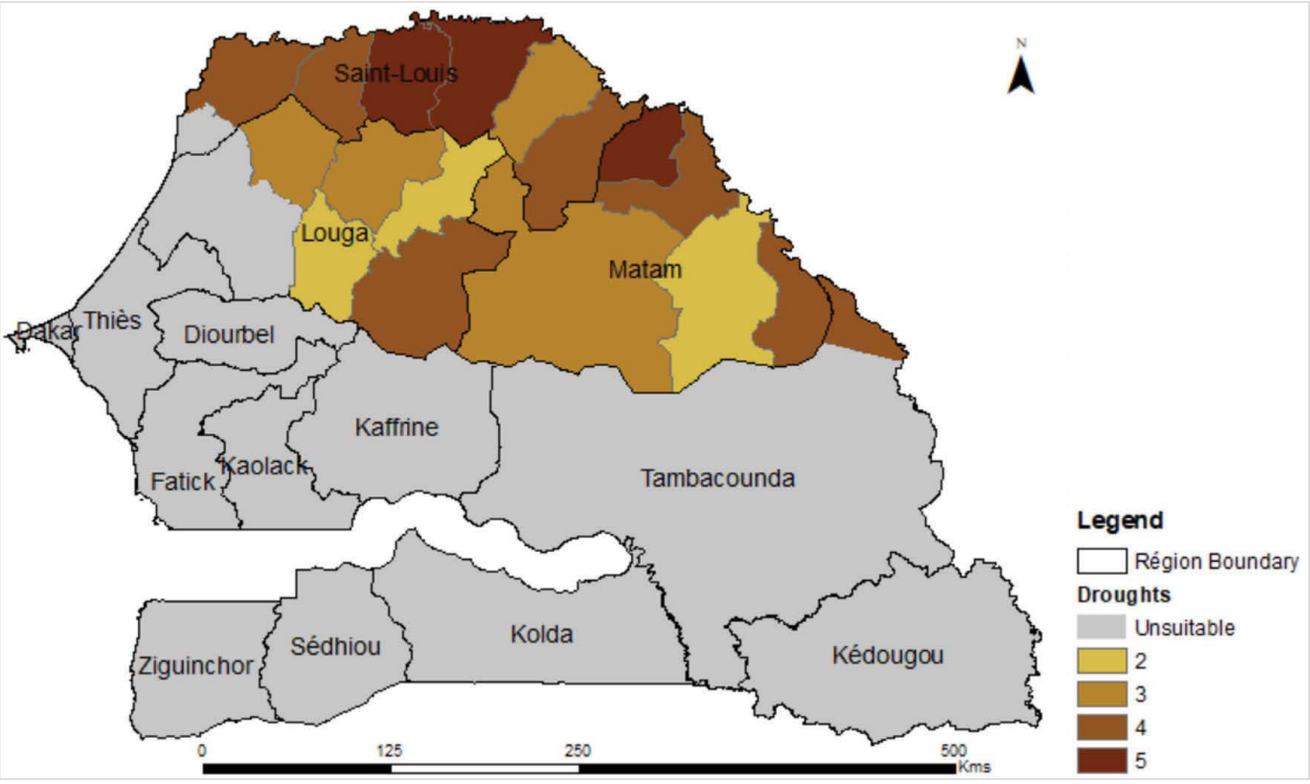
FIGURE 3.7 VARIABILITY IN NDVI OVER THE PASTORAL AREAS IN SENEGAL SHOWN USING THE 10TH, 50TH AND 90TH PERCENTILE RANGES



In the 18 years under consideration (2002-19), the suitable units in Senegal have experienced between 2 to 5 relevant drought episodes [19](Figure 3.8). A certain degree of geographic variability in drought frequency seems to characterize the region, with northern pastoral regions more vulnerable to drought than southern ones. However, this assessment is based on the subjective threshold of the index value (see methods in Appendix 3) and while it can provide a general overview of drought frequency, it might need to be interpreted with caution.

19. A 'relevant' drought episode is defined here using a fixed threshold of the seasonal IBLI index of -0.84 (standard score). This is a subjective threshold, therefore, it should be interpreted as indicative.

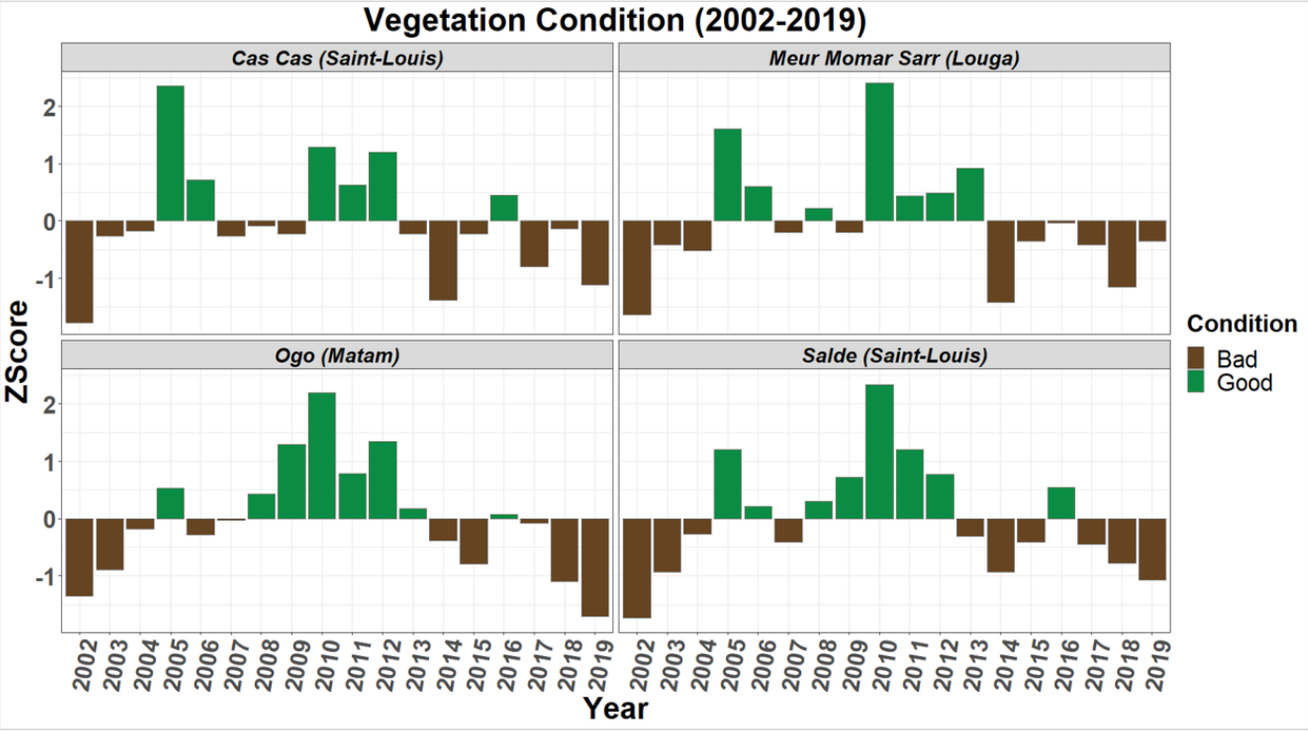
FIGURE 3.8 DROUGHT FREQUENCY IN SENEGAL'S PASTORAL AREAS FOR THE PERIOD 2002 TO 2019



Forage deficit conditions are not regularly distributed and generally persist for either 2 or 3 consecutive seasons (Figure 3.9). Between 2002 and 2019, three major drought events can be deduced, consistent with the observations reported in Section 2.4 (2002-03, 2014-15 and 2018-19 droughts). In all cases, the deficits persist until the following season. This might suggest either cyclic rainfall patterns or limited ability of rangeland systems to recover after major droughts.

Photo credit: EAP Photo Collection/ World Bank

FIGURE 3.9 VEGETATION PERFORMANCE ACROSS FOUR PASTORAL REGIONS IN SENEGAL BASED ON 18-YEAR ENHANCED MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (EMODIS) NDVI OBSERVATIONS (2002-19)



Green and brown bars indicate above and below average vegetation production, respectively.

Based on the typical forage growing season spanning from mid-July to October/November (Figure 3.10) within the suitable areas in Senegal, a single risk period can be defined. The risk period for the coverage is typically defined by the length of the vegetation growing season as the IBLI index is built to estimate seasonal deficits in forage production due to limited rainfall.

Photo credit: EAP Photo Collection/ World Bank

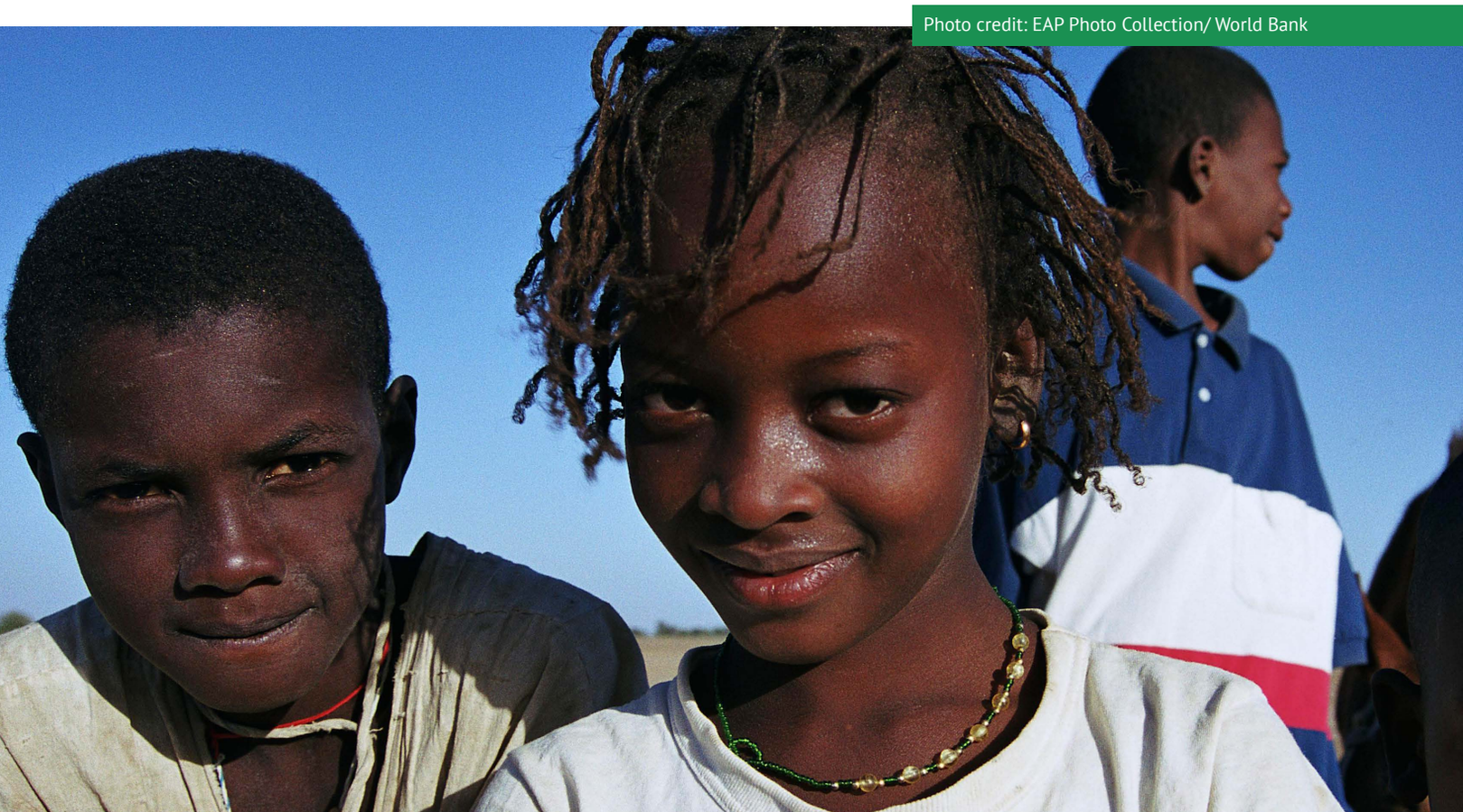
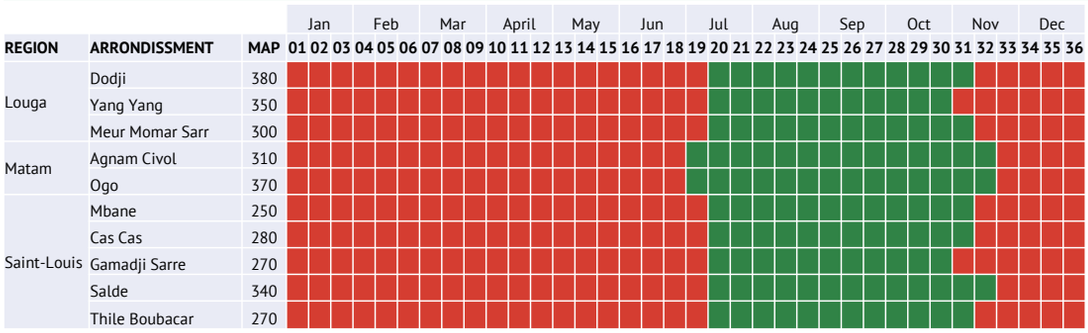


FIGURE 3.10 FORAGE GROWING SEASON FOR THE SUITABLE UNITS (SHADED IN LIGHT BLUE)

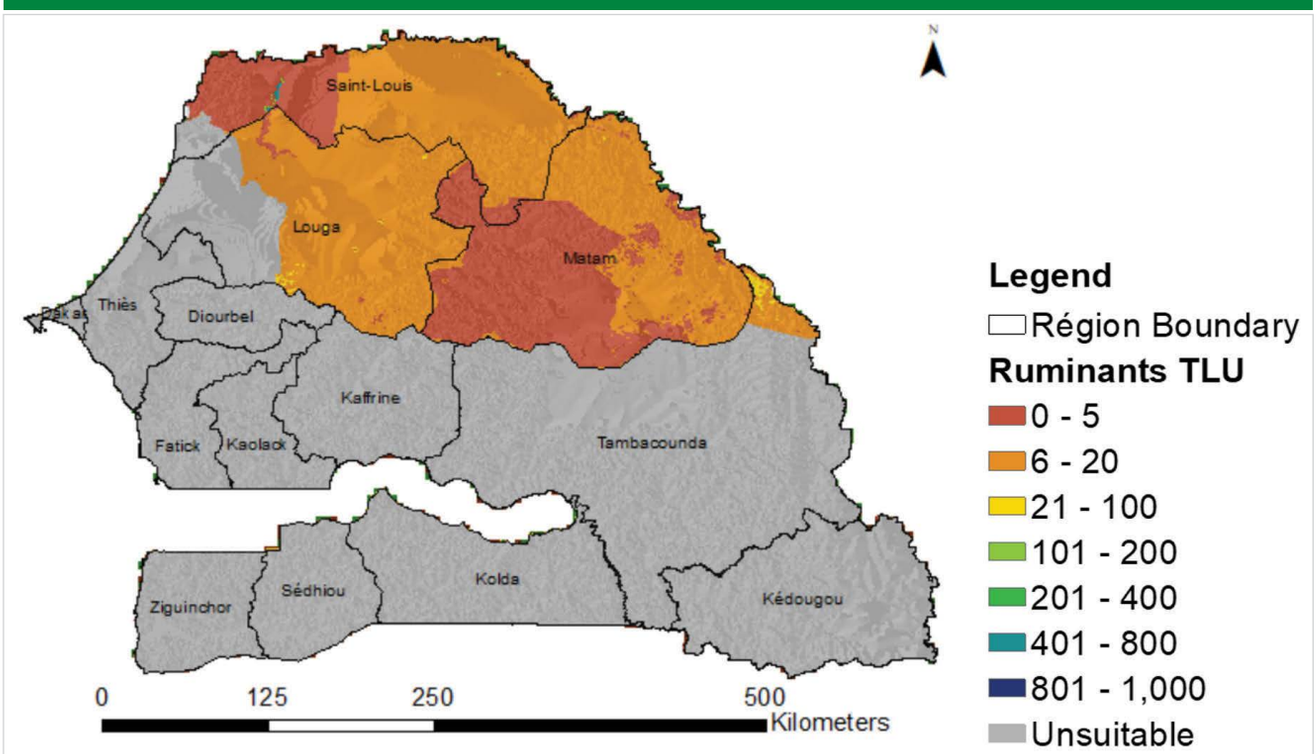
REGION	ARRONDISSMENT	MAP	SOS1	EOS1
Louga	Dodji	380	20	31
	Yang Yang	350	20	30
	Meur Momar Sarr	300	20	31
Matam	Agnam Civol	310	19	32
	Ogo	370	19	32
Saint-Louis	Mbane	250	20	31
	Cas Cas	280	20	31
	Gamadji Sarre	270	20	30
	Salde	340	20	32
	Thile Boubacar	270	20	31



MAP= mean annual precipitation

Suitable pastoral regions host a significant number of the country's livestock population (Figure 3.11 and Table 3.1). The suitable rangeland areas host about 26% of the national livestock herd, with the largest numbers of livestock (14% of national livestock herd) located in what are considered feasible administrative units for insurance cover, while 11% of the national livestock herd is located in administrative units that require further review. Most of the suitable areas are located in the regions of Saint-Louis, Matam and Louga. It would be important to evaluate the opportunity to design an alternative product in the southeastern region of Tambacounda, which hosts a significant portion of the national livestock herd.

FIGURE 3.11 LIVESTOCK (EXCLUDING POULTRY) POPULATION DENSITY DISTRIBUTION (TLU/KM2) WITHIN PASTORAL AREAS THAT COULD BE CONSIDERED FOR DROUGHT INDEX IMPLEMENTATION IN SENEGAL. THE PERCENTAGE IN THE TABLE IS RELATIVE TO THE TOTAL LIVESTOCK POPULATION



Feasibility Class	TLUs	Percentage
Unsuitable	1,933,259	74.2%
Rangeland Review	296,370	11.4%
Suitable	376,037	14.4%

Source: Modified from 2015 FAO ruminants tropical livestock units data (Gilbert et al. 2018)

TABLE 3.1 DISTRIBUTION OF RUMINANT LIVESTOCK TLUS IN SENEGAL. HIGHLIGHTED IN GREEN ARE THE THREE MAIN REGIONS, WHICH INCLUDE FEASIBLE UNITS

Region	TLUs	Percentage
Dakar	29,134	1.12%
Kédougou	34,700	1.33%
Ziguinchor	46,391	1.78%
Sédhiou	51,144	1.96%
Kaffrine	125,014	4.80%
Diourbel	126,293	4.85%
Fatick	129,910	4.99%
Thiès	141,790	5.44%
Matam	177,432	6.81%
Kaolack	197,253	7.57%
Saint-Louis	233,006	8.94%
Kolda	304,903	11.70%
Louga	383,559	14.72%
Tambacounda	625,137	23.99%

Key takeaways from Chapter 3: Technical feasibility assessment	
Rangeland dominance	Extensive natural rangelands dominate the northern part of the country and would be suitable for IBDRFI initiatives (IBLI design). The extent of extensive rangelands is the main factor limiting feasibility of an IBLI design. Small-holder cropping, or mixed crop-livestock systems are prevalent in western and southern Senegal, while the eastern portion of the county is characterized by high woody plant cover and a more complex mosaic of land uses, making these areas sub-optimal for IBLI design.
Seasonality and signal intensity	Rangeland seasonality is well-defined and relatively homogenous across the country. In the northern region, the typical rangeland growing season lasts from July to November. These factors do not limit the feasibility of IBLI design in the country.
Overall feasibility	The feasible areas, located in the north of the country and dominated by pastoralism, cover about 33% of Senegal's land area, inclusive of those areas that are fully feasible (14%) and those requiring a review during early implementation stages (19%). The feasible areas also carry about 26% of the national herd. More substantial product design refinements should be considered to assess the possibility of including the central and eastern regions in future IBDRFI initiatives as they also host a significant fraction of the national herd.
Factors requiring further analysis	Significant land cover changes have been reported in the last 30 years, with conversion of rangelands into croplands. In addition, ongoing rangeland degradation is reported in the pastoral regions. The potential impact of these factors on the index and risk profiling should be carefully evaluated in the early implementation stages.

4. Operational assessment

This section reports the results of the operational feasibility assessment, which evaluated the conditions required to supply IBDRFI solutions and support the development of an enabling environment (institutional, regulatory and social) for long-term social and financial sustainability. Thus, it seeks to assess the existing financial infrastructure and services, policy and regulatory environment, potential distribution channels and the existing private and public stakeholders and their capacity in the financial sector. The analysis has been conducted through a combination of desktop reviews and key informant interviews with country stakeholders (see Appendix 4).

4.1 Drought risk management and financing institutional policies

4.1.1. Drought response mechanisms for the livestock sector

The government of Senegal and pastoral associations have put in place different mechanisms to respond to drought emergencies in the livestock sector. While this demonstrates the importance of drought risk management and social protection in pastoral areas from a national policy perspective, there is a clear gap in the use of IBDFRI instruments targeting livestock keepers, as discussed in Section 5. It would be important to consider how the different instruments can be integrated through a harmonized framework.

Key initiatives include the following:

- **Programme de Réponse Nationale à l'Insécurité Alimentaire (PRNIA)/National Food Insecurity Response Program:** The PRNIA distributes food assistance to affected population groups and is implemented by the food security commission, the WFP and NGOs. Like the Opération Sauvegard du Bétail (OSB), the PRNIA is managed under the second National Social Protection Strategy (NSPS) with a goal "to strengthen the resilience of individuals experiencing shocks and crises that could cause them to slip into poverty," (Rougeaux 2017). The NSPS represents a major departure in the country's policy evolution regarding risk management. This strategy calls for revision of the country's emergency response system by placing greater emphasis on prevention. It argues for replacing the reactive approach with a structural option, aimed at preventing and managing covariate risks by considering the specificity of the environment in which they occur.
- **Scalable social protection:** In Senegal, a broad array of more than 50 different social protection programs provides social protection services to beneficiaries. The most important one is the National Family Security Grants Program that provides regular cash transfers to some 300,000 poor households, thus enabling them to meet their basic needs. Over the last few years, with support from the World Bank, efforts have been made to utilize the existing social protection systems to provide rapid emergency transfers after the occurrence of shocks such as floods, food insecurity, fire and the COVID-19 pandemic. Significant work has been undertaken together with the WFP to expand Senegal's social registry, which already includes around 590,000 households (including 65% of all poor households). The objective is for the registry to cover all poor households in the country. In addition, over 8,300 households or 75,429 people have already been targeted through selected shock-response pilot cash transfers in response to food insecurity, floods and fire (WBG 2020). In 2020 the national cash transfer coverage was expanded to cover more than 1 million people in response to the COVID-19 pandemic.
- **Opération Sauvegard du Bétail/Livestock Rescue Operation:** The OSB was developed in direct response to drought-related livestock losses and the subsequent food security crisis of 2011-12. Under this scheme, the directorate of livestock and animal production in the ministry of livestock purchases animal feed from suppliers and makes it available to departmental (administrative units) committees. During droughts, targeted pastoralists are provided with animal feed at subsidized rates (50% of cost) to protect vulnerable animals, usually gestating females or diseased ones (African Risk Capacity 2015). In general, the management of OSB funds is the duty of fund management committees in each of the 45 departments that decide when to effect feed subsidies. Eligibility to the subsidized animal feed schemes is contingent upon membership in local pastoralist associations.
- **Early Warning Systems (EWS):** Different EWS tailored to the livestock sector have been developed. The Information System on Pastoralism in the Sahel (SIPSA) was developed in the early 2000s by the French Agricultural Research Centre for International Development/Centre de coopération internationale en recherche (CIRAD) and the FAO Livestock, Environment and Development program and subsequently customized in collaboration with the Senegalese authorities, including the Commissariat à la Sécurité Alimentaire (CSA) and the ministry of livestock. The SIPSA system records and analyses various indicators relevant to pastoral livelihoods, e.g. rainfall, biomass

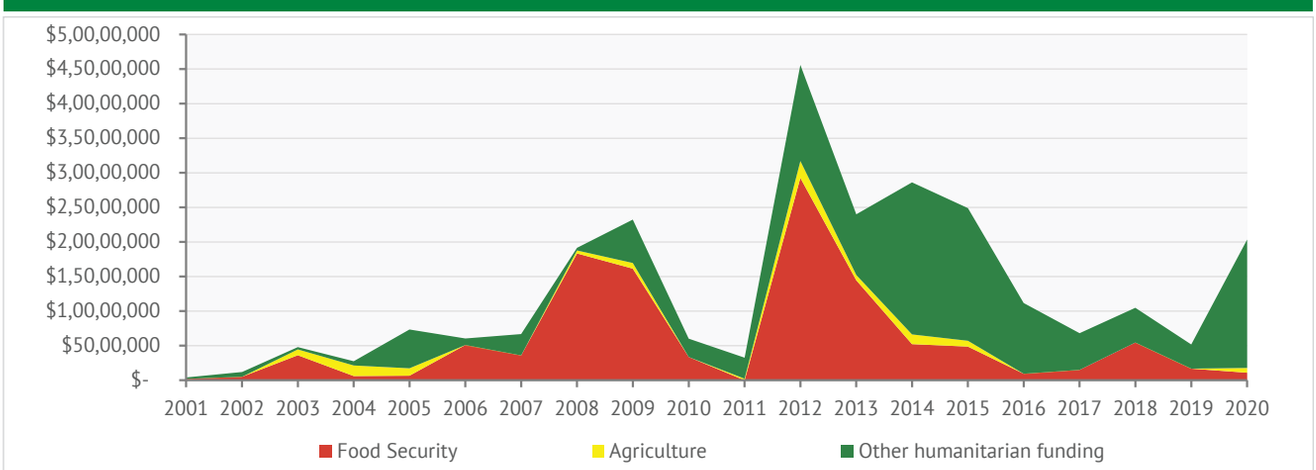
evolution estimated from NDVI (SPOT vegetation sensor), pastoral migration patterns, market locations and drilling and veterinary stations (CIRAD 2014). Unfortunately, the SIPSA system suffered from lack of enthusiasm by the stakeholders involved (Cao et al. 2008). No current information could be found on the program, although the World Bank has referred to it extensively in its preparation of the Regional Sahel Pastoralism Support Project (PRAPS) (WBG 2014). Another EWS relevant to the livestock sector is the Pastoral Warning and Information System (SPAI), which is operated by the CSE in cooperation with the Agronomes et Vétérinaires Sans Frontières. The SPAI focuses specifically on the Ferlo region and provides information on animal health, livestock theft, pastoral units, environmental data and infrastructure via its website (PARM, 2018).[20] Other EWS include the FAO Global Information and Early Warning System [21]and national systems. Some of the national systems have been reviewed (e.g. Jokalante 2018).

- **Stores of animal feed along transhumance corridors:** As a complementary measure to government programs, local pastoral associations, e.g. RBM have established stores of animal feed along transhumance corridors for communities to buy from. Other autonomous pastoral associations such as Rural and Agro-pastoral Cooperative for Development (CORAD) and the Network of Farmers and Pastoralists of Senegal (RESOPP) have been involved in ensuring smooth movement of pastoralists along the mobility corridors by facilitating negotiations among different pastoralist groups, establishing rest areas, mobile pharmacies and developing non-paying ponds for watering livestock. [22]

4.1.2. Disaster risk financing framework

The use of pre-arranged shock-responsive financing mechanisms in Senegal is still in its infancy. Senegal has not adopted a national strategy or approach to financing shock-related costs. Work is ongoing together with the World Bank on developing a disaster risk finance diagnostic and, subsequently, a national disaster risk financing strategy. Shock-responsive financing is characterized by many different institutions focusing on specific hazard types and target populations, with little coordination amongst them. As presented below, there are some pre-arranged shock-responsive financing arrangements but these are not based on any ex ante analysis of contingent liabilities. The total amount of shock-responsive finance made available by the government frequently tends to be insufficient to respond to overall needs, leading to ad hoc budget reallocations and the intervention of international humanitarian donors. On average, Senegal received USD 12.9 million annually in external humanitarian funding during the period 2001 to 2020. Funding peaked at USD 23.2 million in 2009 after severe floods and at USD 45.6 million in 2012 after the 2011 drought and food security crisis (Figure 4.1).

FIGURE 4.1 TOTAL INTERNATIONAL HUMANITARIAN FUNDING (USD) RECEIVED BY SENEGAL (2001-20)



Source: United Nations Office for the Coordination of Humanitarian Assistance (U.N. OCHA) Financial Tracking Service (https://fts.unocha.org/).

The government of Senegal uses several shock-responsive financing approaches and has shown significant interest in the use of new disaster risk financing instruments during the last decade.

20. www.spaif.org, which could not be accessed for the purposes of this study.

21. http://www.fao.org/giews/countrybrief/country.jsp?code=SEN&lang=fr

22. Interview with the president of CORAD on 10th November, 2020.

- **Allocated relief budget for the livestock sector:** The estimated budget of the ministry of livestock for humanitarian relief against drought was approximately USD 2.6 million (2014), USD 4.5million (2017) and USD 5 million (2019). Much of this funding is used for the OSB. The ministry of livestock indicated that from 2012 to 2019, the government allocated more than XOF 8 billion (USD 14.7 million) in support of OSB. This financial outlay to the ministry of livestock is the only funding specifically provided by the government for shock response in the livestock sector.
- **Other allocated shock financing budgets:** The government allocates funding to several ministries and agencies for shock responses. Recipients include the CSA, the Secrétariat Exécutif du Conseil National de Sécurité Alimentaire, the Département de la Protection Civile, the Ministère du Renouveau Urbain, de l'Habitat et du Cadre de Vie, the Caisse Nationale du Crédit Agricole du Sénégal (CNCAS), the Fonds de Solidarité Nationale and the Cellule contre la Malnutrition. The size of these budget allocations varies from year to year. They are not specific to the livestock sector but include other sectors.
- **Agricultural insurance:** Senegal has several agricultural insurance programs, which are subsidized by the government and implemented through the PPP with CNAAS. These are evaluated in further detail in Section 4.
- **Sovereign drought insurance:** The government of Senegal was one of the founding participants of the first drought risk pool of the ARC in 2014 and has participated in all subsequent risk pools. At the government level, the ARC program is managed by the CSA. Senegal received drought-related payouts from the ARC in 2015 and 2019 amounting to a total of USD 16.5 and 12.5 million, respectively. Payouts to the government are channeled through the Senegal Operations Plan, which mandates part of the funding to be distributed via the OSB program. For example, of the USD 16.5 million received by the government in 2015, USD 1.8 million was dedicated to the livestock sector through the OSB program. Through Save the Children, Senegal also participates in the ARC Replica program and thus received another USD 10.7 million in drought-related payouts in 2019. For the 2019-20 agricultural season, Senegal had purchased a maximum coverage of USD 20 million from ARC, plus an additional maximum coverage of USD 17 million via Save the Children/ARC Replica program.

4.2 Insurance market

4.2.1 Overview of the insurance sector and regulation

In 2018, Senegal was ranked 118th in the world in terms of insurance premium income, which is far behind several other African countries. The insurance market penetration in Senegal is very low. In 2018, the insurance business was equivalent to only 0.62% of GDP and USD 19.91 per capita. Compared with larger markets such as South Africa and Kenya, the insurance business in Senegal is under-developed.

Conversely, Senegal is the third largest non-life insurance market in the CIMA zone (behind Côte d'Ivoire and Cameroon). The insurance business has benefited recently from political stability and investments in infrastructure to support delivery of the country's medium-term development plan.

In 2018, there were 19 licensed insurance companies operating in the Senegalese market. With a market share of 13.6%, AXA Assurances is the leading insurer followed by Allianz Senegal Assurances (12.8%) and Prevoyance Assurance (10.5%). The only agriculture focused insurance business in the country, CNAAS, ranked 18th in terms of written premiums with an equivalent 1.4% share of the overall market in the Senegalese non-life market in 2018. The motor insurance business has consistently been the largest non-life insurance class, generating 31.5% of premiums in 2018, followed by personal accident and healthcare at 27.3%. Competition among the 19 licensed insurers has been intense, leading to what is described by some observers as 'price dumping'. The second stage of increases in CIMA's minimum capital requirements due in 2021 is expected to present financial challenges to some of the insurance companies and this is expected to lead to mergers and consolidations (Non-life AXO Reports 2020).

Senegal belongs to CIMA, which issued a specific framework concerning data management and index provision for index insurance in 2016. CIMA is a regional body comprising 14 Francophone countries with common insurance regulations. The code is continually revised with the view to support the development of insurance and reinsurance markets in Senegal and the wider region in which CIMA operates. In recent years, the code has incorporated provisions on micro-insurance, reinsurance and takaful insurance, among others. The code outlined the licensing requirements for insurers interested in takaful insurance, the necessary operating regimes, administrative, accounting and investment rules, governance and internal controls, classes that can be underwritten and the specific requirements of intermediaries and reinsurers wishing to engage in takaful business. In December 2019, CIMA introduced the Sharia compliance framework.

The Conférence Interafricaine des Marchés d'Assurances does not yet have a policy for disaster risk financing. In the foreseeable future, CIMA is planning to develop new regulations governing digital insurance and to modify existing micro-insurance regulations to encourage the establishment of specialist micro-insurers and increase insurance penetration in the CIMA region.

4.2.2 Agricultural and livestock insurance services

The Senegalese agricultural insurance market has grown in the last few years because of investments in infrastructure to support the country's strategic development plan, which has a specific focus on agriculture. Senegal has a relatively well-established PPP framework through the CNAAS (Table 4.2).

The CNAAS was set up in July 2008 as a PPP with an initial capital investment of USD 2.45 million shared between local insurers and the government (which has a 25% stake in CNAAS). It is reinsured by SWISS-RE. The CNAAS leverages off the capacity of public actors like the ministries of finance and agriculture for regional institutional support, Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM) for weather data, the Direction de l'Analyse, de la Prévision et des Statistiques Agricoles for production and yield data analysis and a network of producers and micro-finance institutions (MFIs) for distribution. All private insurance companies are required to invest in CNAAS. While financial or customer data is not shared amongst the insurers, public good activities like customer education and awareness campaigns are performed collaboratively.

The turnover (annual written premium) declared by CNAAS for agricultural insurance was USD 2 million and 2.7 million in 2017 and 2018, respectively. Of this turnover, traditional livestock insurance premiums contributed USD 0.15 million in both years (8 and 5% of the total turnover in 2017 and 2018, respectively). Crop insurance has the larger share of the turnover (above 90% of premiums) and a significant portion of this is for crop index-insurance (43%). The CNAAS provides insurance against death of livestock and drought, agricultural equipment and specific crops. The company estimates that there is potential to underwrite USD 16.34 million worth of agricultural insurance premiums in the country, mostly in the Senegal river valley. The CNAAS claims to have presence in most areas of Senegal, including the pastoral regions.

A premium subsidy of up to 50% is offered to all the farmers insured under the different policies of CNAAS. This subsidy is granted by the government, which has mandated CNAAS to support the modernization efforts of agricultural activities. For crop insurance, it costs farmers approximately USD 4.51 (premium) to insure a hectare of land. A claim for a natural disaster could be as high as USD 326.83 per hectare. The biggest clientele for CNAAS are farmers engaged in cotton, groundnuts, rice and tomato production. CNAAS reported premium collection of USD 1.80 million in 2017, most of which was cover for rice and tomato crops. From the summer of 2017, the Senegalese cotton sector was insured by CNAAS against weather-related risks under an index-based insurance policy supported by financial backing from the West African Development Bank (Banque Ouest Africaine de Développement). About USD 1.18 million worth of claims were paid in 2018 under this scheme. It should be noted that existing index-insurance products are linked to agricultural credit.

The agricultural insurance sector is rapidly expanding, especially index-based products for crops. Table 4.1 compares the number of agricultural insurance policies sold in 2012 (when the first index insurance product was launched) and in 2018 (based on the data that was available). There is evidence of a major growth in uptake of crop index insurance over this period as opposed to the more modest growth in sales of traditional indemnity-based crop and livestock insurance.

TABLE 4.1 TYPE OF PRODUCTS OFFERED BY CNAAS

Type of insurance	Number of policies (2012)	Number of policies (2018)
Traditional crop insurance	1,900	28,000
All risks of livestock mortality	7,985	32,563
Index-based crop insurance	232	165,000

Source: Interview with CNAAS official

The CNAAS is offering a traditional indemnity-based livestock insurance product called, 'All Risks Livestock Mortality Insurance', covering livestock death under conditions of natural shocks, accidents and emergency slaughter. Premiums for comprehensive insurance are set at a percentage of the market value of cattle (between 2 and 8%), horses (9%), sheep (6.5%) and goats (6%). In the event of a loss, compensation corresponds to 80% of the market value. Under the current system, premiums are 50% subsidized by the government. Livestock insurance is tailored to the specific insured animal, which must undergo initial examination by a veterinarian to establish its health status and market value. Until now, these products have mainly been designed to cover the needs of sedentary and peri-urban livestock producers, especially targeting high yielding exotic animal breeds that are generally kept in corrals. So far, there are no Sharia-compliant products as there has been no specific demand for them.

The CNAAS has recently shown interest in further developing livestock insurance to cover extensive livestock production. The plan is to develop an insurance package linked to the use of livestock feed. This plan will involve several herders' organizations and Borehole Users Associations (Associations d'Usagers de Forage), some of whom have access to warehouses. Animal feed will be purchased from manufacturers (SEDIMA and New African Milling) and transported to sites where it is required.

Dialogue on index-insurance for livestock in pastoral areas is already taking place in Senegal. Under the BRACED framework, multi-stakeholder discussions around index-insurance products for pastoralists have been carried out since 2018 (Syll 2019). As part of this effort, a review study on livestock insurance has been conducted and the results shared in a workshop held in May 2019. The CNAAS has expressed interest in introducing index-insurance for livestock as a complementary product more suited to the extensive pastoral production systems. However, CNASS has indicated challenges in human and technological capacity. Most of its operations are still conducted manually, yet with the anticipated growth in portfolios, digital tools will be required to handle premium payments and claims.

Private insurance brokers, such as Inclusive Guarantee (former Planet Guarantee), IBISA and Micro Ensure, are also operating in the country. Micro Ensure used to be a major player in the retail weather insurance market for smallholder farmers in Africa but withdrew from this class of business in 2015 due to concerns over basis risk. Today, the company mainly offers life, health and accident insurance underwriting for low-income consumers.

Inclusive Guarantee is one of the few private companies working with CNAAS as a broker. Inclusive Guarantee develops climate insurance for smallholder farmers among other products, such as accident and death insurance. The first crop index product developed in 2012 for Senegal was a result of the collaboration between CNAAS and Inclusive Guarantee. In 2017, Inclusive Guarantee partnered with Okiocredit, a worldwide cooperative that promotes sustainable development by providing loans, investments and capacity building to the financial inclusion, agriculture and renewable energy sectors.

Inclusive Guarantee is responsible for marketing, training and proposing the product to clients and agents. Inclusive Guarantee works with aggregators such as farmers' organizations, banks and micro-finance institutions (since 2018) for registration of clients, premium collection and claim settlements. A part of the premium collected is deducted as commission by Inclusive Guarantee. Most of these activities are manually carried out by aggregators (locally selected organizations) and Inclusive Guarantee. The sales agents and representatives of the aggregators are trained by Inclusive Guarantee on product features, risk covered and other technical aspects.

Inclusive Guarantee is working on a digital platform called 'inclusive market', which should have been launched by June 2021. The platform is expected to centralize all the processes for index insurance, including collection of premiums. The company has shown interest in livestock index insurance and claim that the digital platform under construction will be able to facilitate the implementation of the product in pastoral areas. They are interested in a product design based on NDVI data and would be able to assist in capacity building, marketing and process management.

Through a risk-sharing platform, IBISA provides digital driven services in underwriting along with onboarding and management of clients. An index-insurance product similar to IBLI for the pastoral areas of Niger was designed by IBISA in collaboration with RBM. The product is based on the concept of mutual insurance and it is in pre-piloting stage. Recently, IBISA and Allianz RE have started dialogue with CNAAS and RBM to use their platform to launch a drought index-insurance product for livestock keepers.

To build resilience for communities facing increasing climate risks, the R4 Rural Resilience Initiative (R4), implemented jointly by the WFP and the Oxford Committee for Famine Relief (Oxfam) America in collaboration with CNAAS, is also providing weather index insurance. The weather index insurance program is based on the insurance for assets (IFA) approach. It uses a two-pronged approach, targeting both the most vulnerable and the wealthier groups. The premium for the vulnerable groups is paid through premium by work schemes, whereas clients who do not want to pay their premium through work are connected to the insurer, so that they can pay the premium directly. Two kinds of indices are

used, depending on the areas of operation. A rainfall index based on ground weather stations developed by CNAAS and ANACIM is used in the Kolda region, while a satellite rainfall index developed by the International Research Institute for Climate and Society (IRI) is used in the Tamba region. Senegal has over 7,000 registered beneficiaries as part of the IFA scheme, leveraging off the Oxfam's Saving for Change program. Since 2018, the cheaper and, therefore, more preferred IRI product has been rolled out to regions where the CNAAS and ANACIM product was initially proposed.

The overall objective of R4 is to build rural resilience to climatic and natural disasters. Currently the R4 program has been implemented in five regions in Senegal. The R4 initiative involves working with local institutions to increase their capacity for product design and sustainable insurance services provision, since effective distribution channels remain a challenge. Besides providing financial education to the target communities, the R4 initiative is working on mobile registration of clients and identification of delivery systems for efficient service provision. In 2021, the program intends to expand into four more regions, some of which are pastoral areas. The WFP, which is already involved in meso-level livestock index insurance through the SIIPE program in Ethiopia, is interested in a livestock index insurance product for Senegal and is in talks with private sector entities such as Pula Advisors of Kenya.

The R4 risk transfer component distributes its product through local associations, which connect the producers to existing banking networks. In addition to the risk transfer component, the R4 initiative has the risk reduction, calculated risk taking and savings components. As part of this, the farmers are trained on technical aspects of production, provision of climate information (through the National Meteorological Agency), access to financial markets for micro-credit and savings. Specifically, the WFP works with the savings groups organized in the form of Groupement d'intérêt Économique/Group of Economic Interest (GIE), with presence in almost all municipalities. The GIEs register the clients for either cash payment or the insurance for work options. For the IFA mechanism, the premium is paid by the WFP. Once collected by the IGAs, the premiums are sent directly to CNAAS, the insurer. In the event of a payout, the payment is made through cheques in the name of the GIE. The GIEs are then responsible for distributing the claims among the beneficiaries. For accountability, payouts are made in the presence of a CNAAS official. For every policy issued, the GIEs are paid 5% commission on the premium collected.

The National Credit Agricole Fund of Senegal (CNCAS) is a banking institution specializing in agricultural financing. It has the guarantee of the State and is majority owned by public entities (government, public institutions and donors). The CNCAS has a 10% stake in CNAAS. This is the only bank that funds agricultural value chains in the rural areas of Senegal. Total CNCAS agricultural financing is estimated at about XOF 65 billion, which funds agricultural production (XOF 20 billion), animal production (XOF 3.9 billion), import of inputs (XOF 17 billion), seed procurement (XOF 16 billion) and processing and marketing (XOF 8 billion). The bank mainly offers different types of input credit for the agricultural season . The bank also funds some micro-finance institutions in the rural areas to support savings and credit products. It has several branches and sales offices in different pastoral areas such as Podor, Ndioum, Daara, Kougheul, Ourossogui and Matam. The branch/office also serves Ranérou, where the bank currently has no presence. The bank works closely with the ministry of livestock when implementing some of its initiatives and also holds major portfolios for the government, especially for agricultural related activities, e.g. the OSB (see Section 4.1.2). Though interested in investing in the pastoral regions and livestock breeders, the mobility challenges of the breeders have been the main reason for the lack of specific program targeted at pastoralists.

4.3 Agro-meteorological and extension services

The ANACIM is already collaborating with CNAAS in index-based insurance programs targeting crops. ANACIM is responsible for the supervision and coordination of all-weather related activities regarding climate change research and studies. It collects data using rain gauges that are installed across the country. It is also responsible for providing forecasts, early warning alerts and climate services. In the pastoral areas, ANACIM collects agro-meteorological data in collaboration with the National Meteorological Centre. The NDVI imagery are some of the datasets collected regularly. As part of a project called 'Bawane', ANACIM is also trying to improve weather data availability in the pastoral areas. While the focus of ANACIM has been largely on crops, discussions with livestock breeders' associations are currently underway to support future monitoring of bush fires, droughts and floods in pastoral areas. The ANACIM is also a member of CSE, a publicly supported institution focusing on sustainable management of natural resources.

The core activity of CSE is environmental monitoring through crop and pasture biomass data collection. The CSE has been conducting seasonal rangeland biomass surveys since 1998 at 24 sites distributed all over Senegal's pastoral regions. Ground data collected are spatialized using satellite NDVI data. Thus, an assessment of the correlation between pasture biomass and NDVI is available. This is a unique dataset in the African context that can support the design of

insurance products targeting pastoral regions. In addition, data are collected on water availability and water points in the pastoral areas, usually at the end of each rainy reason. As bush fires play an important role in pasture dynamics in Senegal, they are also monitored during the dry season.

The CSE carries out extension services by collaborating with the ministry of livestock (directorate of livestock) and the directorate of water and forests at the national level and with the technical livestock, water and forest services at the local level. The CSE also collaborates with organizations such as the National Food Security Council and Action Against Hunger (ACF) to disseminate data. However, data are made available for the pastoral regions only on request.

The ACF has established a pastoral surveillance system in the Sahel region by combining satellite data to monitor pasture biomass and surface water resources. The information is integrated with ground surveys to generate early warning and food security bulletins. Since 2015, the ACF pastoral surveillance system included a growing network of sentinel sites where ground qualitative information is collected. Data collectors are chosen at the village level to provide weekly data on water availability, market prices, animal diseases and pasture conditions. The system is low cost and managed through short messaging services (SMS). While currently not used for index-insurance applications, this system could be potentially adapted for IBDRFI initiatives.

The Pastoralisme et Zones Seches (PPZS) partnership system has the mandate to control the internal organization and to guide and validate the activities based on a multi-year scientific strategy. This includes the collection of biomass and socio-economic (related to household incomes and herd sizes) data in the pastoral areas. This has also included a census on transit zones for 70 families in the Ferlo region, under the BRACED framework. The PPZS partners with some private sector organizations in the dairy sector, academic institutions, breeders' associations and NGOs.

The regional AGHRYMET centre, which is headquartered in Niger but operates in the whole Sahel region, also has significant capacity in managing remote sensing datasets and hosts the National Aeronautics and Space Administration-SERVIR hub for west Africa. The AGRHYMET is part of the Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) and is mandated to provide early warning information on a regular basis to support governments in managing droughts. It provides regular food security bulletins according to the integrated food security phase classification approach.

Successive governments of Senegal have attempted to provide extension services to the rural population including pastoralists through the Agence National de Conseil Agricole et Rural, which has agents in all the country's districts. Of greater importance to the sustenance of pastoral livelihoods are the activities of the Direction Regional du Développement Agricole (DRDRs), which are decentralized structures at the regional level, but answerable to the Ministry of Agriculture and Water. There is one rural development directorate per administrative region. Among other activities, DRDRs are responsible for providing technical support to producers and their organizations and to local communities in the preparation and implementation of local and regional agricultural development programs. The ministry also works closely with the livestock breeders' association as a delivery channel for services, one of them being livestock vaccinations, organized by the ministry on a regular basis.

4.4 Telecommunications and digital financial services

The telecommunication system is well-developed in Senegal, e.g. Orange 2G (76%) and 3G (54%), including in the rural areas. Over 70% of the Senegalese adult population own a mobile phone. In addition, Senegal is highly ranked in Africa for the availability of 4G networks. Most of the population is numerate (97%) and has the required identification documents to open a bank account (95%). Two thirds of the population (66.2%) live within 5 km of a mobile money operator, banking agent, store or kiosk with over-the-counter services (UNCDF 2016).

Even though many pastoral areas do not have access to telecommunication networks and services, some of the common meeting places such as weekly markets are well covered. As part of the COVID-19 pandemic intervention, the FAO ran a cash transfer program for the livestock breeders through the Orange Money Platform. This cash transfer program was launched in July 2020, to mitigate effects of market closures on pastoral households. With a budget of USD 400,000 the objective of the program is to improve the purchasing power, livelihoods and nutritional conditions of vulnerable pastoralists (FAO 2020). So far, there have been 3,000 beneficiaries, who were identified jointly by the ministry of livestock and the FAO. Each beneficiary received USD 90 to buy a food kit as part of the program. In general, mobile money operators can deliver financial solutions to pastoral areas by taking advantage of pastoralists' weekly gatherings such as at livestock markets. Sales agents from telecommunication companies such as Orange, can carry out transactions at these meetings.

As a core instrument of its social protection system, the government has made significant efforts to develop a national targeting mechanism, the National Unique Registry (RNU). The registry combines community-based targeting and the application of surveys to identify the poorest households. In 2018, the register included 588,673 households (Ndiaye et al. 2019), but it has been expanded to 1 million households as part of the COVID-19 pandemic food distribution program. Accordingly, the register now includes all poor households in the country. The RNU extends and covers all regions of the country, including the pastoral areas.

The broader micro-finance sector in Senegal is governed by the council of ministers of the west African monetary union through a regional act ratified on 6th April, 2007. In Senegal, the act (Act No. 2008-47) was passed by the national assembly of Senegal and enacted on 3rd September, 2008.

Financial inclusion is rapidly growing in Senegal because of recent targeted efforts from national institutions and development actors, such as the Mobile Money for the Poor, a United Nations Capital Development Fund (UNCDF) and the Mastercard Foundation Initiative. According to the UNCDF market development framework, the DFS sector evolved from the startup to late expansion stage in 2019. Close to 30% of adults have an active DFS account. There are three mobile networks operators (MNOs), three banks and three over-the-counter providers that are expanding to electronic wallet services. In addition, at least two financial technology firms are offering e-wallet services while the post office is also an actor in the DFS sector (UNCDF 2021).

Several startup companies and pilot projects that offer DFS solutions are emerging in the country. Interesting examples include InTouch, which offers an agent network in rural areas. However, penetration of DFS in rural areas, particularly extensive pastoral areas, seems to still be limited. Other interesting digital solutions include the mAgri platform developed by Manobi. The mAgri platform was set up to communicate information and send alerts to farmers in rural areas. The mAgri is a private platform, which aims to provide farmers with real-time information on market prices of agricultural products via SMS.

There is a limited set of private sector actors who are active in the rural areas providing financial goods and services. The ones present are mainly locally based organizations. Some of them are Crédit Mutuel du Senegal, Production Credit and Savings Agency, Partnership for the Mobilization of Savings and Credit in Senegal, the Agricultural Bank, Union of Mutualist Community Savings and Credit Institutions, Network of Peasant and Pastoral Organizations of Senegal, RESOPP and Credit and the Mutual Savings and Credit Union of the Federation of Community Development Associations. These institutions work closely with the local cooperatives in a given area.

The OXFAM has been collaborating with the Strømme Foundation on the Hunger Project and the Saving for Change mobile banking initiative, to develop fodder banks and savings groups in rural communities of the northern regions of Senegal. It has also partnered with La lumière (an NGO also working as an implementing partner for the R4 project), to deliver what they term as numeric solutions (the INEDIT project). It is being implemented in the pastoral region of Kolda where 13,000 people are using mobile financial services tailored to their needs, including conducting money transfer services. The OXFAM and its partners are currently working with the government and telecommunication operators to reduce 'white zones' (areas in the pastoral regions without good network connectivity), thus contributing to the digital and financial inclusion of the vulnerable populations.

At present, the banks serving the rural areas such as the National Agriculture Bank do not have a digital platform exclusively for the pastoral areas, but have launched an AgriCash platform called AgriTech in partnership with UNCDF. However, the COVID -19 pandemic has affected its operations and platform capacity development, as the digital literacy is still low in the rural areas. There is scope for adding features relevant to the pastoral areas as platform development improves.

The Crédit Mutuel du Sénégal and the Alliance de Credit et d'Epargne pour la Production are the main micro-finance institutions working with the informal sector and in the rural areas. Most of the MFIs and cooperatives are registered and have a decentralized financial system, though they utilize community engagements and an element of informality in practice. Most of the MFIs and the cooperatives have legal and financial frameworks, which allow for control of risks to a large extent. Besides the legal structures, they also have well-structured distribution channels, usually local based community development organizations and farmers' association, thus also strengthening the overall livelihoods and resilience of the population. Among the financial institutions, the Agriculture Bank is well-known for working with vulnerable populations and remote areas, where most of the other financial service providers have no presence.

The MNOs are increasingly investing in DFS while over-the-counter providers are moving towards electronic wallets. Banks are investing actively in mobile money. The financial technology entities add value to the product portfolio and distribution channels. The MFIs are beginning to invest in digital solutions. In addition, providers are showing more willingness to serve the rural communities. First-generation products and high-volume payments are offered (government to person and business to person; person to government and person to person). Merchant payments are also expanding. However, there is only one provider offering digital credit. A couple of providers facilitate insurance subscriptions as well as premium and indemnity payments.

4.5 Pastoral organizations

Besides the available financial inclusion services, there are several development organizations providing livelihood interventions in the pastoral areas. Some of these are Gret, an NGO that promotes technical and organizational innovations in areas of fodder production, the USAID's Global Food Security Strategy, which is working in emergency response through a multi-organization approach (including government agencies in Senegal) and PASA Lou-Ma-Kaf food security support project, working towards development of livestock infrastructure in the pastoral areas.

About 20% of the pastoralists in Senegal have memberships in the local livestock breeders' association. The most important pastoralist network which coordinates most of the local livestock breeders' associations specialized in pastoral farming in west Africa is the RBM. The RBM oversees pastoralists from nine countries: Niger, Burkina Faso, Mali, Senegal, Togo, Benin, Mauritania, Nigeria and Chad, with several local pastoralists' associations holding membership in this regional organization. Local livestock breeders' organisations include the Association pour le Développement Intégré de Dahra, Association pour le Développement de Namarel et Villages Environnants (ADENA), Kawral Yonoufere and Unité pastorale en transhumance ou Maison des éleveurs.

The RBM has about 6,000 to 7,000 members in Senegal and has its subgroups in most of the local pastoral areas in the country. Besides the advocacy work on transhumance and mobility, RBM assists communities with readily available feed stock through feed stores and by mobilizing auxiliary veterinarians to provide animal health services to the communities. The feed stores are the responsibility of the local organizations, which are under the RBM umbrella. The local organizations are also responsible for sensitizing the members on the importance of acquiring feed stock. This feed in addition to the subsidized feed being provided by the government every dry season. These feed stores are also present along some of the transhumance corridors and rules governing store usage are put in place to prevent conflicts. Payments for feed are done through Orange money, where agents are part of the RBM network. The payment system is flexible, for example, if a herder wants to purchase feed for animals in one region, the owners of the animals in another region can make the payment. In addition, sales agents are also available at the weekly markets where transactions can be done. The RBM has also been collaborating with NGOs and development organizations to promote growing of forage crops amongst its members. Membership to the RBM is through local organizations, which are members of RBM as there are no individual memberships allowed.

One of the main activities of BRACED was securing corridor mobility for the livestock, but now this is done by the CORAD. This organization is a network of some of the main pastoral associations such as ADENA. Both CORAD and RESOPP have been involved in ensuring smooth movement of pastoralists along mobility corridors mainly through facilitating negotiations among different pastoralist groups, establishing rest areas, mobile pharmacies and developing non-paying watering ponds for livestock.[23]

23. Interview with the president of CORAD on 10th November 2020.

Key takeaways from Chapter 4: Operational assessment	
Policy environment	There are indications of favourable enabling conditions for implementing IBDFRI, both from a regulatory (i.e. CIMA) and policy perspective. The government has shown interest in IBDRFI initiatives targeting extensive pastoral systems and has already put in place multiple initiatives to finance responses to climatic shocks, including in the livestock sector. The government of Senegal is already supporting index-insurance schemes for crops through partial subsidies.
Insurance sector capacity	The insurance market development is relatively good in the agricultural sector thanks to the activity of CNAAS and the growing role of brokers such as Inclusive Guarantee or IBISA. The CNAAS has already shown interest in IBDRFI for pastoralists and discussions are ongoing on the implementation modalities. However, CNAAS has indicated that it has limited capacity with digital financial service delivery in pastoral areas.
Agro-meteorological and data management services	There are several players with capacity to provide agro-meteorological services and analytical platforms using remote sensing data. Long-term rangeland monitoring efforts (i.e. biomass data collection) carried out by the CSE would be a useful Source of data for assessing the quality of satellite indices for forage production.
Financial service infrastructure	The financial service infrastructure is generally good with telecommunication and DFS services rapidly expanding. Senegal also has a social registry, which already includes around 590,000 households. Its coverage in pastoral regions is unclear, although it is expanding and aiming to cover all poor households in the country.
Distribution channels	The presence of insurers in pastoral areas is limited while existing agricultural insurance initiatives do not yet rely on digital technologies. However, the growing DFS network, activities of several organizations already investing in IBDRFI solutions, e.g. Planet Guarantee and the WFP and the dense network of breeders and pastoralist associations in the pastoral areas offer the opportunity to support effective distribution channels if targeted investments are made.

5. Scenario analysis

5.1 Background and objectives of the scenario analysis

This scenario analysis aims to provide a broad overview of how a product might work and an illustration of indicative costings for two alternative IBDRFI programmatic options: (i) a micro-level retail insurance scheme and (ii) a fully funded macro-level social livelihoods protection program. This was not a product or program design study, thus the analysis is simplified and based only on previous implementation experiences in east Africa. It should be noted that the proposed scenarios neither provide specific recommendations, nor do they pretend to cover an exhaustive range of IBDRFI solutions. Thus, a detailed analysis of alternative programmatic options and product design customizations needs to be planned with local stakeholders during the early implementation stages of future initiatives.

The two programmatic alternatives, built upon experience from existing programs, should be seen as two illustrative options that represent extremes of a broader range of potential IBDRFI programs that could be designed based on Senegal's priorities. Indeed, they could be seen as complementary (not alternative) approaches in a harmonized IBDRFI framework at country level. Both options rely on the private sector for product distribution and management, provide payouts directly to pastoralists and are based on the same index-based model. The two options fundamentally differ in the main goals, targeting approach and the level of participation of non-private sector actors regarding subsidies and direct support to complementary activities. Table 5.1 summarizes key similarities and differences.

The micro-level retail insurance scheme aims to not only protect pastoral households from sliding into poverty during drought periods due to livestock losses, but also to improve access to inputs and credits and stimulate investments in the value chain to improve livestock production and marketing. Clients of the scheme are expected to be able to pay premiums. The level of public sector participation, mainly through partial subsidies, needs to be modulated to facilitate uptake and financial viability of the private sector and to create incentives for additional private sector investments.

The macro-level social livelihoods protection program aims to provide a social safety net to the most vulnerable pastoral households and to complement humanitarian responses that protect pastoralists' key assets and livelihoods during the early stages of drought crises. The program targets beneficiaries that own a small number of livestock assets

but are unable to pay premiums. Targeting and registration, therefore become critical steps. The level of public sector support required for full (or high) subsidies and awareness creation is high. In addition to social protection, subsidies could be linked to good practices to improve the resilience of pastoral households, e.g. rangeland management.

TABLE 5.1 SUMMARY OF THE SIMILARITIES AND DIFFERENCES BETWEEN THE TWO PROGRAMMATIC SCENARIOS

Item	Micro-level commercial retail insurance	Macro-level social livelihood protection
Main goal	• Improve access to inputs and credit to pastoral households. • Protect from sliding down into a poverty trap.	Provide a social safety net to the most vulnerable pastoral households and complement humanitarian responses.
Insurable interest	Herders' interest to protect their livestock assets during extended periods of deficit of forage resources.	Public interest in anticipatory responses to drought and reduction of humanitarian support needs.
Satellite data Source	Same, e.g. NDVI.	Same.
Index design	Same. Proxy of forage availability	Same. Proxy of forage availability
Sum insured	• Same (but could increase for larger commercial herders). • It is based on estimated additional costs of livestock maintenance during seasons with forage deficit.	• Same. • It is based on estimated additional costs of livestock maintenance during seasons with forage deficit.
Commercial premium rates	Same underlying pure loss costs, but commercial premium rates may need to be considerably higher to reflect much higher operational costs associated with voluntary sales to individual pastoralists (insured policyholders).	Same underlying pure loss costs, but potential to minimize operational loadings as automatic cover for large numbers of beneficiaries.
Payouts	Same assuming same sum insured and triggers are adopted (direct to policy holder- Insured)	Same assuming same sum insured and triggers are adopted (direct to beneficiary)
Target audience	More affluent small/medium and large pastoralists who can afford to pay either the full commercial premium rate or a partly subsidized premium rate.	• Vulnerable pastoralists who depend largely on livestock herding for their livelihoods, but who cannot afford to pay commercial premium rates. • These pastoralists should have a minimum herd size.
Distribution approach	Voluntary purchase by the individual pastoralist or group.	Automatic enrolment of selected pastoralist by a government entity/agency.
Policyholder (Insured)	The individual pastoralist is the policyholder and insured as named on the policy certificate.	The insured policyholder is the government entity/ agency on behalf of the pre-selected pastoralists (beneficiaries) listed in the policy issued to the government entity/agency.
Insurance awareness creation and sensitisation	Not essential if marketing, promotion and sales functions are correctly performed by the insurer or its appointed agents/ distribution channels.	Essential as pastoral communities and their members must be made aware of the scheme and why some pastoralists are being identified as beneficiaries and will be automatically enrolled, while others will not be selected.
Targeting (and sales) and Selection	• Insurers will be responsible for their own marketing and promotion and sales programs including: • Own sales agents • Other distributors	The government entity/agency will need to work closely with country-level authorities, community and pastoral leaders to identify the selection criteria and the beneficiaries of the program in each insured unit.
Registration	All insured pastoralists must be electronically registered.	All beneficiaries must be electronically registered.

Item	Micro-level commercial retail insurance	Macro-level social livelihood protection
Premium subsidies	• Variable. • It could also change in time depending on the product uptake.	• 100% or close to. • It is, however, recommended that pastoralists contribute with a token or some other modalities.

Source: Authors

The scenario analysis takes into consideration an IBLI product type, which has been designed, customized and widely tested in Kenya and Ethiopia (Appendix 2). As already described in Section 1.2, the IBLI product design adopted in existing programs, relies on (i) an index calculated from time series of NDVI imagery acquired from satellite sensors and (ii) a payout function to convert the index values into payouts for policyholders/beneficiaries. The analysis is limited to the areas that are considered suitable or partially suitable (i.e. forage review) for the IBLI product implementation (Chapter 4, Figure 4.6).

It should be noted that the index calculation and the payout function of the IBLI product must be customized during the early implementation stages of any initiative aimed at launching IBDRFI solutions in close collaboration with local stakeholders. The cost of any IBDRFI product is largely determined by calculating historical payouts (i.e. pure loss rates) according to the chosen set of parameters and customization options of the IBLI product. This allows tailoring the IBDRFI solution to the local context and to the specific goal of the IBDRFI initiative.

The scenario analysis is divided into two steps, firstly a simulation analysis on historical data is conducted to illustrate the product performance in the country (i.e. independently by the implementation modality) and secondly, financial analysis is conducted to illustrate hypothetical costings of implementing an IBDRFI program in the country. The costings are generated for the two programmatic options illustrated above, a micro-level purely retail insurance program and a macro-level fully subsidized social protection initiative.

5.2 Simulation of historical payouts in Senegal

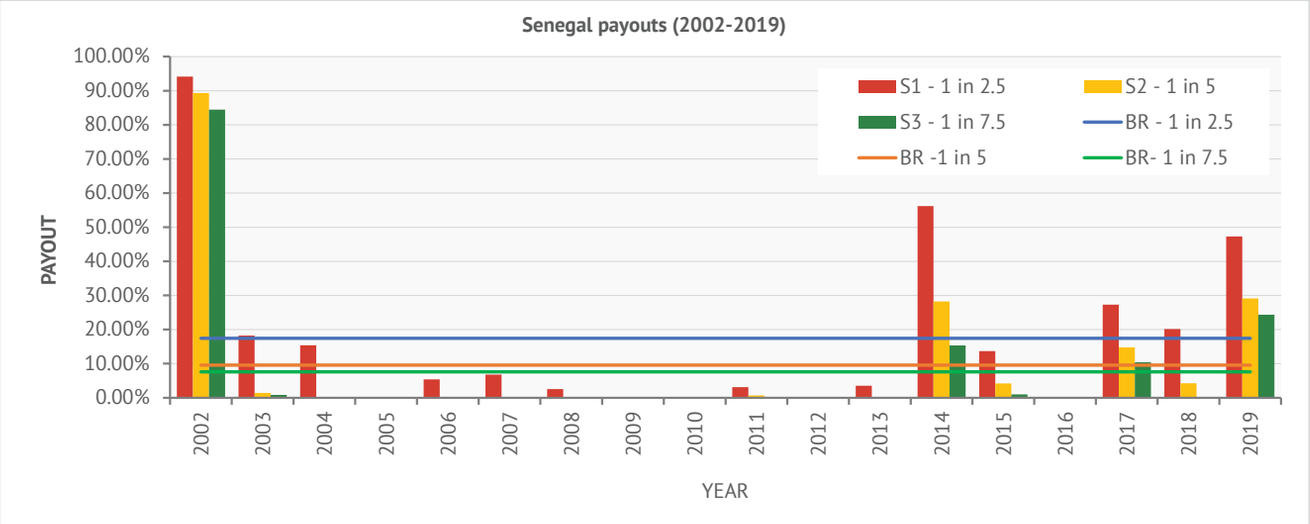
Three historical payout scenarios are presented to illustrate how an IBLI product would have worked in Senegal's pastoral areas over the last two decades. The reference scenario is an IBLI product with a trigger attachment threshold [24]set to one payout in five years (S2). The two alternative scenarios are included to illustrate the implications of changing the attachment threshold to increase the frequency of payouts (i.e. 1 in 2.5 years) (S1) or decrease it (i.e. 1 in 7.5 years) (S3). All the other parameters are constant across the scenarios.

In each of these scenarios, 3 main payouts would have been triggered in Senegal in response to a major drought in 2002 and two severe droughts in 2014 and 2019. The scenario S1 also captures mild drought events, which are clearly not captured by S2 and S3. It is worth noting that from 2014 to 2019, payouts would have been triggered 4 to 5 times in a six-year period (Figure 5.1). More in-depth analysis is required to understand whether this can reflect a trend toward increases in drought frequency.

The observed temporal drought patterns in pastoral areas are generally well aligned with existing national datasets on the main drought events in the region. Drought events in 2002 and 2014 are relatively well documented. The 2019 drought also led to a significant payout from the ARC's sovereign level drought insurance, which estimated that at least 1 million people were affected. The 2011 drought was not fully captured by the product. However, it should be noted that available data do not provide information on the geographic location of droughts, limiting capacity to evaluate the accuracy of the assessment.

24. The index threshold below which a payout is made.

FIGURE 5.1 HISTORICAL ANNUAL PAYOUTS AS A PERCENTAGE OF TOTAL LIABILITY IN SUITABLE SENEGAL ARRONDISSEMENTS (2002–19), ASSUMING A JULY TO NOVEMBER INSURANCE COVER PERIOD



The average payout (pure loss cost rate) would be 17.4, 9.6 and 7.6% for payout scenarios S1, S2 and S3, respectively, illustrating how more frequent payouts would result in significantly higher costs for the IBDRFI product. This demonstrates how decisions made during the product customization with local stakeholders on their desired frequency of payouts have important implications on the premium costs (of which the pure loss rate is a key component) and that the product can be tailored to suit the objectives of the IBDRFI program and capacity to pay the premiums.

5.3 Costing scenarios for future initiatives in Senegal

Indicative costings for the two programmatic scenario (PS) options described in Section 5.2 are presented to illustrate the financial implications for the government or donors of implementing an IBDRFI solution in Senegal. The two PS costings were modelled on the existing implementation experiences in Kenya and Ethiopia and include a micro-level commercial insurance implementation scenario (PS1) and a macro-level social livelihood protection coverage implementation scenario (PS2). Both scenarios were developed using an IBLI product and the trigger attachment threshold of 1 in 5 years (S2 in Section 5.2). The scenarios were designed for a 5-year program.

The two programmatic scenarios differ fundamentally on the expected contribution from the government or development partners, as PS1 assumes 50% subsidies while PS2 assumes 100% subsidies. Another important difference to note is the level of public sector contribution to complementary investments, such as the registration infrastructure, awareness creation and monitoring and evaluation. Finally, the two scenarios differ in the level of expected uptake, as it is assumed from previous experiences that commercial insurance uptake rates are generally rather slow. A detailed summary of assumptions is provided in Appendix 5. It should be noted that the assumptions made for this analysis are an over-simplification of the reality and should be seen as purely illustrative.

Indicative costs of complementary activities, including registration, awareness creation and monitoring and evaluation are provided to illustrate the importance of including these components at the design stage of any IBDRFI initiative. However, the costs are estimated based on a per-person flat rate, which is an oversimplification. In a more realistic scenario, these components would often require an initial larger investment for setting up the infrastructure. The costs would then increase proportionally to the level of program expansion till a certain critical level, when greater cost-efficiencies should in principle reduce costs.

PS1: Micro-level commercial implementation with partial subsidies

The micro-level commercial insurance implementation scenario indicates the costing of supporting a relatively large implementation program in the pastoral areas of Senegal of an IBDRFI micro-insurance product with partial subsidies (i.e. 50% of the premium) (Table 5.2). Under commercial implementation, the uptake is expected to be gradual and in five years, the program could target to reach 25,000 pastoral households and approximately 125,000 TLUs (i.e. five TLUs per pastoral household on average, representing 2.5 and 7.5% of the TLUs in the national herd and extensive pastoral areas, respectively).

TABLE 5.2 COSTS OF MICRO-LEVEL COMMERCIAL IMPLEMENTATION WITH PARTIAL SUBSIDIES OVER FIVE YEARS

Item	Total(Cumulative over 5 years)
Policyholders	75,000
TLUs covered	375,000
Total sum insured (USD)	67,500,000
Indicative premium (total) (USD)	9,720,000
Subsidy (50%) (USD)	4,860,000
1. Electronic registration of livestock producers (USD/Livestock unit)	0
2. Herder awareness, education and training (USD)	750,000
3. Monitoring and Evaluation (USD)	750,000
Total Cost (USD)	6,360,000

Yearly costs are presented in Appendix 5 (Table A5.2).

The global fiscal cost of supporting a micro-level insurance program with 50% subsidies is estimated to be USD 6.3 million over 5 years of implementation, including subsidies (USD 4.9 million) and program support activities (USD 1.5 million). After 5 years, full-scale implementation may be in the order of 125,000 TLUs physical uptake and USD 1.62 million fiscal costs of government support per year.

The insurance premium to be paid by a pastoral household would be approximately USD 12.5/TLU per year with a maximum payout of USD 180/TLU. This amount is already substantially higher than the median willingness to pay indicated by livestock keepers in the IPAR-BRACED study (i.e. USD 6) (Mame Mor et al. 2019 and Section 2.6). However, a significant fraction (25%) of breeders indicated they would be willing to pay up to USD 20. It is worth mentioning that the commercial loadings on pure loss premiums might be underestimated, especially if the insurer needs to undertake significant investments for marketing and distribution channel development.

In this scenario, there is high uncertainty about the uptake Figures and levels of actual private sector investment on the complementary activities. The uptake of agricultural micro-insurance solutions has often been below expectations for a variety of reasons, including poor product design and investment in marketing and awareness creation, high transaction costs of implementation leading to unsTable private sector commitment. Partial subsidies are deemed important to support the initial market uptake, therefore, smart use of subsidies needs to be planned to incentivize the private sector to invest in critical financial and knowledge infrastructures. In this scenario, a fixed 50% premium subsidy was used, but a gradual reduction of subsidy could also be planned over the medium term.

PS2: Macro-level social livelihood protection coverage implementation

The macro-level social livelihoods protection coverage scenario illustrates the costing of supporting a relatively large implementation program of an IBDRF social protection coverage targeting the most vulnerable pastoralists in Senegal who cannot afford to pay insurance premiums (i.e. 100% of the premium is covered) (Table 5.3). Under social protection implementation, the program expansion is expected to be more rapid and in five years, could target to reach 50,000 pastoral households and approximately 250,000 TLUs (i.e. about 5 and 15% of the TLUs in the national herd and extensive pastoral areas, respectively).

TABLE 5.3 COSTS OF MACRO-LEVEL SOCIAL LIVELIHOOD PROTECTION COVERAGE IMPLEMENTATION OVER FIVE YEARS

Item	Total (Cumulative over 5 years)
Beneficiaries	150,000
TLUs covered	750,000
Total sum insured (USD)	1,35,000,000
Indicative premium (total) (USD)	16,848,000
Subsidy (100%) (USD)	16,848,000
1. Electronic registration of livestock producers (USD/Livestock unit)	250,000
2. Herder awareness, education and training (USD)	1,500,000
3. Monitoring and evaluation (USD)	750,000
Total cost (USD)	19,348,000

Yearly costs are presented in Appendix 5 (Table A5.3).

The global fiscal cost of fully supporting the program is estimated to be USD 19.3 million over five years of implementation, including premium subsidies (USD 16.8 million) and program support activities (USD 2.5 million). At the end of the 5-year program, 250,000 TLUs would be protected from drought at an annual cost of USD 5.6 million.

The premium cost per TLU to be covered through subsidies would be USD 22/TLU. No premium is expected to be paid by pastoral households. However, a token contribution is recommended to support awareness of the product. This is an important lesson learnt from ongoing initiatives in Kenya and Ethiopia.

In this scenario, the main Source of uncertainty is associated with the long-term fiscal sustainability of the initiative, as medium-term budget allocation commitments need to be guaranteed. Depending on the social protection goals of the IBDRFI program, a gradual exit strategy should be planned from the beginning. For example, a system incentivizing graduation of pastoral households to partially subsidized commercial coverage could be implemented, allowing for a gradual reduction of fiscal costs over the medium to long term.

Hybrid approach: combining commercial micro-insurance with a social protection program

Experience from operational programs in Kenya and Ethiopia suggest that a hybrid approach could be adopted to address sustainability issues in the two programmatic options illustrated. A macro-level social livelihoods protection program could target the most vulnerable up to a certain number of TLUs (e.g. five) with a highly subsidized product. At the same time, partially subsidized commercial insurance could be sold to those that are not beneficiaries of the social protection program and/or to top-up the coverage with additional TLUs. Subsidies could be modulated over time between the two programs and used as incentives to the private sector and clients to promote uptake and financial sustainability.

This could bring multiple potential benefits including:

- Cost sharing for financial service infrastructure development and complementary activities, as the public sector/ donors could support the initial investments under the social livelihood protection scheme, while the private sector guarantees maintenance and invests heavily in market expansion.
- The macro-level coverage could be planned to scale up relatively rapidly in the medium term and create confidence in the private sector of the short-term profitability of the scheme.
- In the meanwhile, subsidies can be used as an incentive to the private sector to invest in the commercial scheme and expand the retail market.

6. Summary of findings and recommendations

The feasibility assessment indicates that Senegal presents an overall high level of readiness for the implementation of an IBDRFI initiative targeting pastoralists based on socio-economic, technical and operational conditions. Table 6.1 illustrates the key findings with respect to the feasibility criteria considered in this study.

The socio-economic assessment (Table 6.1, green) emphasizes the important role of the livestock sector for Senegal and the vulnerability of pastoralist to droughts, particularly in the northern part of the country. It also indicates that there is a potential demand for the product from pastoral communities. However, there are other relevant risks for the livestock sector (e.g. diseases, cattle rustling and bushfires) and these risks are greater for agro-pastoral farmers, who are the poorest group. These risks would need to be considered as part of a comprehensive social protection and disaster risk management strategy.

The technical assessment (Table 6.1, yellow) classifies 33% of Senegal land area as feasible or feasible but needing review for the implementation of IBDRFI products for pastoralists. This land area carries 26% of the national livestock herd, which could be covered. These areas cover vast portions of Saint Louis, Louga and Matam regions. The areas requiring review are considered feasible from a technical point of view but present more fragmented rangeland cover due to the increased proportion of crops or woody cover and ongoing land use changes. For this reason, it would be important for local stakeholders and experts to confirm the relevance of these areas for extensive livestock herding and to assess in more detail the performance of the drought index.

The operational assessment (Table 6.1, grey) shows that:

- **Senegal has a conducive environment for implementing IBDRFI solutions based on legal and regulatory frameworks, public and private sector capacity, interest and experience.** The government of Senegal and CNAAS have already made significant progress in their discussions on potential IBDRFI options targeting pastoralists through a PPP approach, demonstrating interest and willingness to support. The country also has a strong capacity in the management and provision of remote sensing datasets and agro-meteorological services (e.g. ANACIM and CSE etc.). Furthermore, the government of Senegal has been a participant of the drought risk pool of the African Risk Capacity since 2014, which might offer opportunities to develop a harmonized drought risk management framework in the country.
- **However, the capacity to deliver digital financial services is still weak in the pastoral regions and this could become a barrier to effective implementation.** However, the good mobile money infrastructure and dynamism of private sector actors (e.g. Planet Guarantee and IBISA) and development organizations to expand their DFS portfolios and offer index-insurance brokerage services offers the opportunity to overcome implementation barriers. In addition, the dense network of pastoral and breeding associations in the pastoral regions could also play an important role in product distribution and bundled DFS offerings.

TABLE 6.1 FEASIBILITY ASSESSMENT OF THE COUNTRY'S READINESS FOR IBDRFI PRODUCTS TARGETING PASTORALISTS

			Justification
Socio-economic Feasibility	Importance of pastoral livestock to the local economy	🟢	The livestock sector represents 38 and 3.6% of the agricultural and national GDP, respectively. Pastoralism is the main Source of livelihood in the country's northern and north-eastern regions. The national livestock herd is 18.4 million (excluding poultry).
	Impact of drought on the livestock sector	🟠	Even though there are no detailed records on the cost of recent droughts (to the authors' best knowledge), estimates from models indicate that Senegal would need USD 26 million on average per year and a maximum of USD140 million to respond to drought. Drought is the main risk faced by the country due to the large numbers of affected people. The 2019 drought affected about 1 million people. Estimates of livestock losses during drought events that occurred in the 1970s and 1980s are USD 1-32 million per year.
	Vulnerability of pastoralists to drought	🟠	Pastoralists are vulnerable to drought and indicated it as one of the main risks they face. However, evidence suggests that other issues, such as livestock rustling, disease and bush fires, are also relevant. In terms of poverty, pastoralists are generally better off than agro-pastoralists, supporting the importance of considering complementary IBDRFI approaches that could cover the latter, especially for social protection purposes.
	Pastoralist demand for livestock insurance	🟢	Existing studies suggest that there is demand for index-insurance products from livestock keepers in northern Senegal, i.e. an IBLI. A qualitative study suggests, however, that the willingness to pay might be moderately low compared to the expected premium costs in a commercial program.
	Pastoralist financial literacy	🟠	Pastoralist communities have been exposed to insurance and have some understanding of the concept. However, agricultural and index-insurance are largely unknown in the pastoral areas and their introduction would require investments in awareness creation.
Technical Feasibility	Rangeland dominance	🟠	Extensive rangeland areas used for livestock herding are dominant only in the northern parts of the country. Toward south, the landscape is more fragmented by increased crop and woody plant cover, making the IBLI product design less optimal because the NDVI signal might be strongly affected by vegetation that is not used for grazing.
	Seasonality and signal intensity	🟢	The rangeland seasonality is well-defined and relatively homogenous across the country. In the northern region, the typical rangeland growing season lasts from July to November. The NDVI signal is also sufficiently strong to assess the inter-annual variability. These factors are do not limit the feasibility of IBLI product design in the country.
	Overall feasibility of product design	🟢	The product design can be considered 'fully feasible' and 'feasible but needing review' for 14.6 and 18.3% of Senegal's total land area, respectively. This covers the northern pastoral regions of Senegal. Overall, close to 30% of the national livestock herd is found in the areas that are suitable for implementation. Further analyses should be considered to evaluate the possibility of tailoring the product design such that a broader extent of the agropastoral areas could also be covered.

			Justification
Operational Feasibility	Technical capacity on index calculation and quality assessment	●	Senegal hosts multiple institutions with experience in handling remote sensing data for rangeland monitoring (e.g. CSE),and supporting index-insurance initiative (e.g. ANACIM). The availability of a network of biomass monitoring sites with historical records is a strong asset for product design.
	Legal and regulatory insurance environment	●	Senegal is part of CIMA, which already has regulations in place for index-insurance. Demand for Sharia compliance has not been reported.
	Insurance market development	●	The insurance market development is relatively good in the agricultural sector thanks to the activity of CNAAS and the growing role of brokers such as Inclusive Guarantee. Senegal is also part of the ARC drought risk pool.
	Interest from insurers in IBDRFI	●	CNAAS and other private sector actors are already exploring the possibility of launching IBDRFI products for livestock and have demonstrated a keen interest in the current initiative.
	Effective distribution channels	●	Insurers' presence in pastoral areas is limited and existing agricultural insurance initiatives do not yet utilize digital technologies. However, the growing digital financial services network and dense network of breeders and pastoralist associations in the pastoral regions offer opportunities to support cost-effective distribution channels if targeted investments are made.
	Existing pastoralist beneficiary registries	●	Senegal has a social registry, which already includes around 590,000 households (including 65% of all poor households). Even though its coverage in pastoral regions is unclear, it is expanding and aiming to cover all poor households in the country eventually.
	Finance available for premiums	●	CNAAS, a national company, already offers government funded 50% subsidies for agricultural insurance products. So far there is no clear indication of the government's willingness to finance large initiatives on livestock insurance under this IBDRFI feasibility study.
	Interest from government	●	The government has shown interest in IBDRFI initiatives targeting extensive pastoral systems and already has in place multiple initiatives for financing responses to shocks, including in the livestock sector.

● = low; ● = medium; ● = high.

It should be noted that there are some gaps in the assessment, especially the evaluation of costs and impacts of droughts on pastoralists and the livestock sector in general and the relative importance of other climatic and non-climatic risks. Since these are critical factors to define the type of IBDRFI solution that will be more relevant in Senegal, it is important that more evidence be collected to better inform the decision-making on potential IBDRFI initiatives. Further work is also required to elicit government interest in purchasing macro-level social protection IBDRFI cover in parallel to the proposed micro-level retail program, which would be offered through CNASS. It is also important to see how the two distributional approaches can be combined to achieve financial scale and sustainability.

It should also be noted that although the feasibility study was based on technical solutions, experiences and programmatic options implemented in east African countries (used as benchmarks for the assessment), the overall assessment should be generalizable to a wider range of alternative IBDRFI options for pastoralists. It is not the intention of the report to suggest that the product design and scenario options illustrated are the ones that should be considered, as the decision should ultimately emerge through a policy dialogue at a national level and from a set of technical studies during the preparatory stages of any IBDRFI initiative (see recommendations below).

The recommendations below are for the government of Senegal and other public and private stakeholders should they consider to implement an IBDRFI initiative targeting pastoralists.

Recommendations:

Considering the limited scope of a feasibility study, the next steps toward implementing an IBDRFI initiative in Senegal would require in-depth engagement with country stakeholders and planning for analytical studies to address knowledge gaps identified in this assessment.

Next steps

Stakeholders' engagement and policy support

R1: The ongoing discussion on the IBDRFI initiatives for pastoralists should progress to the implementation design stage, in line with similar crop insurance schemes already launched in the country. Considering that the ministry of livestock, CNAAS and other organizations have already conducted in-depth discussions on micro-level index insurance for pastoralists and the feasibility assessment indicates overall favourable socio-economic, technical and operational conditions for implementation, it is recommended that appropriate frameworks be established for discussing and designing an implementation plan for a future scheme.

R2: As part of these efforts, the establishment of policy dialogues to define broad objectives that the government wishes to achieve with IBDRFI initiatives (e.g. protect the poorest, protect better-off pastoralists with more livestock assets and/or both) and the consideration of alternative IBDRFI design and programmatic implementation options are extremely important. The policy objectives should guide preselection of alternative programmatic options for in-depth cost-benefit analysis (R5). The options to be considered might include the micro and macro-level approaches already implemented in east Africa targeting individual pastoralists and the innovative schemes involving meso-level distribution channels. The option of promoting meso-level insurance to risk aggregators, such as pastoralist cooperatives, rural finance institutions or livestock services organizations (e.g. veterinary drugs and feed supplements service providers) may offer potential in lowering the operational costs of the IBDRFI initiative. It is, therefore, recommended that during the planning phase for IBDRFI solutions in Senegal, early discussions are held to identify potential risk aggregators that operate with pastoral communities in the northern regions of the country and that would be potentially interested in purchasing meso-level cover on behalf of these pastoralists.

R3: The policy dialogue should also discuss the scope of initiatives for social livelihoods protection in pastoral areas, such as a shock responsive safety net as part of a broader country drought risk financing strategy. Existing experiences in Africa prove that IBDRFI social livelihoods protection schemes have positive welfare impacts and allow partial transfer of risks from public budgets to the private sector. If used in combination with commercial micro-insurance, they can facilitate faster expansion, thanks to public sector investments in subsidies and complementary interventions. It should be noted that information/data gaps in this study have limited the ability to conduct an accurate assessment of costs associated with drought responses in pastoral areas. These gaps should be filled to allow better evaluation of the drought impacts and the need for social livelihoods protection of vulnerable pastoral households in the northern pastoral regions, which are feasible for IBLI and IBDRFI solutions (Figure 3.6).

R4: Should the government of Senegal and CNAAS proceed to implementation, it is recommended that a board and TWG for the design phase of the initiative be established. These committees would be comprised of representatives of all public and private sector stakeholders and development organizations with experience in IBDRFI implementation. The board would chair the strategic decision-making fora for the initiative, particularly regarding implementation sites, subsidy levels and targeting. The board could be coordinated by CNAAS and supported by a TWG. It should include government agencies responsible for extension and agro-meteorological service provision in pastoral areas and pastoral associations (among others). The mandate will be to develop practical structures for scheme implementation, product design evaluation, development of monitoring and evaluation frameworks, coordination of awareness creation efforts and the evaluation of suitability of product to specific target areas.

Next steps

Follow-up actions as priority areas

R5: Cost-benefit analyses:

- **A comparative technical approach is recommended where multiple IBDRFI products can be identified and cost-benefit analyses conducted prior to implementation.** The cost analyses should also address the information gaps identified in this study on the impacts of drought and associated cost of responses. While illustrative scenarios and costs have been proposed in this study for alternative programmatic options ranging from commercial micro-insurance to fully subsidized social livelihoods protection programs, a more comprehensive review of options, subsidy levels and incentive mechanisms for private sector investment in IBDRFI is highly recommended. This should be included in the cost-benefit analyses.
- **The review, guided by the TWG, should carefully weigh alternative subsidy options and evaluate the trade-offs from a cost-benefit perspective, including long-term financial sustainability and governance aspects.** Lessons learned from ongoing IBDRFI initiatives suggest that the smart use of subsidies is important, but also that an exit strategy from a highly subsidized regime should be in place from the beginning. The assessment should also explore how to harmonize programmatic options with ongoing drought risk management and financing frameworks, for example, with the LSO implemented by the ministry of livestock to provide subsidized feed resources during drought. Finally, the assessment should consider the approach to be followed for implementation regarding priority areas and geographic expansion.
- A cluster approach should be used to develop pastoral systems, starting with regions where livestock input and output services are more developed. In these regions, certain minimum requirements should be already in place, such as the existence of fodder markets and pastoralists' access to them, minimum levels of financial inclusion among pastoralists and herd sizes, to ensure that payouts are useful.

R6: Distribution and delivery

- **Targeted investments on DFS infrastructure and service provision require planning to establish efficient and robust registration and delivery and distribution mechanisms.** Major challenges in operational IBDRFI initiatives have resulted from failures in the delivery chain, particularly regarding payouts. Given that the cover is designed for early responses to shocks and asset protection, quick delivery is of essence. Digital payments are necessary and largely preferred by clients/beneficiaries. An efficient distribution and delivery infrastructure is also important to reduce the insurance companies' operational costs thus making the product profiTable.
- **The study indicates that DFS service networks and the presence of insurance service providers are still weak in the pastoral regions and, therefore, targeted investments should be planned for.** There is significant potential to leverage ongoing initiatives to develop DFS services in the country. These include the new platforms supported by the WFP R4 initiative and the household registry (now targeting inclusion of all the poor households) that could be a key instrument for registration of beneficiaries in IBDRFI initiatives. Other examples are the service platforms that Inclusive Guarantee and IBISA are developing specifically for insurance service provision. These platforms could reduce the delivery and distribution costs for the insurers. In terms of distribution, the livestock breeders and pastoralist associations should be considered as potential channels given their strong presence in the pastoral areas and capacity to interact with pastoral communities. Most of the private sector entities and development organizations rely heavily on the local livestock and breeders' association as entry points for their interventions and emphasized their central role in the potential implementation of IBDRFI initiatives.

Next steps

R7: Product design

- **Considering that to date no IBDRFI products for pastoralists in the Sahel have been implemented, it would be important to conduct a technical study to explore alternative drought index design options then establish multi-stakeholder review exercises to tailor and customize the index product to the local context.** The product design study should be informed by initiatives such as NDGI and QUUIC. It would also need to be informed by operational rangeland monitoring systems in the country/region (e.g. CSE and AGRHYMET). Similarly, existing regional surveillance systems, such as the one developed by the ACF (also in collaboration with CSE), might be considered as a platform for IBDRFI-related data services. The multi-stakeholder reviews and customization should include the definition of unit areas of insurance that should reflect wet season grazing areas and mobility patterns, reviews of the areas flagged as needing 'forage review' in this study and considerations on alternative payout functions. Additional factors to be considered during the review include the impact of bushfires, woodland cover and land cover changes/degradation on the drought index (e.g. by conducting trend analyses). Ground rangeland biomass datasets, such as the one collected by the CSE would be an important asset to improve the quality of product design through rigorous comparative analyses. In addition, state of the art scientific studies on drought index design and herd mobility modelling need to be explored with the goal of further improving the definition of the insurance units through more objective approaches.
- **A systematic review of ongoing pastoral development interventions in northern Senegal (e.g. PRAPS) should be conducted to explore synergies and opportunities for bundling services.** Lessons learned from existing programs suggest that linking financial and physical resilience interventions can create a win-win situation toward the achievement of development outcomes. In addition, several stakeholders have indicated the importance of connecting IBDRFI payouts to other interventions aimed at supporting improved livestock production. These include market linkages and value-chain development, feed and fodder development, forage conservation and water management, animal health and access to finance and credit. A specific point was also made on the potential role of payouts in mitigating conflicts between pastoralists and farmers during transhumance. If pastoralists receive the payouts before the dry season when the transhumance is planned, the payouts will enable them to better manage the transhumance by buying animal feed/water in advance. Thus they could avoid other coping strategies, such as anticipated transhumance, that are often Sources of conflict with farmers. As indicated by multiple country stakeholders, bundling of the IBDRFI product with additional services, such as micro-credit, access to animal feed or veterinary services could also be considered to facilitate the IBDRFI products uptake and make better use of payouts. It will be critical to design this package in a collaborative manner between the insurers, implementing parties, livestock breeders, veterinary auxiliaries and agro-meteorological institutions involved in tracking and evaluating forage biomass.

Next steps

R8: Capacity development and learning

- **A capacity building and awareness creation strategy targeting institutional and private sector actors and pastoral communities should be planned from the early stages of implementation.** All stakeholders indicated that financial literacy is limited in pastoral areas and the knowledge about agricultural insurance mechanisms is minimal. Increasing financial literacy and the understanding of index-insurance products among pastoralists would be a critical step in the early implementation of any IBDRFI initiative. This effort should be part of broader awareness creation and engagement strategy that includes breeders and pastoralists' associations, government officials, insurance companies, commercial banks, money transfer operators and other micro-finance institutions, NGOs and donor organizations. A strategy combining face to face training campaigns, radio, television programs and workshops could support this task. In this perspective, the roles of breeders and pastoral associations and institutions such as the National Bank of Agriculture, which is keen to expand its portfolio in the pastoral areas and support financial literacy, should be explored further. Targeted capacity building efforts should also be planned for agro-meteorological service providers that might take data management and index calculation responsibilities.
- **A monitoring and evaluation strategy should also be designed as part of a broader learning framework to ensure that appropriate mechanisms for quality assurance and impact evaluation are in place.** Senegal is at the forefront of research and development innovation in west Africa, with strong local capacity and active presence of international organizations with experience in IBDRFI and pastoral development, such as the WFP, ILRI, CIRAD, AGHRYMET and ARC, among others. This creates opportunities for a learning and impact evaluation laboratory that could be a model for the region. The rigorous impact evaluations conducted during the commercial IBLI program in Kenya and Ethiopia still represent huge knowledge capital for IBDRFI initiative improvements in Africa. However, the failure to set up a robust monitoring and evaluation framework during KLIP has severely limited the possibility of generating strong evidence on the value and costs/ benefits of the program, with broader repercussions on the quality of implementation. Therefore, this should be considered as one of the priority areas during the implementation design phase.

Photo credit: EAP Photo Collection/ World Bank

References

Adriansen, H. K. (2008). Understanding pastoral mobility: the case of Senegalese Fulani. Geographical Journal, 174(3), 207-222.

African Risk Capacity (ARC). (2020). @ARC Newsletter. 2nd Edition. November 2020. https://www.africanriskcapacity.org/wp-content/uploads/2021/01/@ARC_2nd-edition.pdf

Anchang, J. Y., Prihodko, L., Ji, W., Kumar, S. S., Ross, C. W., Yu, Q., Lind, B., Sarr, M. A., Diouf, A. A., & Hanan, N. P. (2020). Toward Operational Mapping of Woody Canopy Cover in Tropical Savannas Using Google Earth Engine. *Frontiers in Environmental Science, 8*(4). doi:10.3389/fenvs.2020.00004

ANSD. 2014. "Recensement Général de La Population et de l'Habitat, de l'Agriculture et de l'Elevage 2013." http://www.ansd.sn/resSources/rapports/Rapport-definitif-RGPHAE2013.pdf.

———. 2016. "Mapping the Poor in Senegal: Technical Report." Ministère de l'Économie, des Finances et du Plan. https://www.ansd.sn/resSources/publications/SEN_PovMap_160512_rapport%20Version%20Anglaise.pdf.

———. 2019. "Situation Économique et Sociale Du Sénégal, Chapître 11: Èlevage." https://www.ansd.sn/index.php?option=com_sess&view=sess&Itemid=418#:~:text=Agence%20Nationale%20de%20la%20Statistique%20et%20de%20la%20D%C3%A9mographie&text=La%20croissance%20%C3%A9conomique%20du%20S%C3%A9n%C3%A9gal,6%2C2%25%20en%202018.

Archibald, S., Lehmann, C. E. R., Gómez-Dans, J. L., & Bradstock, R. A. (2013). Defining pyromes and global syndromes of fire regimes. *Proceedings of the National Academy of Sciences, 110*(16), 6442-6447. doi:10.1073/pnas.1211466110

Bond, W. J. (2001). Fires, ecological effects of. *Encyclopedia of biodiversity, 2,* 745-753.

Bowman, D. M., Balch, J. K., Artaxo, P., Bond, W. J., Carlson, J. M., Cochrane, M. A., D'Antonio, C. M., DeFries, R. S., Doyle, J. C., & Harrison, S. P. (2009). Fire in the Earth system. *Science, 324*(5926), 481-484.

Cabral, A. I., & Costa, F. L. (2017). Land cover changes and landscape pattern dynamics in Senegal and Guinea Bissau borderland. *Applied Geography, 82,* 115-128.

ao, GianPietro, Alexandre Ickowicz, Toure Ibra, and Pierre J. Gerber. 2008. "An Information and Early Warning System Designed for Sahelian Pastoral Systems: The Example of SIPSA Implementation in Senegal," January.

CEP-MEPA. 2017. "Recueil de Statistiques d'élevage 2017." Cellule des Études et de la Planification (CEP), Ministère de l'Élevage et des Productions Animales (MEPA). http://www.elevage.gouv.sn/sites/default/files/Statistiques%20Elevage%202017.pdf.

CIA. 2021. "CIA Factbook, Senegal." 2021. https://www.cia.gov/the-world-factbook/countries/senegal/#introduction.

CIRAD. 2014. "SIPSA: An Information System for Monitoring Pastoral Dynamics in the Sahel - CIRAD." 2014. https://www.cirad.fr/en/our-research/research-results/2014/sipsa-an-information-system-for-monitoring-pastoral-dynamics-in-the-sahel.

CSE. 2010. "Suivi de Feux de Brousse de 2003 à 2010 à Partir de l'imagerie MODIS."

Houerou, H. N. Le, and C. H. Hoste. 1977. "Rangeland Production and Annual Rainfall Relations in the Mediterranean Basin and in the African Sahelo Sudanian Zone." *Rangeland Ecology & Management / Journal of Range Management Archives* 30 (3): 181–89. https://journals.uair.arizona.edu/index.php/jrm/article/view/6701.

Chelanga, P., Khalai, D. C., Fava, F., & Mude, A. (2017). *Determining insurable units for index-based livestock insurance in northern Kenya and southern Ethiopia*: ILRI (aka ILCA and ILRAD).

Clarke, D., & Vargas Hill, R. (2013). Cost-benefit analysis of the African Risk Capacity Facility. IFPRI Discussion Paper

CILSS. (2016). Landscapes of West Africa – A Window on a Changing World. U.S. *Geological Survey EROS, 47914 252nd St, Garretson, SD 57030, UNITED STATES.*

Cotillon, S. E. (2017). West Africa land use and land cover time series: U.S. Geological Survey Fact Sheet 2017–3004, 4 p. https://doi.org/10.3133/fs20173004

FAO (2020) Senegal: FAO launches project to assist transhumant herders affected by COVID -19. http://www.fao.org/senegal/actualites/detail-events/en/c/1300044/. Accessed on 6th February, 2021

Fare, Y., Dufumier, M., Loloum, M., Miss, F., Pouye, A., Khastalani, A., & Fall, A. (2017). Analysis and diagnosis of the agrarian system in the Niayes region, northwest Senegal (West Africa). Agriculture, 7(7), 59.

Fava, F., J. Jensen, J. Sinah, and B. Maher. 2020. Building Financial Resilience in Pastoral Communities in Africa. Lessons Learned from Implementing the Kenya Livestock Insurance Program (KLIP). World Bank Group.

Fava, F. and Anton Vrieling. 2021. "Earth Observation for Drought Risk Financing in Pastoral Systems of Sub-Saharan Africa." Current Opinion in Environmental Sustainability 48: 44–52. http://www.sciencedirect.com/science/article/pii/S1877343520300804 (December 30, 2020).

FEWSNET. (2015). MALI New Livelihood Zone Descriptions. Retrieved from

Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., & Michaelsen, J. (2015). The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes. 2, 150066. doi:10.1038/sdata.2014.66

IRLI (2021). A Regional Approach to Drought Insurance in IGAD Countries – Operational Feasibility Report. Vol 1. Main Report

Kahiu, M. N., & Hanan, N. (2018). Fire in subSaharan Africa: The fuel, cure and connectivity hypothesis. *Global Ecology and Biogeography,* 27(8), 946-957.

Klisch, A., & Atzberger, C. (2016). Operational drought monitoring in Kenya using MODIS NDVI time series. *Remote Sensing,* 8(4), 267.

Giglio, L., Randerson, J. T., & Werf, G. R. (2013). Analysis of daily, monthly, and annual burned area using the fourth generation global fire emissions database (GFED4). *Journal of Geophysical Research: Biogeosciences,* 118(1), 317-328. .

Janzen, S. A. and M. R. Carter. 2019. "After the drought: The Impact of Microinsurance on Consumption Smoothing and Asset Protection." American Journal of Agricultural Economics 101(3):651-671.

Jensen, N. D., C. B. Barrett and A. G. Mude. 2017. "Cash Transfers and Index Insurance: A comparative impact analysis from northern Kenya." Journal of Development Economics 129: 14-28.

Marcantonio, F., & Kayitakire, F. (2017). Review of Pilot Projects on Index-Based Insurance in Africa: Insights and Lessons Learned.

Matsuda, A., K. Takahashi, and M. Ikegami. 2019. "Direct and indirect impact of index-based livestock insurance in Southern Ethiopia." The Geneva Papers on Risk and Insurance-Issues and Practice 44(3): 481-502.

JOKALANTE. 2018. "Cartographie Des Systèmes d'Alerte Précoces (SAP) Existants Dans Les Régions de Tambacounda et Louga." https://issuu.com/concernuniversal/docs/cartographie_des_syste_mes_d_alerte.

PARM. 2016. "Agricultural Risk Assessment Study in Senegal - PARM." Rome: International Fund for Agricultural Development. https://p4arm.org/document/agricultural-risk-assessment-study-in-senegal/.

Patrice, S., & Kalinganire, J. (2017). *Restoration of Degraded Lands in Mali: a review on lessons learnt and opportunities for scaling.* Retrieved from World Agroforestry Centre (ICRAF). Bamako, Mali:

Samasse, K., Hanan, N. P., Anchang, J. Y., & Diallo, Y. (2020). A High-Resolution Cropland Map for the West African Sahel Based on High-Density Training Data, Google Earth Engine, and Locally Optimized Machine Learning. Remote Sensing, 12(9), 1436.

Schaefer, L., and E. Waters. 2016. Climate Risk Insurance for the Poor & Vulnerable: How to Effectively Implement the pro-Poor Focus of InsuResilience. Munich: Munich Climate Insurance Initiative.

Syll, M.M. (2019). Diagnostic des initiatives sur l'assurance indicielle betail au senegal: bilan et enseignements. IPAR-BRACED

Tappan, G. G., Cushing, W. M., Cotillon, S. E., Mathis, M. L., Hutchinson, J. A., Herrmann, S. M., & Dalsted, K. J. (2016). Land Use, Land Cover and Trends in Senegal (Publication no. http://dx.doi.org/10.5066/F73N21JF). from USGS https://eros.usgs.gov/westafrica/land-cover/land-use-land-cover-and-trends-senegal

Taye, M., V. Alulu, W. Gobu, and N. Jensen. 2019. "Livestock Insurance Payouts and Coping Strategies of Pastoralists during Drought." ILRI Research Brief 90.

Touré, Ibra, Alexandre Ickowicz, Wane A., Issa Garba, and Pierre J. Gerber. 2012. "Atlas of Trends in Pastoral Systems in the Sahel 1970-2012. SIPSA. FAO-CIRAD, 32 Pages (Http://Umr-Selmet.Cirad.Fr/Publications-et-ResSources/Documents-Techniques)." CIRAD. http://www.fao.org/3/a-i2601e.pdf.

Turner, M. D., McPeak, J. G., Gillin, K., Kitchell, E., & Kimambo, N. (2016). Reconciling flexibility and tenure security for pastoral resources: The geography of transhumance networks in eastern Senegal. *Human Ecology,* 44(2), 199-214.

Vrieling, A., Meroni, M., Mude, A. G., Chantarat, S., Ummenhofer, C. C., & de Bie, K. (2016). Early assessment of seasonal forage availability for mitigating the impact of drought on East African pastoralists. Remote Sensing of Environment, 174, 44-54. doi:https://doi.org/10.1016/j.rse.2014.12.003

UNCDF. (2020). Growing Digital Financial Inclusion in Senegal. https://www.uncdf.org/article/5243/growing-digital-financial-inclusion-in-senegal-report. Accessed 6th February, 2021

UNECA. 2017. "New Fringe Pastoralism: Conflict and Insecurity and Development in the Horn of Africa and the Sahel." 2017. https://repository.uneca.org/bitstream/handle/10855/23727/b11836179.pdf?sequence=3&isAllowed=y.

USAID. 2018. "The Economy of Resilience to Drought". https://www.usaid.gov/resilience/economics-resilience-drought

WBG. 2014. "Regional Pastoral Livelihoods Resilience Project." Project Appraisal Document. World Bank Group.

———. 2015. "Senegal - Agricultural Sector Risk Assessment." Text/HTML. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/238261468184467370/Senegal-Agricultural-sector-risk-assessment.

———. 2020. "Sahel Adaptive Social Protection Program - Annual Report 2019." Washington, D.C.: World Bank Group. https://www.worldbank.org/en/programs/sahel-adaptive-social-protection-program-trust-fund#5.

———. 2021. "World Development Indicators." 2021. https://databank.worldbank.org/Source/world-development-indicators#.

Weicker, Martin. 1993. *Nomades et sédentaires au Sénégal*. Occasional paper (Dakar, Senegal) ; no. 139-140. Dakar: Enda-éditions.

WFP. 2014. "Climate Risk and Food Security in Senegal: Analysis of Climate Impacts on Food Security and Livelihoods." Rome: World Food Programme. https://www.wfp.org/publications/climate-risk-and-food-security-senegal-analysis-climate-impacts-food-security-and-livelihoods.

Wood, E., Tappan, G. G., & Hadj, A. (2004). Understanding the drivers of agricultural land use change in south-central Senegal. *Journal of Arid Environments, 59*(3), 565-582.

Photo credit: Curioso Photography From Unsplash

APPENDICES

Appendix 1. Key differences between micro-level retail IBLI and modified macro-level social livelihoods protection programs

TABLE A1.1 DIFFERENCES BETWEEN MICRO AND MACRO-LEVEL PROGRAMS IN KENYA AND ETHIOPIA

Item	IBLI micro-level commercial retail insurance	KLIP social livelihoods protection program
Product design and rating		
Index: Satellite NDVI (MODIS)	• Same	• Same
Contract design (triggers) and payouts (loss cost rates)	• Same	• Same
Sum insured	• Same (but could increase for larger commercial herders according to the feed requirements of their herds)	• Same (but as livelihoods protection, based on minimum nutritional requirements of livestock)
Commercial premium rates	• Same underlying pure loss costs, but commercial premium rates may need to be considerably higher to reflect much higher operational costs associated with sales to individual pastoralists (insured policyholders	• Same underlying pure loss costs, but potential to minimize operational loadings as automatic cover for large numbers of beneficiaries and potential to achieve economies of scale in operational costs
Payouts	• Same assuming same sum insured and triggers adopted (direct to policyholder/Insured)	• Same assuming same sum insured and triggers adopted (direct to beneficiary)
Target audience	• More affluent small/medium and large pastoralists who can afford to pay either the full commercial premium rate or a partly subsidized premium rate	• Vulnerable pastoralists who depend largely on livestock herding for their livelihoods but who cannot afford to pay commercial premium rates. • These pastoralists should have a minimum herd size of no less than 5 TLUs
Compulsion of IBLI insurance	• Purely voluntary decision by the individual pastoralist or group	• Automatic enrolment of selected pastoralists by the project management team / government entity
Policyholder (insured)	• The individual pastoralist is the policyholder and insured as named in the policy certificate	• The insured policyholder is the government entity/ agency on behalf of the preselected pastoralists who will be listed in the schedule (or annex) attached to the policy issued to the government entity/agency
Preconditions of insurability	Insured pastoralist households must: • Be able to pay their share of premiums • Have a smartphone to receive SMS messages • Have a bank account (fixed or mobile money) into which payouts can be directly made	Beneficiary pastoralist households must: • Own a minimum of 5 TLUs and be livestock herders • Have a smartphone to receive SMS messages • Have a bank account (fixed or mobile money) into which payouts can be directly made
IBLI insurance awareness creation and sensitization	• Not essential if marketing and promotion and sales functions are correctly performed by the insurer or its appointed agents/ distribution channels	• Essential as pastoral communities and their members must be made aware of the government livelihoods protection program and why some pastoralists are being identified as beneficiaries and will be automatically enrolled, while others will not be selected

Item	IBLI micro-level commercial retail insurance	KLIP social livelihoods protection program
Targeting (and sales) and selection	Insurers will be responsible for their own marketing and promotion and sales programs including: • Own sales agents • Other distributers	• The government agency will need to work closely with country-level authorities, community and pastoral leaders to identify the selection criteria and the beneficiaries of the program in each insured unit (IU)
Registration	• All insured pastoralists must be electronically registered along with their livestock holdings and details of their address, phone number and bank/mobile money account details and name of the IU in which their livestock are normally grazed and which they have selected to be their trigger IU • IBLI details must also be recorded including no insured TLUs, sum insured, premium rates for that IU and premiums paid by the pastoralist	• All beneficiaries must be electronically registered along with their livestock holding and details of their address, phone number and bank/mobile money account details and name of the IU in which their livestock are normally grazed and which they have selected to be their trigger IU. • IBLI details must also be recorded including no insured TLUs, sum insured, premium rates for that IU and premiums paid by the government
Premium payment and policy issuance	• On the payment of their share of premium, each insured policyholder should receive a uniquely numbered certificate of insurance (local language), policy wording and schedule of cover (as necessary)	• Beneficiaries do not pay any premium (at least in initial year(s)). A single master policy document will be issued to the government entity that purchases cover. • Each beneficiary must receive a certificate detailing the protection they are receiving (no TLU, sum insured and maximum payouts per season and IU)
End of season notification (and settlement of payouts)	• Ideally SMS messaging will be used to advise each insured during the coverage period if drought conditions are developing in their IU and at end of the cover period whether a drought payout has been triggered or not and the payout due • Electronic money transfers should be carefully tracked to each insured's bank or mobile money account	• Ideally SMS messaging will be used to advise each beneficiary during the coverage period if drought conditions are developing in their IU and at end of the cover period whether a drought payout has been triggered or not and the payout due • Electronic money transfers should be carefully tracked to each beneficiary's bank or mobile money account
Government support: Premium subsidies	• Currently none under IBLI micro-level programs in Kenya and Ethiopia	• Kenya: 100% subsidized and financed by the government of Kenya (out of SDL-MALF budget) • Ethiopia: the WFP finances 100%, but pastoralists are expected to contribute towards premium costs through insurance for assets, in kind labour on PSNP public works programs
Costs of implementing program to insurers	• The administration, operating requirements and expenses for insurers to market micro-level IBLI policies to individual pastoralists in the ASAL regions are extremely high including awareness creation and policy promotion/sales, policy issuance, premium collection and claims payouts (See Table 4.7 for further details)	• The administration, operating requirements and expenses for insurers to underwrite a single modified macro-level policy with government are much lower than for a micro-level IBLI program. • Main costs include registering pastoralists (beneficiaries) and insurance awareness creation
IGAD country experience to date	• IBLI ASAL counties of Kenya since 2010-11 • IBLI Borena, Oromia region, Ethiopia since 2012-13	• KLIP, ASAL counties of Kenya since 2015-16 • SIIPE, Somali region and Ethiopia since 2017-18

Source: ILRI (2021)

Appendix 2. IBLI product design and overview of customization options

This section describes the standard IBLI product used for the scenario analysis in this study while providing a brief, non-exhaustive overview of alternative customization options that can be considered during the product design customization at the early stages of implementation.

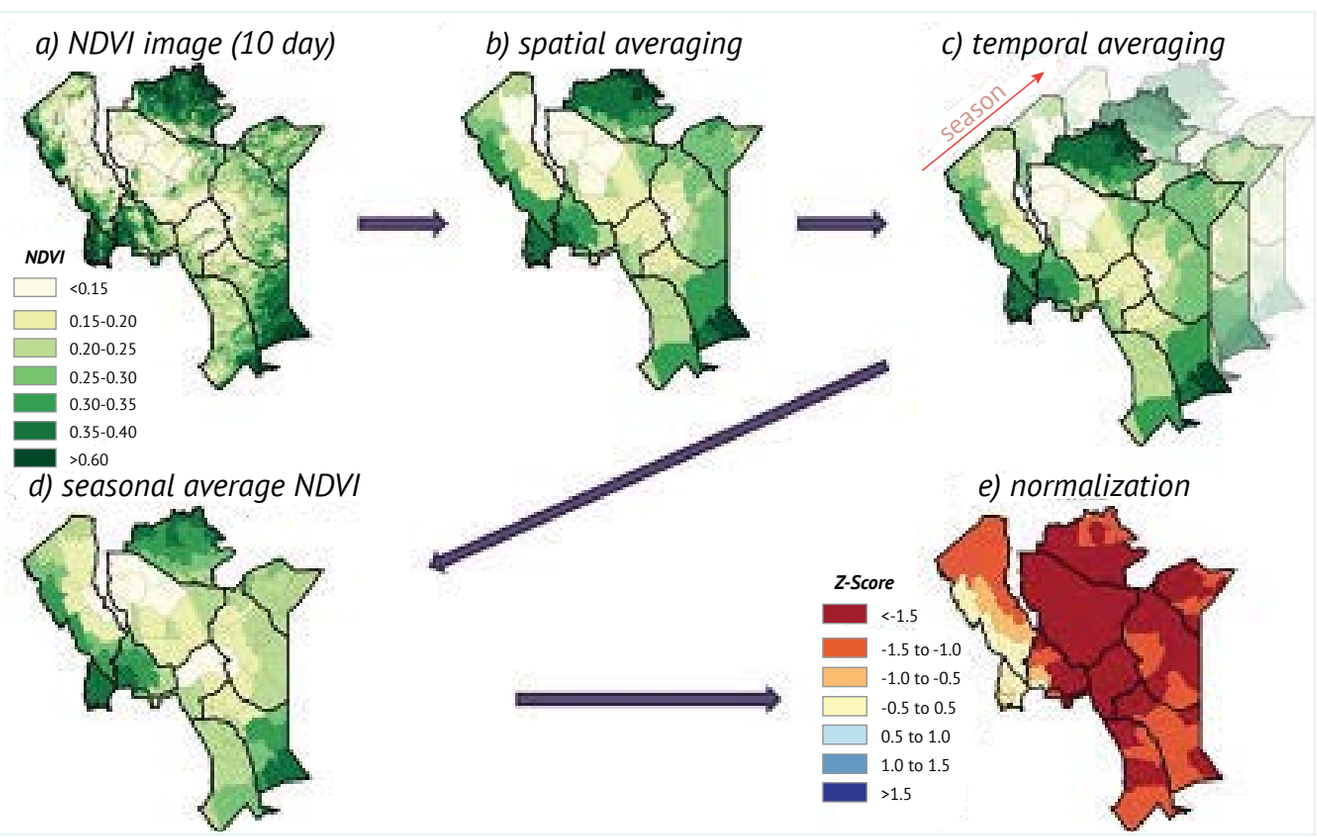
Index design

The IBLI product relies on NDVI time series acquired from the MODIS satellite sensors (eMODIS product). The use of alternative satellite indicators, such as rainfall estimates or soil moisture is not considered in this study, as currently there are no products designed for African pastoral regions based on these alternative indicators (Fava and Vrieling 2021). While in principle they could offer a valuable alternative, rigorous research and quality assessments would need to be performed prior to their adoption.

To transform the NDVI into a useful index for pastoral IBDRFI schemes, three steps are required:

1. **Spatial aggregation:** Geographic units are normally larger than grid cells, both for operational reasons and to reflect that herds move. Aggregation within units generally incorporates a mask of where rangelands occur.
2. **Temporal aggregation:** Most schemes aim to assess seasonal forage scarcity, requiring expert or EO derived [32] knowledge on rainfall/vegetation seasonality.
3. **Normalization** to compare the current index values against historic index realizations in past years.

FIGURE A2.1 IBLI PRODUCT DESIGN



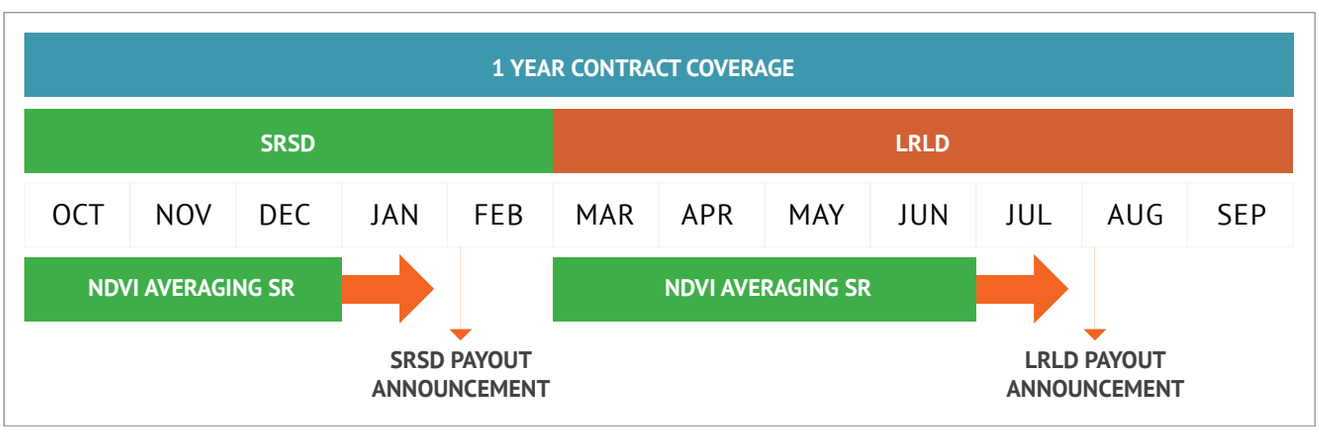
Source: (Vrieling et al. 2016)

Spatial aggregation units are administration level 2 units. Insurance units are generally defined in collaboration with local stakeholders according to a set of criteria (Chelanga et al. 2017), but this would be out of scope for a feasibility study. However, it should be noted that this is a very important step that requires planning in the early implementation steps.

Temporal aggregation is set to seasonally aggregated data. To define the pasture growing season temporal boundaries, unit level SOS and EOS dates are estimated using the Joint Research Centre phenology maps.[25] When the spatial variability of SOS and EOS is limited, fixed dates are be used. For Senegal, the SOS was fixed to July and the EOS to November. Figure A2.2 shows an example of the temporal aggregation in the KLIP program.

Depending on the type of IBDRFI instrument used, the temporal aggregation can be customized. For example, running averages (e.g. monthly and quarterly) have been proposed and utilized as an alternative (i.e. in the Hunger Safety Net Program in Kenya).

FIGURE A2.2 IBLI KLIP CONTRACT COVERAGE PERIOD, INDEX CALCULATION PERIOD AND TIMING OF PAYOUTS IN KENYA



Source: (Fava et al. 2021)

The normalization approach is based on the use of standard scores. However, multiple options exist, such as linear scaling between minimum and maximum historic values (i.e. the vegetation condition index), percentile calculation or per cent deviation from average. However, it is not expected that there will be major implications on the payouts related to the normalization metric used.

Payout function

The formulation of the payout function is a linear function of the index value between an index attachment and an index exit threshold. Payouts range from 0 (below the attachment value), to a predefined maximum value below the exit. In the standard model, the attachment threshold is calculated at unit level in terms of expected payout frequency (i.e. 1 out of 5 seasons) on the historical dataset. The exit threshold is commonly fixed or set to the minimum historical index value. The maximum payout is calculated as the cost of maintaining the livestock alive during a severe drought shock .[26] These parameters are not constant across IBDRFI programs and need to be individually customized.

The standard payout function is applied to end of season index values (in agreement with the temporal aggregation step described above (Appendix 2). However, options for multiple seasonal payouts (e.g. one early and one end of season) have also been proposed and utilized. The early payout is not a fully independent payout, but an anticipation of the main payout.

25. (Available at https://mars.jrc.ec.europa.eu/asap/) (Accessed on date)

26. In Kenya the monthly sum insured is currently 1,167 Kenyan Shilling (KES) per TLU per month (KES amount = USD 1.00 at date) to cover the costs of purchased fodder and feed supplements. The Kenyan IBLI programs provide payouts to enable pastoralists to purchase supplementary feeds for their animals over the 5-month short rains dry season (October to February) and for the 7-month long rains dry season (March to September). Therefore, the sum insured to feed 1 TLU over 12 months is KES 14,000 (KES amount = USD 1.00 at date) per TLU.

Alternative formulations of the payout function have also been proposed but not yet applied in operational programs in Africa. For example, an alternative formulation of the payout function is based on the persistency of forage deficit conditions rather than the seasonally aggregated values. In this case, when index values fall below a predefined attachment threshold for a given number of consecutive time periods (e.g. 2 or 3 decads), payouts are triggered. The payouts increase proportionally to the length of the forage-deficit period till a maximum payout is reached.

Appendix 3. Technical feasibility assessment methods

The technical feasibility analysis was based on the standard IBLI product. This product has been specifically designed and tested for extensive pastoral systems of east Africa and, therefore, few conditions need to be met for its use in different geographic contexts as discussed below. In addition to these requirements, the product can be refined, customized and improved upon to reflect conditions within a specific country.

For successful implementation, three major premises should be satisfied, including:

1. **Dominance of extensive rangelands to provide clear linkage between satellite NDVI values and ground forage conditions.** The estimation of forage indices is built on spatial aggregation of predefined units or UAIs. Thus, heterogeneous landscapes, such as agropastoral systems, mixed crops, agroforestry areas, non-forage production areas etc. are challenging to drought index design.
2. **Sufficient forage production that can be easily detected by clear satellite NDVI signals.** Since NDVI is used as an indicator of forage availability for determining insurance index and payouts, rangelands that have little or no forage resources, such as barren lands, must be identified and eliminated.
3. **Clear seasonal patterns for both wet and dry seasons to allow identification of the risk period and related insurance parameters,** (i.e. coverage period, sales windows and time of payouts). Other factors such as drought history and migration patterns are also important elements to be considered when designing the index.

To determine rangeland dominance, forage availability and seasonality, the analysis was based on various satellite products (Table A3.1), including the 10-day eMODIS[27] NDVI time series at 250 m spatial resolution, decadal rainfall estimates from the Climate Hazards Group Infra-red Precipitation with Station (CHIRPS) (CHIRPS; Funk et al., 2015) data available at a spatial resolution of 0.05° for the period 2002-19, land cover characteristics defining cropland/ rangeland extent and phenological metrics for the number of growing seasons (NGS), SOS and EOS from the Joint Research Centre. The metrics NGS, SOS and EOS were derived from the long-term average of eMODIS NDVI data at 1 km resolution for the period 2003-16 (Klisch et al., 2016).

To delineate homogenous zones and to help identify community groupings for the pragmatic implementation of drought risk financing (Chelanga et al., 2017), level three administration (arrondissment) boundary units were used. The analysis was done by spatial aggregation of the satellite products at these arrondissment levels. To determine the rangeland extent and dominance, average fractional covers of human landscape (croplands and built-up areas), savanna (shrubs and grass) and trees were used. Using stepwise conditional thresholding, the rangeland dominance areas were determined. If the ratio of rangelands to human landscapes was ⩾3 and tree cover was ⩽25%, then the unit was classified as fully meeting the rangeland requirement, however, if the rangelands to human landscapes ratio was <3 but ⩾1.5, the unit was classified as partially meeting the rangeland requirement.

27 Earth resources Observation and Science Moderate Resolution Imaging Spectroradiometer.

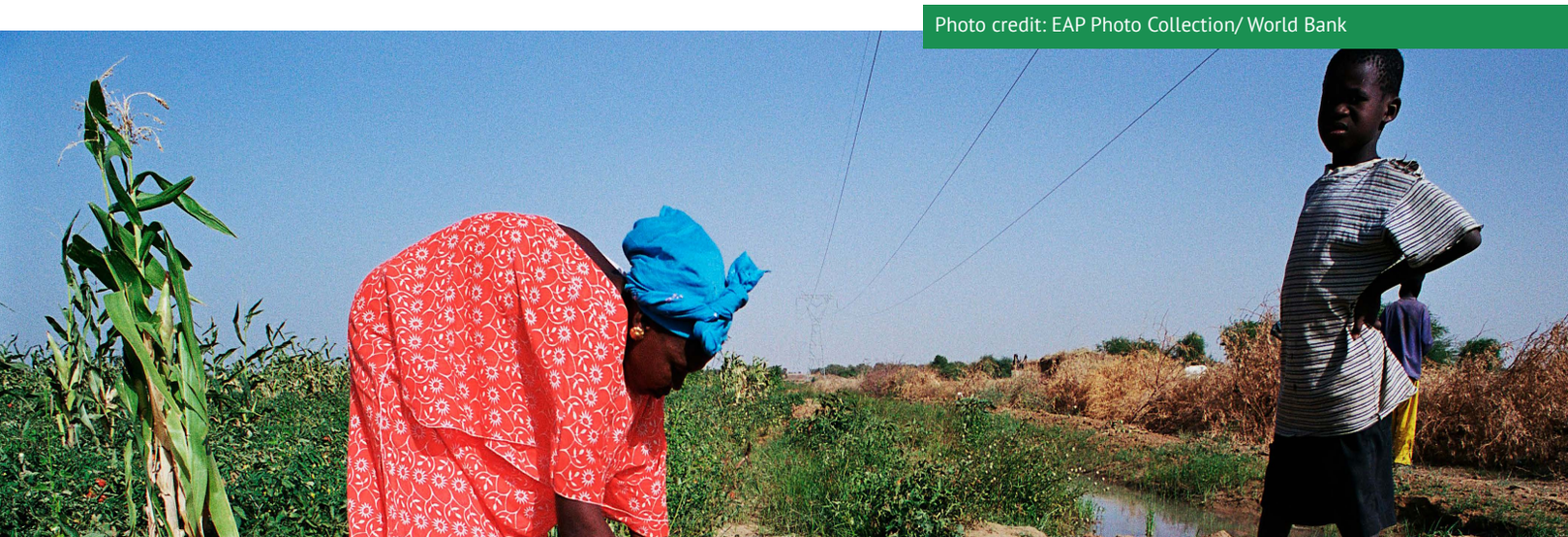
TABLE A3.1 SATELLITE DATA PRODUCTS USED IN THE STUDY

Data	Product	Description and Source
NDVI	• Normalized Difference Vegetation Index	• A 10-day temporary smoothed NDVI product at 250 m spatial resolution covering the period July 2002 to July 2020 • from eMODIS (United States Geological Survey).
Land cover	• Copernicus Global Land Service: Land cover 100 m: • Collection 3: 2019 Epoch (Globe) • Copernicus Global Land Service: Fractional covers for grass, shrubs, trees, bare, built-up, croplands	• A global near real time annual product for the 2019 epoch collection 3 land cover maps at 100 m spatial resolution. • These are produced by the global component of the Copernicus Land Service, derived from Project for Onboard Autonomy-V satellite observations and ancillary datasets. • The global map includes a discrete classification with 23 classes aligned with UN FAO's land cover classification system (Meroni 2018). • Global land cover fractions, i.e. percentage of ground cover for the four main classes used in the analysis, for 2019.
Phenology	Phenological timings • Number of growing seasons • Start of season • End of season	Three products were used: • Number of growing seasons per year, • Start of season and • End of season. • The IGAD region has both unimodal and bimodal precipitation regimes, thus each season has a start and end. • These metrics were derived from long term averages of the 10-day MODIS NDVI data produced by BOKU university at 1 km resolution for the period 2013-16 (Klisch et al. 2016), produced by the European JRC.
Precipitation	• Climate Hazards Group Infra-red Precipitation with Station data	• Computed decadal averages using the 10-day product for Kenya for the years 2002 to 2018, available at 0.05° (Funk et al. 2015).

Once the rangeland condition was met, the unit forage availability was determined. In Senegal some of the areas are characterized by scarce vegetation and barren lands, which get drier towards the Sahara desert. To eliminate areas considered unsuitable for the product implementation, NDVI and bare land fractional cover product were used to define the extent of productive lands in Senegal.

To aid in the identification of productive land areas with high NDVI intensity, the NDVI's amplitude was computed by calculating the difference between the 95th and 5th percentiles of NDVI, restricted to > 0.1 (Vrieling et al., 2016). The non-land areas were disregarded if the NDVI time series comprised < 60% of land valid NDVI values. Combining the bare land fractional cover and NDVI metrics, if the non-productive land areas were < 60%, then the forage availability condition was satisfied, otherwise it was classified as 'need for forage review'. The seasonality conditions were assessed by extracting the majority phenological metrics for NGS, SOS and EOS per arrondissment, with further refinement using average precipitation conditions and NDVI profiles.

Photo credit: EAP Photo Collection/ World Bank



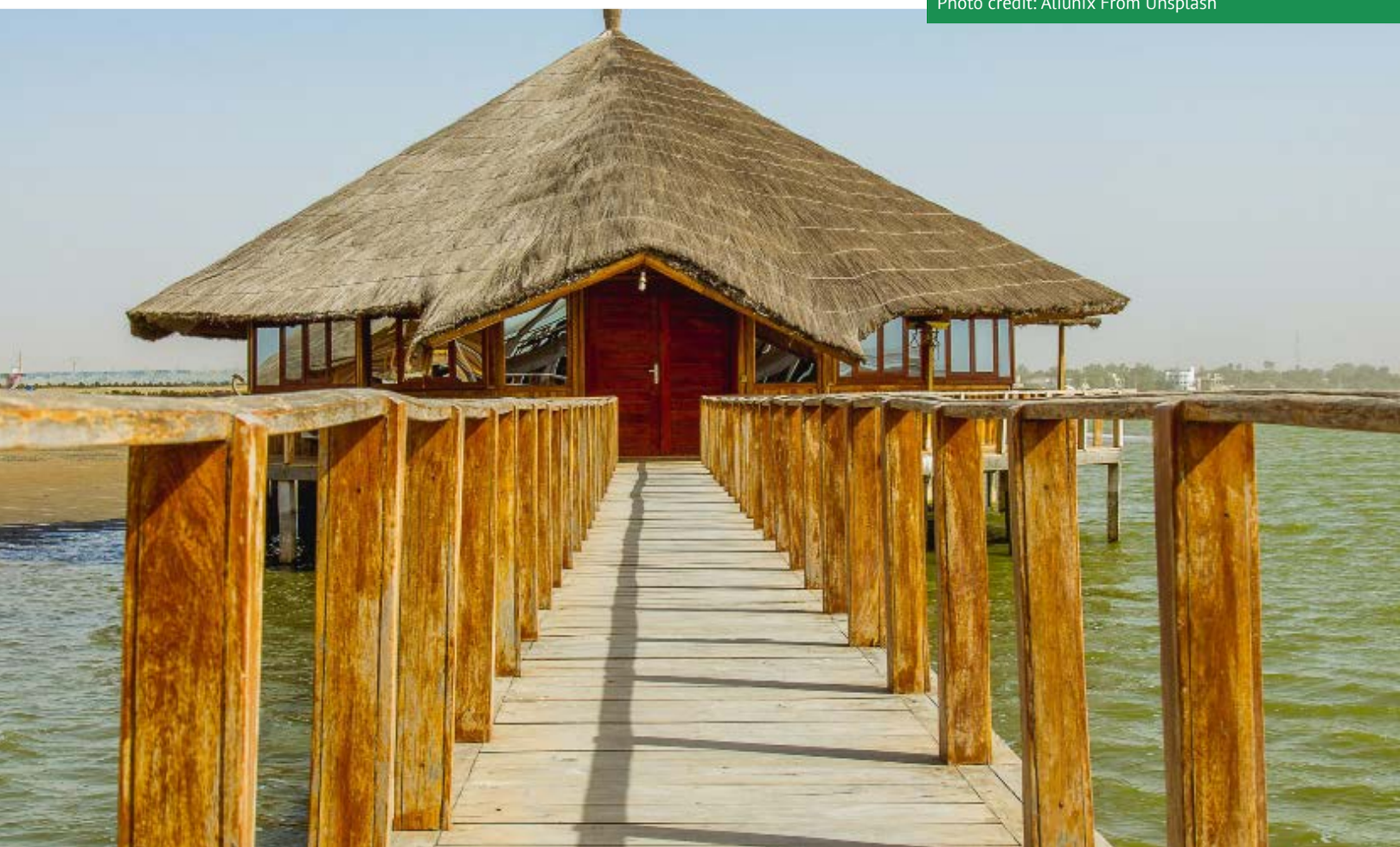
Appendix 4. Stakeholder engagement

Based on the scoping mission literature review, key stakeholders were identified for further information and fact finding to assess the socio-economic and operational feasibility of a drought risk financing product. The stakeholders were representatives from the insurance markets, private and public sector, regulators, members of government bodies, financial organizations, international development organizations and local pastoral groups. A list of key stakeholders is provided in Table A4.1.

TABLE A4.1 LIST OF STAKEHOLDERS

No.	Type	Stakeholder
1.	Insurance providers	Inclusive Guarantee CNAAS IBISA network
2.	Financial organizations	National Agriculture Bank
3.	Agro-meteorological and research organizations	ANACIM CSE PPZS
4.	Government bodies	Department of livestock, Ministry of livestock Department of Insurance Ministry of finance
5.	International Development Organizations	OXFAM World Food Programme BRACED
6.	Pastoral organizations	RBM

Photo credit: Aliunix From Unsplash



Appendix 5. Scenario analysis

The assumptions made for scenario PS1 (commercial micro-insurance) and PS2 (social livelihoods protection) are presented in Table A5.1. These assumptions are based on very general and simplified considerations, therefore, the presented costs should be seen as purely illustrative.

TABLE A5.1 SUMMARY OF THE ASSUMPTIONS MADE IN THE COSTING ANALYSIS

Item	Micro-level commercial insurance (PS1)	Macro-level social protection coverage (PS2)	Authors' assumptions
Uptake in 5 years	2,5% of total herd 0.5%/year increase rate	5% of total herd 1%/year increase rate	Uptake levels are generally lower in PS1, while they can be predefined in PS2
TLU per policyholder/ beneficiary	5	5	Aligned with existing programs[28]
Total sum insured/TLU	USD 180	USD 180	Indicative average value provided by stakeholder during willingness to pay study (IPAR 2019)
Trigger frequency	1 in 5	1 in 5	Realistic frequency in the country
Premium commercial loadings	Pure loss rate*1.5	Pure loss rate*1.3	Higher commercial loadings are expected for PS1. These loadings are at the lower end of the typical loadings applied internationally by the insurance sector and should be carefully reviewed for the local markets
Subsidies (government or donors)	50%	100%	PS1 is partially subsidized. PS2 needs to be fully subsidized. However, any intermediate subsidy option is also possible
Registration costs (government or donors)	-	USD 5 /beneficiary	For PS1, the cost is covered by the private sector. The amount is purely illustrative
Awareness creation	USD 2.5 / policyholder	USD 5 /beneficiary	For PS1, the cost is reduced by the contribution of the private sector (marketing). The amount is purely illustrative
Monitoring and evaluation	USD 5 /policyholder	USD 5 /beneficiary	This is an important component to demonstrate the value of the initiative. The amount is purely illustrative

The yearly and total indicative costs for the two scenarios are presented in Tables A5.2 and A5.3. The premium paid by each policyholder for each TLU in the S1 scenario can be obtained by the formula: (premium - subsidy)/TLUs.

28. Five TLUs have been selected on the KLIP and SIIPE macro-level social safety-net protection insurance programs as this is considered to be the minimum number of 'breeding' stock/TLUs required to maintain a viable herd through times of severe drought. However, this value is country specific.

TABLE A5.2 ANNUAL AND TOTAL COSTS FOR FIVE YEARS OF MICRO-LEVEL COMMERCIAL INSURANCE IMPLEMENTATION (IN USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Beneficiaries	5,000	10,000	15,000	20,000	25,000	75,000
TLUs	25,000	50,000	75,000	100,000	125,000	375,000
TSI	4,500,000	9,000,000	13,500,000	18,000,000	22,500,000	67,500,000
Premium	648,000	1,296,000	1,944,000	2,592,000	3,240,000	9,720,000
Subsidy	324,000	648,000	972,000	1,296,000	1,620,000	4,860,000
1. Electronic registration of livestock producers	0	0	0	0	0	0
2. Farmer awareness, education and training	50,000	100,000	150,000	200,000	250,000	750,000
3. Monitoring and evaluation	50,000	100,000	150,000	200,000	250,000	750,000
Total	424,000	848,000	1,272,000	1,696,000	2,120,000	6,360,000

TSI = Total sum insured

TABLE A5.3 ANNUAL AND TOTAL COSTS FOR FIVE YEARS OF MACRO-LEVEL SOCIAL PROTECTION COVERAGE IMPLEMENTATION (IN USD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Beneficiaries	10,000	20,000	30,000	40,000	50,000	150,000
TLUs	50,000	100,000	150,000	200,000	250,000	750,000
TSI	9,000,000	18,000,000	27,000,000	36,000,000	45,000,000	1,35,000,000
Premium	1,123,200	2,246,400	3,369,600	4,492,800	5,616,000	16,848,000
Subsidy	1,123,200	2,246,400	3,369,600	4,492,800	5,616,000	16,848,000
1. Electronic registration of livestock producers	50,000	50,000	50,000	50,000	50,000	250,000
2. Farmer awareness, education and training	100,000	200,000	300,000	400,000	500,000	1,500,000
3. Monitoring and evaluation	50,000	100,000	150,000	200,000	250,000	750,000
Total	1,323,200	2,596,400	3,869,600	5,142,800	6,416,000	19,348,000

TSI = Total sum insured

ILRI | INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Global Index Insurance Facility
MANAGED BY WORLD BANK GROUP

USAID
FROM THE AMERICAN PEOPLE