Measuring greenhouse gas emissions and tracking adaptation to climate change in Africa's livestock sector

Findings from the Programme for Climate-Smart Livestock Systems

Lucy Njuguna, Claudia Arndt, Todd Crane, Sonja Leitner, Michael Graham, Phyllis Ndung'u and Jesse Kagai

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ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

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Key messages

- The livestock sector is both a driver and victim of climate change. Livestock (and the livestock sector as a whole) emit greenhouse gases, but they are also severely affected by a changing climate.
- The livestock sector offers opportunities for African countries to meet their commitments under the Paris Agreement to reduce greenhouse gas emissions and adapt to climate change.
- Improved methods and more accurate data are needed to measure greenhouse gas emissions from the livestock sector more accurately and to report progress towards goals laid out in the Paris Agreement.
- The International Livestock Research Institute (ILRI) is developing methods to improve the baseline estimates of emissions as well as measure the results of promising practices that could reduce them. These will generate better data to inform policymaking and international reporting.
- Climate change can affect the livestock sector in many ways, and the sector may also adapt in many ways. ILRI is developing a set of indicators and a tool that countries can use to track and report on this adaptation.
- The tracking of adaptation to climate change also depends on institutional structures: in particular the interactions within the government and between the government and broader society.

The 2015 Paris Agreement is a legally binding international treaty on climate change. It aims to limit global temperature rises to 2°C compared to pre-industrial levels, preferably to 1.5°C. The Agreement also establishes a global goal on adaptation of enhancing adaptive capacity and resilience and reducing vulnerability to climate change.

Under the Agreement, 196 governments around the world committed to limit global warming. Each government submitted an action plan, or "nationally determined contribution", to cut its greenhouse gas emissions and adapt to the impacts of climate change. The signatories agreed to report their progress towards achieving their commitments on a regular basis. To do this, they must have ways to monitor and report on emissions, and to track adaptation to climate change.

> *"Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions."*
>
> *—Paris Agreement, Article 4, paragraph 2*

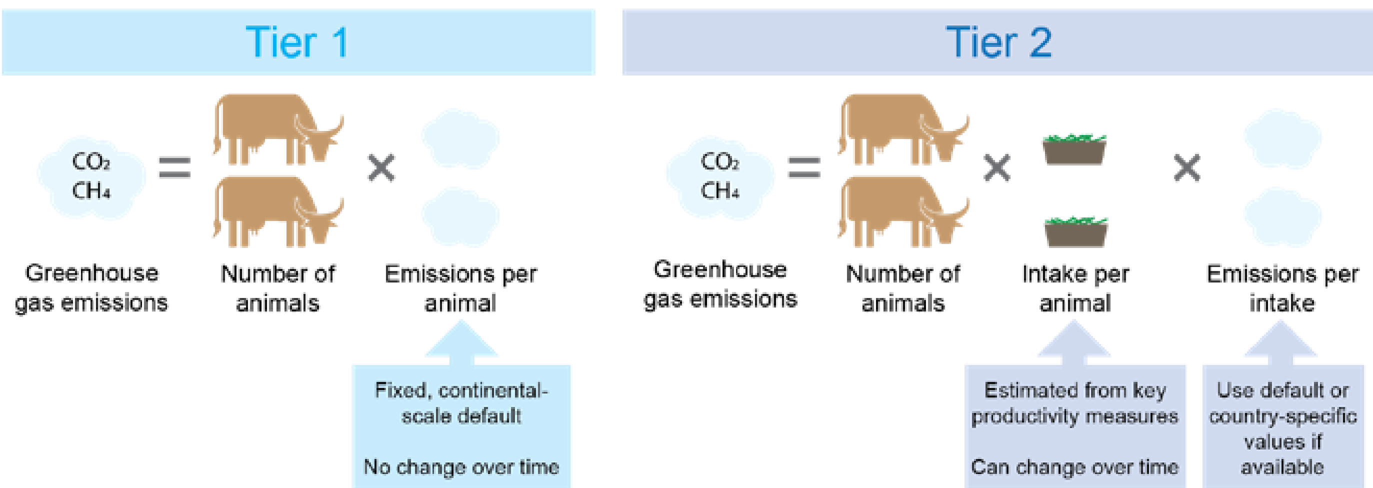
Current methods for measuring greenhouse gas emissions in the livestock sector

Africa's greenhouse gas emissions matter. FAO's Global Livestock Environmental Assessment Model estimates that the sub-Saharan African livestock sector produces 416 million tonnes of CO_2-equivalent per year, about half from beef production, another quarter from cattle dairying, and most of the rest from sheep and goats. However, the continent's consumption of animal protein is still far below recommended levels, so emissions from livestock are expected to rise further as both human populations and the demand for animal proteins increase.

The livestock sector emits methane through enteric fermentation in the digestive tract of ruminant livestock such as cattle, sheep and goats, as well as methane and nitrous oxide from manure. But how much of these gases does the livestock sector in Africa actually produce? An accurate value is hard to determine. Improving the accuracy of estimates is important to allow African governments to report on their commitments under the Paris Agreement. More accurate estimates are also needed to develop meaningful interventions to limit emissions.

Most current estimates of greenhouse gas emissions from livestock are based on a first approximation, known as "Tier 1". This multiplies the number of animals by the estimated emissions per animal (see figure below). This approximation has four major disadvantages:

- **Animal numbers are uncertain** Many countries in Africa have big uncertainties in their livestock populations, especially in pastoral regions. This is the largest source of potential error in estimates of livestock-related greenhouse gas emissions.
- **Emission factors (per animal) do not reflect local conditions** The values for the enteric methane emissions per animal are calculated based on the energy needs of different categories of animals, such as dairy cattle, mature males, and calves. The default values are provided by the Intergovernmental Panel on Climate Change (IPCC), which are in turn based on measurements made in developed countries – typically, Europe or the United States of America – where livestock are typically bigger and are more productive than animals under African conditions.



Source: GRA 2016

Left: A first approximation ("Tier 1") of enteric methane emissions from livestock. Right: An improved method ("Tier 2") of calculating emissions

Photo ILRI/Sarah Kasyoka

Taking cattle live-weight measurements at ILRI's Mazingira Centre. This is necessary to estimate the animals' greenhouse gas emissions.

Photo: ILRI/Sarah Kasyoka

Chambers to measure emissions from manure heaps at the Mazingira Centre.

The same is true for methane and nitrous oxide emissions from manure. Most default emission factors are based on numbers from the Global North, where animals receive nutrient-rich feed and excrete nutrient-rich manure that produces more methane and nitrous oxide. This is not representative of most African livestock systems.

- **Emission factors are not country-specific** The emission values are assumed to be the same for the whole of Africa. Yet the continent has a vast variety of climatic zones, livestock breeds, production systems, feed sources, and ways to manage manure. Only a few measurements have been made under African conditions.
- **The method does not reflect variations in emissions** The Tier-1 measures cannot be used to track variations in emissions, except those due to a rise or fall in the number of animals. For instance, it ignores changes in emissions that result from new production practices.

A better method: The Tier-2 approach

A better approximation, known as "Tier 2", uses country-specific data on animals, production systems, manure management, and the amount, quality and types of feed that the animals eat. These measures can be adjusted based on the particular location and production system (dairying, smallholder production, pastoralism, etc.). They give a much more accurate estimate of the amount of greenhouse gases emitted. They can also reflect changes in management practices and technologies, making it possible to account for measures to reduce emissions.

The emissions an animal produces depend on the type and amount of feed it eats. These depend in turn on its requirements for growth and maintenance, the distance it moves (and so the energy it expends) and the amount of milk it produces. Combining estimates of these values makes it possible to calculate the emissions per kilogram of protein (in terms of meat or milk) produced. The emissions from manure can be estimated in a similar way, by calculating the amount of manure excreted and its nutrient content based on the animals' feed intake.

Scientists at the International Livestock Research Institute (ILRI) have collected feed and animal data and used these to calculate more specific emission factors. The aim is to provide estimates for as many different situations as possible: livestock categories (males, females, adults, young), species (cattle, sheep, goats), management systems (smallholder, extensive, intensive), manure-management methods, and agroecological zones (highland, lowland, etc.) in Africa.

As a further improvement, it is necessary to measure the emissions from the animals and manure directly. This involves putting an animal in a closed container and measuring the amount of greenhouse gases it emits. Emissions from manure can be measured with a similar approach either in the lab or under field conditions. ILRI has the specialist equipment for such direct measurements. Some of its findings are already included in the IPCC's estimates of emission factors.

The ILRI scientists discovered that cattle under African conditions are likely to emit 15% less methane than the IPCC's default figures. Emissions from manure deposited on pasture and from manure heaps are also lower than the defaults. The estimated emissions for sheep were broadly correct, but those for goats were rather too high.

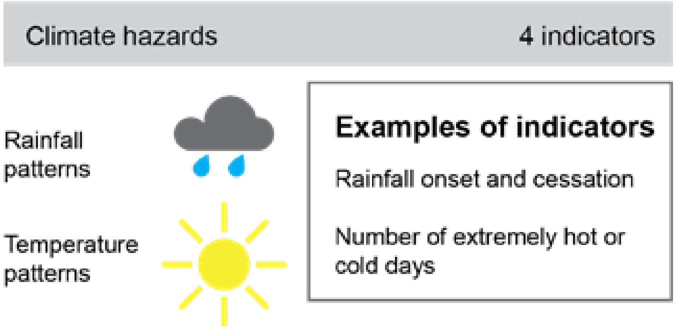
The IPCC currently has no category for traditional livestock enclosures (*bomas* or *kraals*) used by pastoralists, so emissions from manure in such enclosures are missed. ILRI scientists estimate that such enclosures alone may contribute 5% of the nitrous oxide emissions of the African continent, so accounting for these emissions is urgently needed.

Another important source of emissions from livestock are those associated with land-use change, overgrazing, soil degradation, and feed production. ILRI scientists have measured soil emissions from different land-use types in East Africa. To get a more complete picture, they are currently assessing the carbon footprint at an ecosystem scale (including vegetation, animals, manure, soils, and water bodies) of different land uses in the semi-arid drylands of southern Kenya. This is the first such research in the arid- and semi-arid lands. The results will enable researchers, policymakers, and other stakeholders to make decisions about food-production systems that take into account both productivity and the greenhouse gas emissions balance.

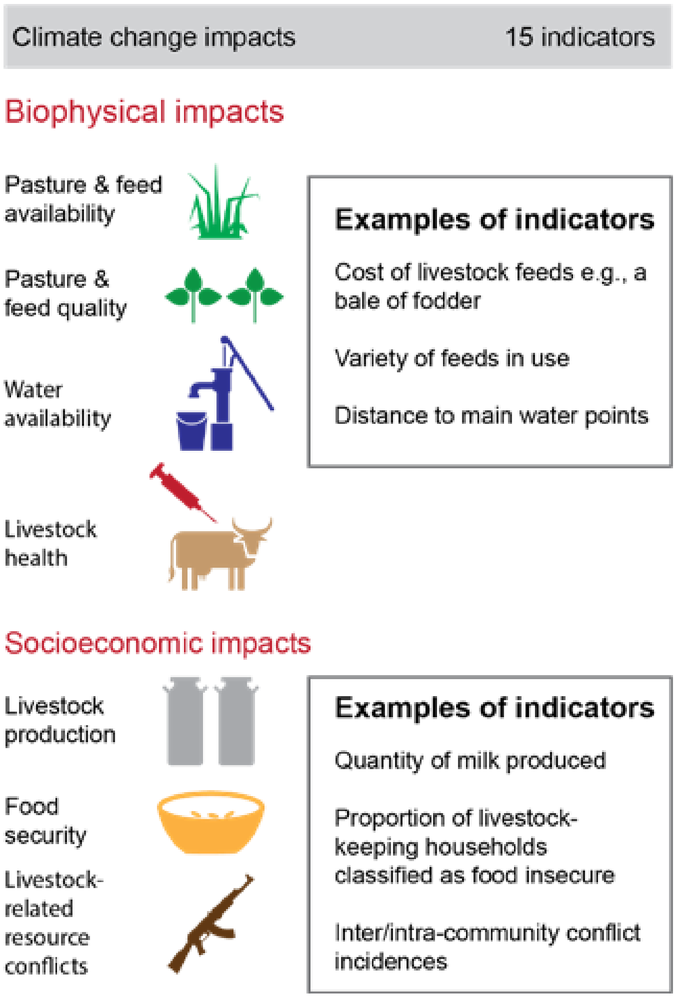
Tracking adaptation in the livestock sector

Tracking adaptation is very different from monitoring greenhouse gases. Adaptation is an abstract concept, so requires a more diverse array of variables and data, as well as difficult methodological choices. What constitutes adaptation can differ widely from one situation to another. Livestock are kept in a wide range of management types in Africa: from mobile pastoralism and ranching, through mixed crop–livestock systems (often by smallholders), to intensive dairying. Furthermore, adaptation can occur in many different situations, in farming households, collective bodies (such as cooperatives or herder associations), and policy frameworks.

Climate change may affect these livestock systems in many ways. Most obviously, animals may succumb to heat stress, or may go hungry and thirsty in a drought. Forage plants are affected by changes in rainfall and temperatures. A changing climate is likely to lead to more extreme heatwaves and more damaging floods. Shifting rainfall patterns will make certain areas less (or more) suitable for livestock production, or for growing the feed that animals eat. Depending on the location, livestock production may become less (or more) attractive as an enterprise or as a way of life.



Examples of indicators of climate hazards

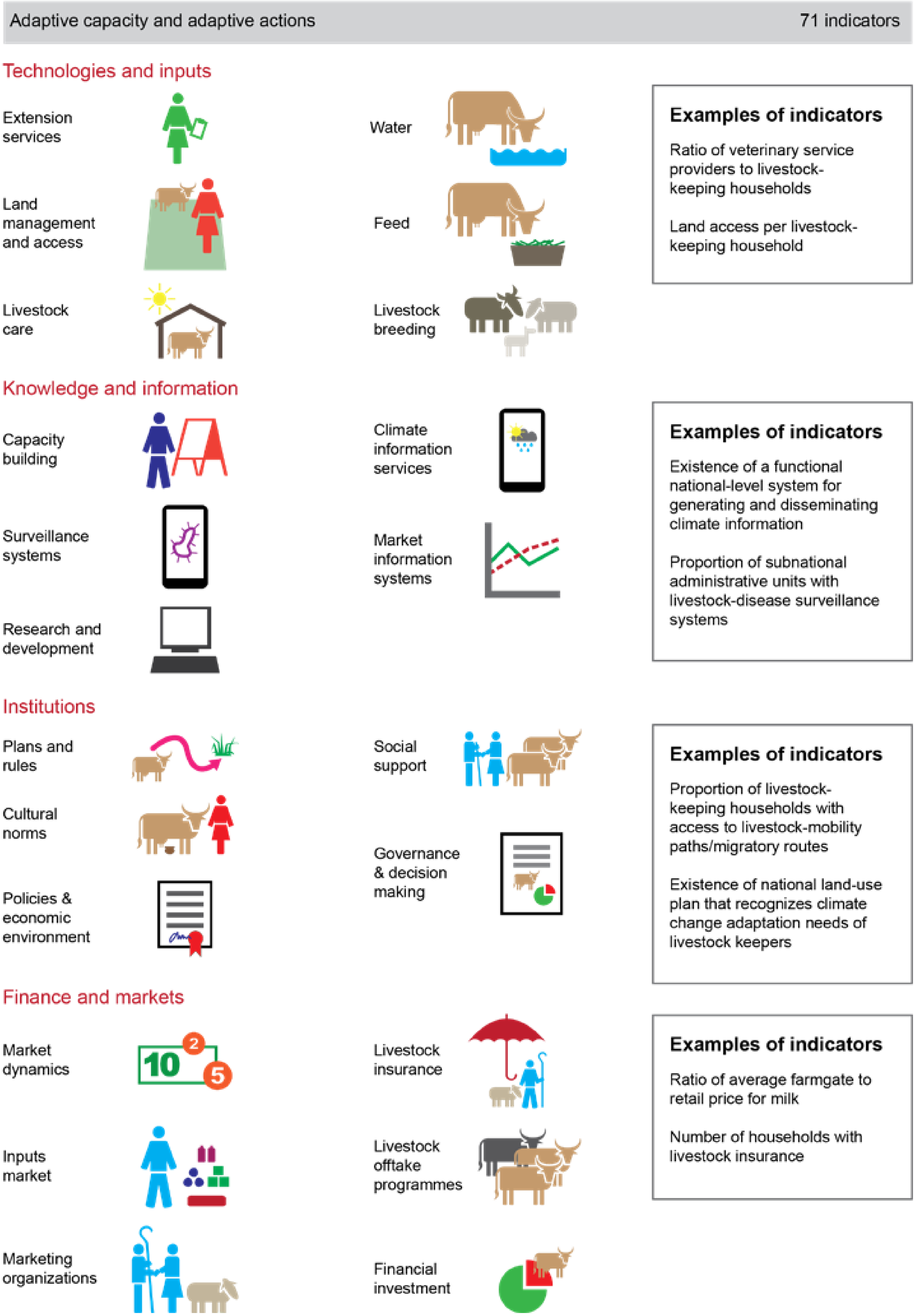


Examples of indicators of climate change impacts

Similarly, livestock keepers and other actors may adapt in different ways to climate change. Livestock keepers may change their management methods, start keeping goats and camels (which tolerate drought better than cattle), move their herds elsewhere, keep fewer (or more) animals, seek additional sources of income, or drop out of livestock keeping altogether. Unlike with greenhouse gas emissions, there are no universally agreed indicators or methodologies to track the effectiveness of adaptation efforts, particularly for international reporting.

Plus, the livestock system is not just the animals and the people who keep them. It also encompasses a range of other stakeholders, from governments to consumers. All these influence how systems adapt to climate change. This makes tracking adaptation an extremely complex process.

To track adaptation, it is necessary to develop a manageable number of measurable indicators that reflect the key dimensions of adaptation across the wide range of management types. These indicators should be usable across different countries with their different physical environments, institutional frameworks and policy contexts. They should cover various scales – from the individual farm up to the national level. They must also be specific: they must measure adaptation to climate change (and not something else). They must be sensitive to change, and measuring them must be feasible.



Examples of indicators of adaptive capacity and adaptive actions

Photo: CIAT/GeorginaSmith

Livestock keepers can adapt to climate change and improve their productivity at the same time – for example by growing forage crops to feed to their animals

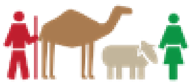
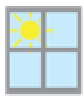
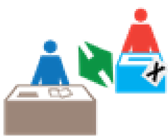
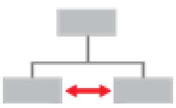
Three dimensions of adaptation

In consultation with scientists, livestock keepers and government officials, the ILRI team has developed a climate change adaptation protocol that includes over 90 indicators of climate change adaptation for livestock in Eastern Africa (see figure on the previous page). These indicators are combined into an index that can reflect the progress of adaptation over time. The indicators fall into three dimensions: hazards, impacts, and adaptive capacity and actions.

Climatic hazards The four indicators under this dimension reflect the climatic events that are relevant for livestock systems.

Climate change impacts This dimension reflects the effects of climate change on livestock systems, so can be used to evaluate the adequacy of adaptation measures. It includes both biophysical and socioeconomic impacts. This dimension includes 15 indicators.

Adaptive capacity and adaptive actions These indicators show the ability of livestock systems to adapt to climate change, and the efforts taken to do so. This dimension covers four domains: technologies and inputs, knowledge and information, institutions, and finance and markets. This is a wide spectrum, so a total of 71 indicators are needed to cover it.

Framework for understanding institutional structures		6 dimensions
Stakeholder participation		Engagement between the government and relevant stakeholders in data production and use
Transparency		Accessibility of government-held data by non-state actors
Bureaucratic accountability		Mechanisms for holding bureaucrats accountable in their activities of producing and using data
Engagement with experts		Modalities of engagement with individuals or organizations that government relies on for specialized advice on data production and use
Politico-administrative relations		Interactions between the political and administrative realms of the government and their implications for data production and use
Coordination within the administration		Interactions between interdependent administrative units and how they consider each other's decisions and actions in knowledge production and use

Framework for understanding institutional structures for producing and using data to track adaptation

ILRI has integrated these indicators and the index into a tool that governments can use to monitor adaptation progress. The tool requires annual data from subnational administrative levels. The data are first validated, then are fed into algorithms that normalize and calculate weighted scores for each indicator. The scores are then aggregated in a series of steps to give measures for each category and dimension, plus an overall adaptation progress score.

The tool allows government officials to visualize and analyse adaptation at the national and subnational levels, compare progress across years, and zoom in to understand the performance along different dimensions, categories, and indicators.

Understanding institutional structures

The success of a system to measure emissions and track adaptation will depend on the capacity and willingness of national governments to collect the appropriate data. This in turn depends on how each government is organized, which varies widely from country to country and even within a country, especially in one that is decentralized. Trying to impose a standard set of variables for adaptation tracking across very diverse countries is likely to fail. That makes it important to anticipate the contexts within which adaptation tracking will be implemented.

ILRI has developed a framework to examine institutional structures that are relevant for adaptation tracking (see the figure on the previous page). The six dimensions capture the interactions within the government and between the government and the broader society. They provide a starting point for reflection on the implication of existing structures on the collection and use of data. Because of the differences between countries, the methods to measure adaptation must be tailored to each one.

Both the monitoring of greenhouse gas emissions and the tracking of adaptation to climate change require suitable data that are collected regularly, synthesized and reported. The procedures to do this must be institutionalized within the government. Doing so will enable countries to monitor the success of their efforts to mitigate and adapt to climate change, and to report on their progress to the international community.

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Front: Grazing on an island in the River Niger, Niamey. Photo ILRI/Stevie Mann
Back: Searching for water in an almost-dry riverbed. Photo: ILRI/Sonja Leitner

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