

**Leveraging Uganda's Karamoja SDMX Revolutionary Model: Real-Time
Climate and Agriculture Data for Drought Resilience and Inclusive
Governance.**

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1. Abstract:

While the Statistical Data and Metadata eXchange (SDMX) system has modernized how countries share data worldwide, its use in farming and climate resilience remains limited. In Uganda's drought-prone Karamoja sub-region—where 62.9% of households face food insecurity and one-third of children are underweight (Uganda Bureau of Statistics, National Population and Housing Census - NPHC 2024 Report)—delayed and fragmented information systems weaken food security responses. Despite the Parish Development Model (PDM) and its Information System (PDMIS), most data collection is still manual, verification is slow, and institutions struggle to share information. This slows down action in a region where frequent droughts and malnutrition require urgent, coordinated solutions. The lessons from Karamoja, however, extend beyond Uganda and hold relevance for climate-vulnerable regions across Africa and beyond.

This model introduces the first community-level use of SDMX in sub-Saharan Africa for combining agricultural and climate data. It creates a connected information system that delivers real-time insights for drought preparedness and food security. It directly links farmers to decision-makers through continuous, cross-sector information exchange.

The approach follows a bottom-up flow of data, ensuring accuracy, inclusivity, and ownership. Farmers, agents, and extension workers record details on crops, soil conditions, weather, and livestock. To ensure participation from communities, information is gathered through both modern tools like tablets and simple channels such as Short Message Service (SMS) and Unstructured Supplementary Service Data (USSD) on basic phones. This design guarantees digital equity, enabling marginalized populations to contribute and benefit regardless of technological access.

At the parish level, data is validated and integrated into the PDMIS. District offices then turn it into local drought and hunger alerts, giving communities earlier warnings to act. At the national level, a central SDMX-powered Data Hub connects information from key agencies—including the Ministry of Agriculture, the Meteorological Authority, and the Ministry of Water and Environment. Policymakers can track drought patterns in real time, test policy options, and design rapid, targeted responses. The system also supports scenario modeling, for example, simulating irrigation expansion or food distribution—before implementation.

A distinctive feature of this model is the feedback loop to communities. Through gatherings such as Community Barazas, farmers receive simple, actionable updates from their own data, such as weather forecasts, market prices, and food security alerts. By translating complex information into practical insights, the system empowers households to make better decisions, strengthening adaptive capacity and reducing vulnerability.

Compared to common practices in Uganda and much of Africa—where information often arrives late and remains siloed—this model delivers three major innovations:

1. Real-time sharing of information across sectors.
2. Inclusive, bottom-up reporting that values community input.
3. Two-way information flows that keep both government and farmers informed.

These innovations move Uganda from reacting to crises after they strike to preparing before they escalate. Ministries will be able to activate early-warning systems, pre-position food

supplies, expand irrigation, among others. This directly advances Sustainable Development Goal (SDG) 2 (Zero Hunger) and SDG 13 (Climate Action).

If implemented, the system will reduce the average time from field data collection to national availability by 95%—from 30 days to just 7. This acceleration will allow district offices to generate localized early warnings a week earlier, providing communities with a critical window to take preventive measures. Beyond speed, the system lowers long-term costs by reducing reliance on expensive one-off surveys and duplicated reporting. Every dollar invested in automated, real-time data flows has the potential to save multiple dollars in avoided emergency responses, making the case compelling for implementation.

Expected results include:

- Faster action during droughts leading to more effective interventions.
- Better targeting of aid and resilience programs, reducing waste and ensuring fairness.
- Stronger cooperation across ministries, improving policy impact.
- Greater cost-efficiency through smarter data management and resource allocation.

The project will be guided by a steering committee of ministries, district leaders, communities, and development partners. Training programs will build digital skills, data stewardship, and SDMX use, while also addressing ethics, privacy, and governance to ensure responsible and trusted data management.

The system's flexible design allows easy adaptation and scaling, making it a model for other drought-prone regions in East Africa and beyond.

Ultimately, this initiative is more than a technical upgrade—it is a new way of governing resilience. By connecting farmers directly with decision-makers, it creates an information flow that is fast, inclusive, and reliable. The model contributes new knowledge to the global agricultural statistics community, showing how SDMX can support climate adaptation and food security. By leveraging real-time shared data, Uganda positions itself as a leader in localizing global resilience standards. This model shows how digital transformation anchored in community participation and policy integration can reshape how nations prepare for climate risks.

Keywords: SDMX, Shared Data Systems, Drought Resilience, Food Security, Bottom-up Planning, Parish Development Model, Agricultural Statistics, Uganda, Climate Adaptation.

2. Introduction:

Agriculture remains the backbone of food security worldwide, yet climate change has exposed the fragility of traditional information systems.

Globally, scholars emphasize that fragmented data flows delay interventions and increase costs in resilience programs. For instance, El Chami and El Moujabber (2024) argue that climate change has intensified droughts, floods, and erratic rainfall, making sustainable agriculture dependent on timely and interoperable data systems. International organizations such as the FAO and World Bank have repeatedly called for harmonized agricultural statistics to support sustainable development, noting that delays in survey-based reporting hinder rapid responses to crises. RTI International (2024). The Statistical Data and Metadata eXchange (SDMX) framework has modernized how countries share data worldwide, but its application in

agriculture and climate resilience remains limited. This gap underscores the urgent need for models that can bridge local realities with global policy frameworks.

At the continental level in Africa, digital technologies are increasingly recognized as catalysts for climate-smart agriculture. Mollel et al. (2025) emphasize that next-generation farmers across Africa are adopting digital platforms to accelerate resilience practices, with interoperability and inclusivity identified as critical success factors. The *Sustainable Agriculture and Climate Resilience Report (2022)* also underscore the importance of integrated data systems in addressing climate shocks. Furthermore, the African Union's *Digital Transformation Strategy (2020–2030)* highlights the role of digital innovation in achieving Agenda 2063 goals, particularly food security and climate adaptation. Despite these commitments, however, most African countries continue to rely on siloed surveys and manual reporting, which delay interventions during climate emergencies. The Karamoja SDMX model therefore aligns with continental priorities by offering a scalable, interoperable solution that can be replicated across drought-prone regions in Sub-Saharan Africa and beyond

At the national level in Uganda, agriculture is highly vulnerable to climate variability, with rain-fed farming dominating production. Studies project that climate impacts could cost Uganda up to USD 332 billion over the next 40 years if resilience measures are not strengthened (UCSATP, 2025). In response, the government has initiated projects such as the *Uganda Climate Smart Agricultural Transformation Project (UCSATP)*, supported by the World Bank, to promote climate-smart practices and enhance productivity (National Agricultural Research Organization [NARO], 2025). Yet, despite these efforts, manual data collection and fragmented reporting remain major bottlenecks. Karamoja, Uganda's most drought-prone region, continues to face persistent challenges of food insecurity, malnutrition, and weak information systems (Office of the Prime Minister, 2025). Although the Parish Development Model (PDM) and its Management Information System (PDMIS) were designed to improve local data flows, verification processes remain slow, and interoperability across institutions is limited (Auditor General, 2025). These bottlenecks prevent institutions from sharing critical information in a timely manner.

The Karamoja SDMX Revolutionary Model directly addresses these challenges by automating data collection, ensuring interoperability, and reducing data lag. By enabling real-time policy testing and two-way communication between communities and policymakers, the model demonstrates how localized innovations can contribute to national resilience strategies, continental digital transformation goals, and global commitments to sustainable agriculture. This paper explores how SDMX can revolutionize agricultural statistics and climate adaptation by creating a connected, real-time information system that bridges local realities with national and international policy frameworks.

3. Problem Statement:

In Uganda's drought-prone Karamoja sub-region, where 62.9% of households face food insecurity and one-third of children are underweight (*Uganda Bureau of Statistics, NPHC 2024 Report*) delayed and fragmented information systems weaken food security responses. Despite the Parish Development Model (PDM) and its Management Information System (PDMIS), most data collection is still manual, verification is slow, and institutions struggle to share information. This slows down action in a region where frequent droughts and malnutrition require urgent and coordinated solutions. SDMX Revolutionary model is the answer to all these challenges. If implemented, the system will reduce the average time from field data collection

to national availability by 95% from 30 days to just 7 days. This acceleration will allow district offices to generate localized early warnings a week earlier, providing communities with a critical window to take preventive measures. Beyond speed, the system lowers long-term costs by reducing reliance on expensive one-off surveys and duplicated reporting.

4. Objectives:

The main objective is to leverage SDMX model to generate and integrate real-time climate and agricultural data for strengthening drought resilience, enhancing evidence-based decision-making, and promoting inclusive, sustainable livelihoods in drought-prone communities

The Specific objectives include.

- To demonstrate how SDMX can accelerate data flows for agriculture and climate resilience.
- To highlight innovations in inclusivity, bottom-up reporting, and feedback loops.
- To assess the potential of scaling the model across Africa.

5. Methodology:

The farmers will adopt SDMX Revolutionary Model to address manual data collection and siloed reporting which hinders timely interventions and slows down verification processes. The Model will integrate agricultural and climate data to deliver real-time insights for drought preparedness and food security and to bridge the gap between local agricultural data and national policy makers. It will directly link farmers to decision-makers through continuous, cross-sector information exchange. This model will focus mainly on Automated Data Collection, Validation, System integration, Data Dissemination, Community engagement, and Capacity building across to different agricultural stakeholders.

Data Collection:

- Farmers, agents, and extension workers record details on crops, soil conditions, weather, and livestock.
- Tools include tablets, SMS, and USSD on basic phones, ensuring digital equality.
- IoT sensors for rainfall and soil moisture are piloted in selected parishes.

Validation:

- Parish chiefs validate data from associations and cooperatives.
- District production offices integrate data across parishes, generating alerts and disseminating information through community Barazas.

Integration

- At the national level, a central SDMX-powered Data Hub connects information from UBOS, the Ministry of Agriculture, the Meteorological Authority, and the Ministry of Water and Environment.
- Policymakers can track drought patterns in real time, test policy options, and design rapid, targeted responses.

Community Engagements:

- **Community Barazas:** Regular gatherings allow farmers to receive feedback in simple, actionable formats weather forecasts, market prices, and food security alerts. These meetings transform raw data into practical insights for everyday decision-making.
- **Two-way communication:** Information doesn't just flow upward to UBOS and ministries; it flows back down to households. This feedback loop empowers communities to act early on drought warnings or market shifts
- **Inclusive participation:** Farmers, pastoralists, and cooperatives contribute data directly through mobile tools (SMS, USSD, tablets). This ensures that even those with limited digital access can participate.
- **Validation at local levels:** Parish chiefs and community associations review and validate data before it moves upward. This builds trust and ownership, reducing skepticism about "external" statistics.

Information Dissemination:

Information dissemination is one of the most transformative features of the SDMX Revolutionary Model. Unlike traditional systems where data flows upward and remains locked within government institutions, this model ensures that processed information is returned to communities in real time. Dissemination is not just about sharing statistics it is about translating complex data into actionable insights that farmers, households, and local leaders can use to strengthen resilience. Information dissemination will be done in the following category

- **Community Barazas:** Local gatherings serve as platforms where district production offices present drought alerts, weather forecasts, and market price updates. These meetings make technical data accessible in simple language, ensuring that households can act on the information.
- **SMS and USSD codes:** allow farmers with basic phones to receive alerts on rainfall patterns, crop diseases, and food security risks.
- **District-Level Alerts:** District production offices generate localized drought and hunger alerts based on validated parish data. These alerts are disseminated through posters, radio, and direct farmer trainings (Barazas)
- **National Data Hub Feedback:** UBOS and ministries use the SDMX hub to design policies and then push back simplified summaries to districts and parishes. This ensures that communities understand how their data influences national decisions.

The approach follows a bottom-up flow of data, ensuring accuracy, inclusivity, and ownership. Farmers, agents, and extension workers record details on crops, soil conditions, weather, and livestock. To ensure participation from communities, information is gathered through both modern tools like tablets and simple channels such as SMS and USSD on basic phones. This design guarantees digital equality and equity, enabling marginalized populations to contribute and benefit regardless of technological access.

At the parish level, data is validated and integrated into the PDMIS. District offices then turn it into local drought and hunger alerts, giving communities earlier warnings to act. Data is shared from parish to the national level. At the national level, a central SDMX-powered Data Hub connects information from key agencies, including the Ministry of Agriculture, the Meteorological Authority, and the Ministry of Water and Environment. Policymakers can track

drought patterns in real time, test policy options, and design rapid, targeted responses. The system also supports scenario modelling for example, simulating irrigation expansion or food distribution before implementation.

This model has a distinctive feedback mechanism for community reporting. Through community gatherings (Community Barazas), farmers receive simple, actionable updates from their own data, such as weather forecasts, current market prices, and food security alerts. By translating complex information into practical insights, the system empowers households to make better decisions, strengthening adaptive capacity and reducing vulnerability. The model is demonstrated as shown in figure 1 below.

Figure 1: Showing Data flow structure of SDMX Revolutionary Model

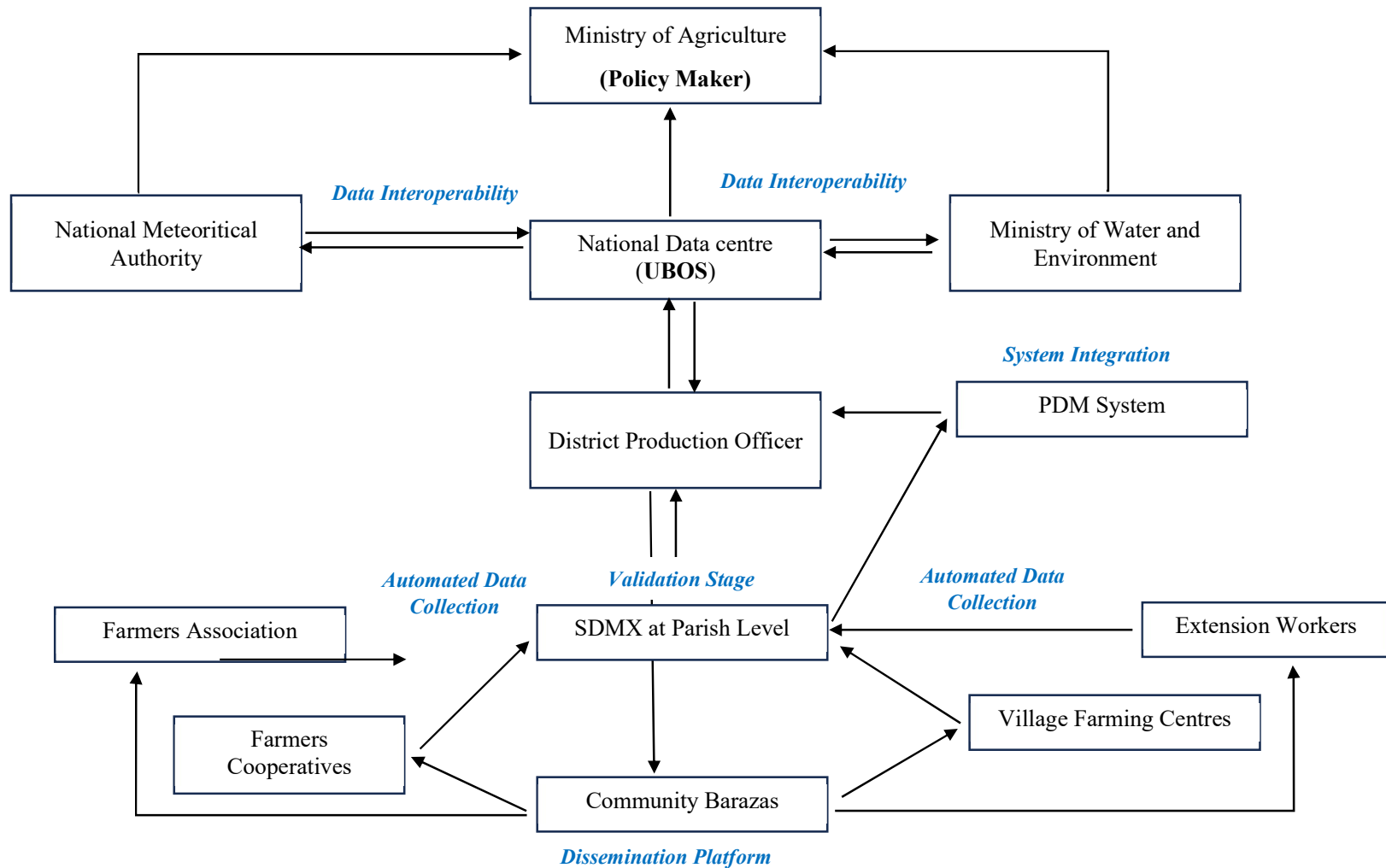
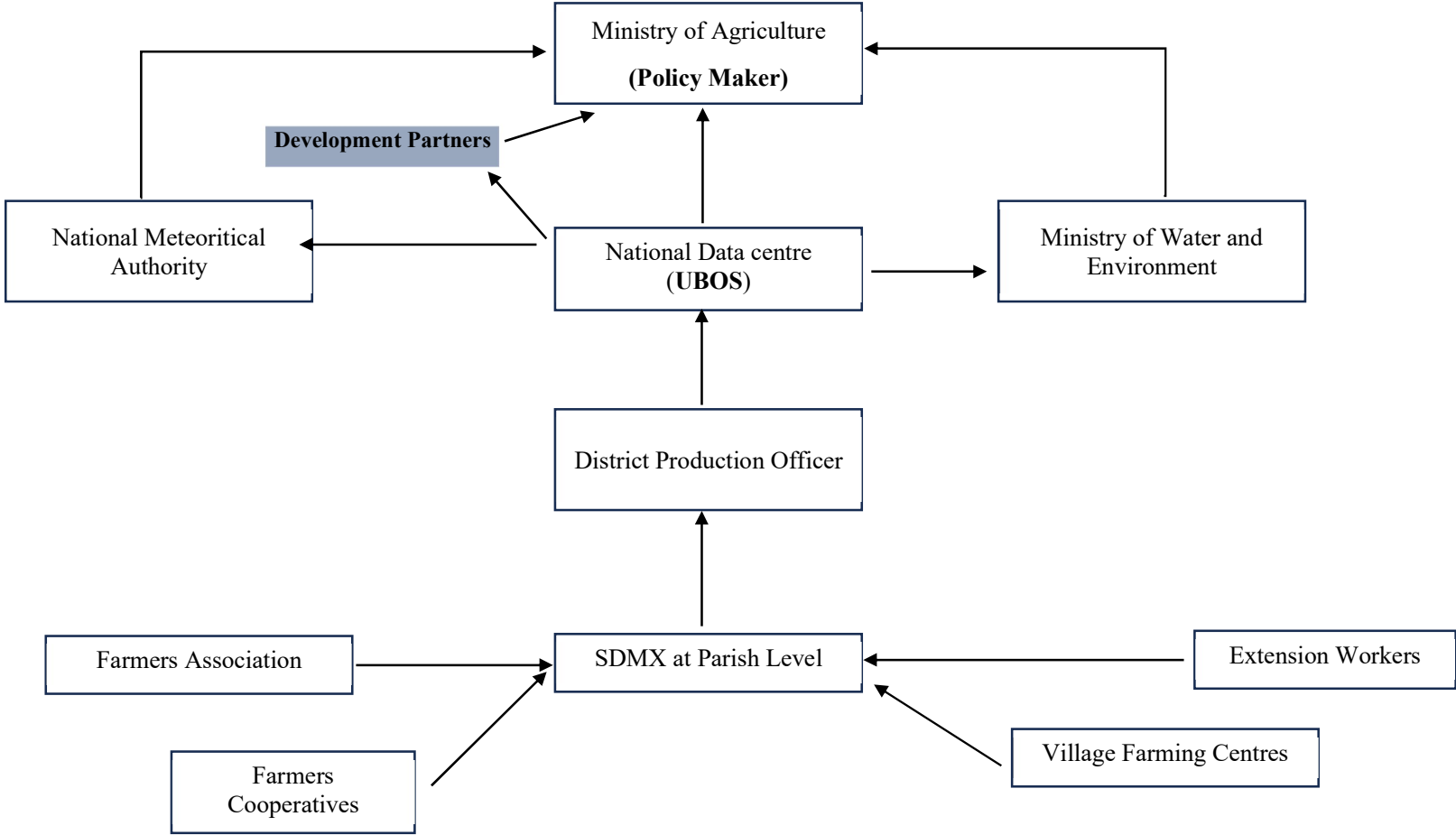


Figure 2: Showing the implementation Structure and stakeholders of SDMX Revolutionary Model



5.1. Institution roles:

- **Farmers Associations & Cooperatives:** Primary data providers from different villages
- **Extension Workers & Village Centers:** Facilitate data collection.
- **Parish Chieftains:** Data collected is validated at this level from associations and cooperatives.
- **District Production Offices:** It integrates data from all the parishes across the district. Generate alerts from data collected and disseminates to farmers through community Barazas. They also provide agricultural trainings to farmers associations and cooperatives.
- **National Data Centre (Uganda Bureau of Statistics):** Central hub for SDMX integration across the county from different districts
- **Ministries Departments and Agencies (MDA) (Agriculture, Meteorology, Water & Environment):** They use validated data from data central hub for Policy design and scenario modelling.

5.2. Model governance:

- **Steering Committee:** Ministries, district leaders, communities, and development partners.
- **Training Programs:** Build digital skills, data stewardship, and ethical governance.

5.3. Results:

5.3.1. Innovations:

- **Real-time sharing:** Cross-sector data exchange reduces delays.
- **Inclusive reporting:** Bottom-up flow ensures community ownership.
- **Two-way communication:** Farmers and government remain equally informed

5.3.2. Expected Impact:

The transition to an SDMX-based model provides several transformative benefits:

- **Cost - efficiency:** Reducing waste and ensuring fairness through better targeting aid and resilience programs.
- **Policy Synergy:** Strengthening cooperation across various ministries to improve the overall impact of climate policy. Supports SDG 2 (Zero Hunger) and SDG 13 (Climate Action) policies.
- **Scalability:** The system is designed to be flexible, serving as a potential model for other drought-prone regions across East African countries and countries under sub-Saharan Africa.
- **Speed:** Data availability reduced from 30 days to 7 days.
- **Resilience:** Earlier warnings enable preventive measures.

Figure 3: Showing the expected impact of SDMX Revolutionary Model

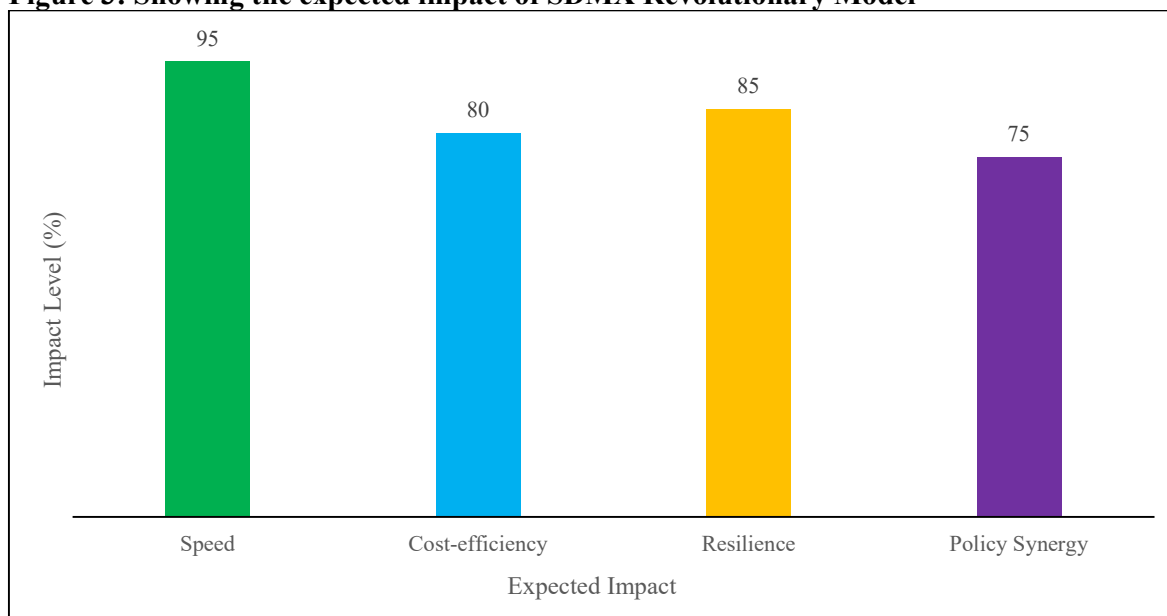


Table 1: Expected improvement of SDMX Revolutionary Model

Aspect	Current system	Proposed SDMX Model
Data Availability Time	30 days	7 days
Survey Costs	High Costs	Reduced Costs
Reporting Structure	Siloed	Integrated
Approach/Planning	Up to Bottom Planning	Bottom to up Planning
Communication	One way Communication	Two-way Communication
Inclusivity	Selective	All inclusive

6. Discussion:

The Karamoja SDMX Revolutionary Model demonstrates how digital transformation anchored in community participation can reshape resilience governance. By linking farmers directly to decision-makers, the system ensures inclusivity and rapid response. Compared to traditional siloed systems, this model offers:

- Faster interventions during droughts.
- Better targeting of aid and resilience programs.
- Stronger cooperation across ministries.
- Greater cost-efficiency in data management.

7. Conclusion:

Uganda's Karamoja SDMX Revolutionary Model represents a new paradigm in resilience governance. By accelerating data flows from communities to national decision-makers, the model ensures inclusivity, rapid response, and cross-sector cooperation. It reduces delays from 30 days to just 7, lowers costs through integrated reporting, and empowers farmers with actionable feedback. Its flexible design makes it scalable to other drought-prone regions, advancing SDG 2 (Zero Hunger) and SDG 13 (Climate Action). More than a technical upgrade, this initiative demonstrates how digital transformation anchored in community participation can reshape national preparedness for climate risks and position Uganda as a leader in localized

global resilience standards. Uganda's Karamoja SDMX model will turn community voices into real-time data, proves resilience and can be governed before crises strike. It will also demonstrate how interoperable, bottom-up data flows can redefine agricultural statistics for climate resilience in the drought prone region.

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