FMAFS
FEDERAL MINISTRY OF AGRICULTURE AND FOOD SECURITY, FEDERAL REPUBLIC OF NIGERIA

IFAD
Investing in rural people

Best Practices Guide

For Nigeria's National Digital Farmer Registry (NDFR)

December 2025

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List of acronyms and abbreviations

Acronym	Definition
ADP	Agricultural Development Programme
API	Application Programming Interface
CBN	Central Bank of Nigeria
DEPA	Data Empowerment and Protection Architecture
DPI	Digital Public Infrastructure
EU	European Union
EUDR	EU Deforestation Regulation
FMAFS	Federal Ministry of Agriculture and Food Security
GESS	Growth Enhancement Support Scheme
IDP	Internally Displaced Person
IFAD	International Fund for Agricultural Development
IoT	Internet of Things
ISO	International Organization for Standardization
IVR	Interactive Voice Response
JSON	JavaScript Object Notation
KYC	Know Your Customer
MNO	Mobile Network Operator
MVP	Minimum Viable Product
NASRDA	National Space Research and Development Agency
NDPA	Nigeria Data Protection Act
NGO	Non-Governmental Organisation
NIMC	National Identity Management Commission
NIN	National Identity Number
NITDA	National Information Technology Development Agency
ORGANS	Open, Revocable, Granular, Auditable, Notice-based, Secure
PII	Personally Identifiable Information
QR	Quick Response Code
UFSI	Unified Farmer Services Interface
NDFR	National Digital Farmer Registry
USSD	Unstructured Supplementary Service Data

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The era of fragmented farmer databases and uncoordinated agricultural data must give way to a new era of harmonization and digital efficiency. A unified registry gives government clear visibility into Nigeria’s farming population and strengthens transparency, reduces duplication, prevents fraud, and supports accurate planning. By anchoring the National Digital Farmers Registry on the National Identification Number, we are ensuring that every farmer is uniquely identified and accurately documented. The sustainability and credibility of the Digital Registry rest on strong data governance. Simply put, data governance is the backbone of any credible national digital registry.

The Federal Ministry of Agriculture and Food Security has taken decisive steps to reform how farmer data is managed. Working with the National Identity Management Commission (NIMC), we are anchoring the National Digital Farmers Registry on the National Identification Number to ensure that every farmer is uniquely identified and accurately documented. We are also working closely with the Office of the National Security Adviser to embed strong data protection standards, cybersecurity safeguards, and national security protocols into the system. Protecting the data of Nigerian farmers is a responsibility and a priority.

…By drawing on global best practices and grounding them in the realities of our own communities, we are building a National Digital Farmers Registry that is globally aligned yet uniquely suited to Nigeria’s needs. This moment offers us the chance to lay a digital foundation that can transform Nigerian agriculture for decades to come. Let us move forward with unity, clarity of purpose, and a shared commitment to ensuring that every farmer in our country is visible, supported, and empowered.

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Sen. Abubakar Kyari, CON
Honourable Minister, Federal Ministry of Agriculture and Food Security,
Federal Republic of Nigeria

Executive Summary

The strategic imperative

Nigeria stands at a pivotal moment in its agricultural transformation. For decades, the sector has relied on static, fragmented databases designed for single-use interventions—most notably the Growth Enhancement Support Scheme (GESS). While GESS successfully registered millions, the data became obsolete the moment the subsidy programme ended, resulting in "Data decay" and limiting the long-term return on public investment in data collection.

The National Digital Farmer Registry (NDFR) represents a fundamental shift from building a "Database" to orchestrating Digital Public Infrastructure (DPI). It is not merely a list of names; it is the digital backbone that connects a producer's identity to the broader economy. By establishing a "single source of truth" for identity, land, and production, the NDFR transforms the Nigerian producer from an anonymous beneficiary of aid into a verifiable economic agent capable of accessing credit, insurance, precise advice, and global markets.

Against this backdrop, the Policy Dialogue Initiative (PDI) on NDFR to achieve 3 specific outcomes: (a) a strengthened capacity of key stakeholders in priority Governmental actors in developing and coordinating effective, efficient and sustainable Unified National Digital Farmers Registry; (b) a strategic recommendation for the development of a Unified National Digital Farmers Registry; (c) multistakeholder platform, including government, private sector, civil society, farmer organizations and development partners launched in support of National Digital Farmer Registry Development. The PDI on NDFR resulted in:

i. Stakeholder mobilization on common understanding, interest and commitment to support the process of developing a unified National Digital Farmers Registry (NDFR).
ii. Rapid assessment and insights from existing farmer databases.
iii. Diversity of stakeholders engaged on Policy Dialogue for NDFR.
iv. Strengthened technical capacity of over 100 government, private sector, and development stakeholders.
v. Strategic recommendations aligned with the best practices and national priorities validated and adopted to enrich NDFR process in Nigeria.
vi. Launch and operationalization of National Digital Farmers Registry (NDFR) Collaborative Knowledge Sharing Platform for enhanced continuous policy dialogue, learning and collaboration with more than 400 actors enrolled on the Platform.
vii. Strengthened commitment of participating institutions towards a coordinated and integrated approach for the design and implementation of the NDFR in Nigeria.

In line with these achievements, the Best Practices Guide serves as the operational manual to translate that vision into reality. Rooted in the consensus of the National Stakeholders Workshop and validated by global evidence, it provides a definitive technical and strategic blueprint for implementation.

The economic case: Food security and national output

Global evidence confirms that a dynamic registry is an investment in national food security and economic growth, not just an administrative cost. Turkey's transition to a

data-driven agricultural model delivered a 10-15% increase in agricultural productivity by ensuring subsidies reached genuine producers and optimising extension services. For Nigeria, the primary driver is domestic transformation: leveraging data to boost food production, enhance national food security, and ensure that scarce resources (fertiliser, seeds, water) are allocated with precision to the producers who feed the nation.

The 5-pillar framework

To achieve this vision, through the National Stakeholders workshop held on 19 and 20 November, 2025 which brought together over 100 representatives from government, development partners, private sector actors, civil society, and farmer organizations. These participants identified and validated five strategic pillars to guide the design and implementation of the NDFR:

> Pillar 1 – Digital Public Infrastructure: The registry must be anchored in the National Identity Number (NIN) to address the "Ghost farmer" problem. It moves beyond simple ID to create a "Trust infrastructure" using Verifiable Credentials.
> Pillar 2 – Secure & interoperable architecture: Adopting a "Data triad" model that decouples identity (static) from production (dynamic). This architecture ensures the system is secure, scalable, and resilient to connectivity challenges through an "Offline-first" design.
> Pillar 3 – Inclusive partnerships: Moving from government-led enrolment to a dynamic ecosystem approach. This leverages cooperatives, agro-dealers, and agri-fintechs as "Trusted nodes" for data capture, reducing the fiscal burden on the state.
> Pillar 4 – Digital use cases: Delivering immediate value through four key themes: sustainable productivity, inclusive markets and value chains, inclusive finance, and integrated analytics.
> Pillar 5 – Data governance: Establishing a "Blind intermediary" architecture that protects producer privacy and operationalises the Nigeria Data Protection Act (NDPA) 2023. This secures the registry's role as a tool for service delivery rather than data exploitation.

In line with these Pillars, strategic recommendations were adopted by the participants on 20 November 2025. These Strategic and Policy Recommendations on NDFR have been forwarded to the Federal Government of Nigeria through the Federal Ministry of Agriculture and Food Security (FMAFS) to enrich the implementation process.

Implementation and sustainability

Success requires a departure from the "Big Bang" rollout. The strategic framework mandates a Phased Implementation Strategy, starting with a Minimum Viable Product (MVP) focused on a single high-value loop, for example, digital Identity + E-Vouchers.

To ensure longevity, the FMAFS needs to secure a dedicated budget line for "*Digital infrastructure maintenance*" (hosting, security patches, call centre operations), distinct from capital expenditure. Long-term sustainability is further secured by value creation: by opening the Unified Farmer Services Interface (UFSI) to the private sector, the NDFR will generate cost-recovery revenue from commercial users, including banks, aggregators, insurers, and input suppliers who pay to query the database. This transition to a "*Public Data Utility*" model ensures the infrastructure remains maintained and operational for generations to come.

Structure of this guide

Chapter 1 introduces the strategic context and vision of the NDFR, while Chapters 2 through 6 operationalise the 5-Pillar Framework, supported by global best practices. Chapter 7 defines the Strategic Implementation Framework and governance roadmap, while Annex 2 catalogues global best-practice evidence from national case studies.

1.0 STRATEGIC CONTEXT & VISION

1.1 Strategic context and purpose of this guide

Nigeria stands at a pivotal moment in its agricultural transformation, which is currently framed by a broader continental shift toward more resilient and inclusive food systems (AGRA, 2023). For decades, the sector has relied on static, fragmented databases designed for single-use interventions—most notably the Growth Enhancement Support Scheme (GESS). While GESS successfully registered millions, the data became obsolete the moment the subsidy programme ended, resulting in "Data decay" and limiting the long-term return on public investment in data collection.

This Best Practices Guide serves as an operational blueprint to translate the National Digital Farmer Registry (NDFR) vision into reality. Rooted in the consensus of the National Stakeholders Workshop and validated by global evidence, it provides a definitive technical and strategic blueprint for implementation. By defining standards and expectations for interoperability, data privacy, and sustainable financing, this document equips the Federal Ministry of Agriculture and Food Security (FMAFS) and its partners with the tools to avoid the "Project trap" and establish the registry as a permanent, resilient public utility.

1.2. Defining the NDFR: User-centric digital infrastructure

The transition to the NDFR is driven by the urgent need to stop building temporary "Databases" and start orchestrating Digital Public Infrastructure (DPI). This approach aligns with global standards for modernizing agricultural data systems to ensure they serve as foundational tools for better policy and strategy development (FAO, 2020). The NDFR is not merely an administrative roll call of producers; it is the digital backbone required to transform the Nigerian producer from an anonymous beneficiary into a verifiable economic agent

Lesson from GESS (2012-2015): *The GESS registry was designed as a subsidy tool, not a national asset. It lacked interoperability with other ministries and failed to deliver lasting value to farmers beyond the subsidy season. This "Silo Trap" resulted in a static database that could not support long-term profiling for access to credit, insurance, markets, etc. (Uduji et al., 2019).*

To avoid past failures, the NDFR will be architected as a "User-centric" Data Exchange. It functions as the digital "Roads and bridges" that allow trusted data to flow securely between independent systems—connecting a producer's identity in a remote village to a bank in Lagos, an off-taker in Kano, or a satellite monitoring system.

The core definition: As mandated by National Stakeholders[1], the NDFR is a federated digital platform that provides a **"single source of truth"** for three essential data domains:

a. **Who the farmer is:** Identity verified by the **National Identity Number (NIN)**.
b. **Where they farm:** Geospatial validated plots (Polygons).
c. **What they produce:** Dynamic crop, livestock, or aquaculture activity

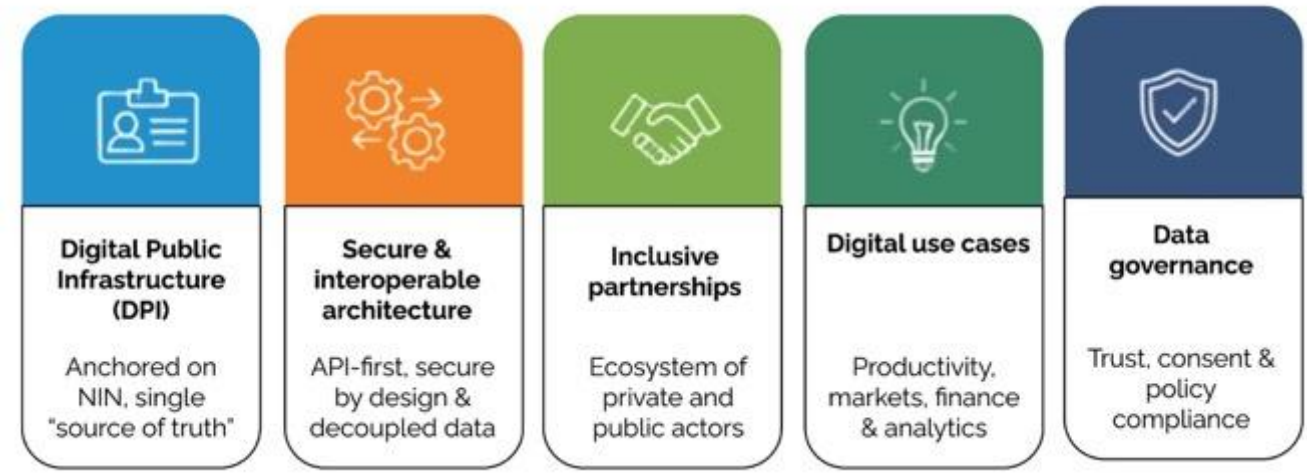
1.3. The strategic drivers: Food security and efficiency

The imperative for the NDFR stems from an intrinsic demand to streamline Nigeria's fragmented agricultural ecosystem. To align with the *Renewed Hope Agenda of the Federal Government of Nigeria*, the registry addresses three gaps identified by national stakeholders:

a. **Food security & subsidy integrity:** Transitioning from the challenges of the GESS era to a transparent, targeted system that ensures subsidies reach genuine smallholders, boosting national output
b. **Financial inclusion:** Transforming the Nigerian farmer from an "unbankable" entity into a verifiable economic agent with a digital credit history.
c. **Policy coherence:** Acting as the single source of truth to harmonize interventions between the FMAFS, the Central Bank of Nigeria (CBN), and development partners.

1.4. The 5-pillar framework for Nigeria

To achieve this vision, the implementation of the NDFR is guided by five strategic pillars, validated by national stakeholders at the 2025 National Workshop.



[1] *The technical architecture and frameworks in this guide derive from the November 2025 National Stakeholder Workshop, where FMAFS and ecosystem partners convened to establish the NDFR's foundational specifications and recommendations.*

Figure 1 - Validated strategic pillars

1.5. Principles of success: Lessons from global evidence

Best practice

Case study - The MVP Approach

Country: Kenya (KIAMIS)

Strategy: Prioritized data quality over quantity. Launched a "Minimum Viable Registry" focused on validating identity and land before adding complex services.

Result: Result: Built trust through a working e-voucher system, eventually registering over 6.45 million farmers and enabling private sector innovation *(Government of Kenya, 2024).*

An analysis of 40 national case studies reveals distinct patterns that distinguish successful registries from failed pilots. The NDFR needs to adopt these evidence-based principles to ensure sustainability.

i. **The "start small" principle (the MVP strategy):** Attempts to digitize the entire agricultural economy (credit, insurance, trading, extension) on Day 1 often leads to complex, bloated systems that fail to launch. Successful implementations focus on one high-value loop first, a Minimum Viable Product (MVP).
ii. **Government as orchestrator, not builder:** Innovation stalls when the government attempts to build, own, and run every application. Effective models position the government as a "Data Refinery." An FMAFS approach to cleaning and publishing data (via the "AgroDataCube" API) enables the private sector (e.g., FinTechs/Agritechs, Aggregators, and banks) to build user-facing applications.
iii. **Data freshness over data volume:** A massive one-time registration campaign often results in data that becomes outdated within two seasons. Sustainable registries link data updates to transactions. Every time a farmer receives a subsidy, pays a premium, or sells produce, their data is verified and updated. This creates a "Living Registry" that remains operationally relevant without requiring expensive census drives.

Best practice

The Productivity Dividend

Country: Turkey (National Farmer Registry)

Mechanism: Linked subsidy payments directly to verified land assets in the registry.

Impact: Enabled precise targeting of support (fertilizers, seeds) to productive farmers. A World Bank analysis attributed a **10-15% increase in agricultural productivity** directly to the registry's implementation *(World Bank, 2019).*

iv. **The economic case for investment**: Building the NDFR is not an administrative cost; it is an investment in national GDP.

Chapters 2 through 6 operationalise the 5-Pillar Framework (see Section 1.5), translating the strategic vision into detailed technical and policy specifications. Informed by the strategic recommendations at the national workshop, each chapter integrates global evidence to validate best practices and ensure contextual relevance. Chapter 7 synthesises the Strategic Recommendations from the National Stakeholders Workshop into a Strategic Implementation Framework, providing the governance roadmap required to transition from design to sustainable operation. Annex 2 catalogues the global evidence base of 40+ national case studies for best practices that this guide builds on.

2.0 DIGITAL PUBLIC INFRASTRUCTURE – PILLAR 1

(Focus: Layers 1 & 2 – Identity, Trust, and Transactions)

Digital Public Infrastructure (DPI) is defined globally by the UN and the G20 as a set of shared, interoperable digital systems organized into three foundational layers: Identity, Payments, and Data Exchange *(G20 Digital Economy Ministers Meeting, 2023; UNDP, 2023)*. For Nigeria's agricultural sector, the NDFR expands this definition to recognize that agriculture requires moving more than just money. It anticipates moving rights (land tenure), entitlements (subsidies), and trust (certifications). Therefore, this guide redefines the second layer as "Value Exchange", see Figure 2.

- **Layer 1 (Identity):** The "Anchor" (Who are you?)
- **Layer 2 (Value Exchange):** The "Rails" (What can you do?)
- **Layer 3 (Data Exchange):** The "Bridge" (How do you share?)

This chapter primarily addresses Layer 1 and 2, while Chapter 3 dwells more on Layer 3 (data exchange).

2.1. Layer 1: Identity as the Anchor

The first layer of the NDFR is Identity. A robust farmer registry relies on definitively solving the "*Who is the farmer?*" question to prevent fraud ("ghost farmers") and enable targeted service delivery.

2.1.1. The foundational identity: NIN integration

The NDFR shall mandate National Identity Number (NIN) verification as the primary anchor for every record of individuals. This aligns with the Federal Government's directive and the statutory mandate of the National Identity Management Commission (NIMC), which establishes the NIN as the foundational identifier for all Nigerian citizens and legal residents *(National Identity Management Commission, 2007)*. By anchoring the registry to this legal standard, the NDFR definitively addresses the '*ghost farmer*' problem through mandatory biometric verification at the point of enrolment.

- **API Integration:** The registry will implement an asynchronous API call to NIMC to verify biometrics and retrieve the NIN.
- **Inclusivity protocol (tiered entry)**: Recognizing that not all rural farmers have obtained NINs, the system should support a "Provisional Entry" status (Tier 0). This protocol leverages the Tiered KYC framework established by the Central Bank of Nigeria (2020) to prevent digital exclusion. These farmers can be onboarded for advisory services using local community validation but must

provide a NIN to "*graduate*" to financial transactions. This prevents the lack of formal ID from becoming a permanent barrier to entry.

Figure 2: The Agriculture DPI Stack

2.1.2. Identity resolution: The "single source of truth."

Moving from static lists to dynamic resolution.

A significant flaw in previous schemes (such as the GES) was the proliferation of duplicate records, where one individual registered multiple times. To solve this, Layer 1 should function as a Deduplication & Resolution Engine.

- **The Mechanism:** The registry will utilize an Automated Biometric Identification System (ABIS) logic. When a new farmer is onboarded, the system queries existing records by biometric anchors (via NIMC) to ensure "***1 person = 1 identity***".
- **The "Golden Record":** This process creates a single, clean profile for each farmer. This record is not just a list of names; it is a gateway to economic rights, much as Brazil uses its registry to grant market access.

2.1.3 Inclusive authentication: Multi-modal standards

Addressing the "literacy barrier" and "fingerprint erosion".

Standard banking apps often fail in rural Nigeria because they assume every user has pristine fingerprints and high literacy. To ensure universal access, the NDFR mandates a Multi-Modal Authentication framework—leveraging global standards for voice and inclusive biometrics—that supports three tiers of verification *(FIDO/NIST, 2024)*:

- **Standard biometrics (Primary):** The default authentication method uses ISO-compliant fingerprint or facial recognition (in line with the NIMC standard). This is the preferred mode for most users with viable biometric data.
- **Voice biometrics (Inclusive Fallback):** For farmers with worn fingerprints (common in manual labor) or low literacy, the system should support voice authentication. Farmers authenticate transactions by speaking a passphrase in their local language (Hausa, Yoruba, Igbo, Pidgin, or others), providing "Proof of Life" without requiring a PIN.
- **Assisted mode (Delegated authority):** For older adults and persons with disabilities (PWDs), the architecture should support delegated authentication. A registered proxy (e.g., a next of kin) can be authorized to sign digitally on the farmer's behalf. This ensures that physical disability or age does not result in economic exclusion.

Best practice

Linking identity to markets

Country: Brazil (Declaration of Aptitude - DAP)

Strategy: Brazil did not just "count" farmers; it issued a dynamic "DAP" status to verified family farmers.

Impact: This status automatically qualified them for the Food Acquisition Program (PAA), where the government **buys 30% of food for schools directly from smallholders**. The identity registry became the engine for a massive public procurement market, proving that a registry is an economic tool, not just a statistical one *(World Bank, 2022)*.

2.2. Layer 2: Transaction & Value exchange infrastructure

The second layer of DPI moves beyond "*Who are you?*" to "*What can you do?*" It provides the rails for moving money, goods, entitlements, and credentials.

2.2.1 The settlement rail: Financial value

To support the '*Cash+*' approach (combining social protection with agricultural support), the NDFR will integrate with Nigeria's existing payment switches, including the Nigeria Central Switch managed by NIBSS and various Mobile Money Operators (MMOs). This integration directly supports the national mandate to expand financial services to the most excluded rural populations by leveraging diverse delivery channels.

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- **The Principle of Device Agnosticism:** The payment rail must not rely only on smartphones. It needs to fully support low-tech mechanisms such as USSD (Unstructured Supplementary Service Data) and Agent Banking networks.
- **Inclusion Outcome:** A farmer with a basic "*torchlight*" phone in a 2G network area can still receive and cash out subsidy funds via a local agent, ensuring last-mile financial inclusion.

2.2.2 The trade rail: Decentralised discovery and fulfilment

To prevent the 'walled garden' problem—where farmers are locked into a single e-commerce app—the NDFR will implement the Beckn Protocol as the national standard for decentralised trade *(Beckn Foundation, 2023)*. This ensures that the registry functions as a trust anchor within a distributed network, allowing farmers to interact with multiple buyers and service providers through a common language rather than being restricted to a proprietary platform

- **Function:** While the settlement rail moves money, this trade rail moves goods and services. It handles the lifecycle of discovery (allowing a farmer to broadcast a structured intent, e.g., "I have 5 tonnes of maize. Asking price: ₦300/kg. Location: Zaria") and fulfilment (logistics and delivery).
- **Role of NDFR:** Before a buyer "discovers" a farmer, the network queries the NDFR to verify that the entity broadcasting the produce is a legitimate, identified producer.

2.2.3. The entitlement engine: Digitizing subsidies

Moving beyond simple cash transfers.

While payment rails move money, the Ministry of Agriculture often requires an infrastructure to manage non-monetary subsidies (fertilizer, seeds, agrochemicals). The NDFR requires a logic-based "*Entitlement Engine*". This software module should calculate a farmer's specific eligibility based on their registry data (e.g., Land Size < 2Ha AND Crop = Maize) and issue a cryptographically secure digital token (E-Voucher).

Best practice

Solving the "Ghost Farmer" crisis

The Lesson (Nigeria GES Scheme):

The 2012-2015 Growth Enhancement Support (GES) scheme faced challenges with "ghost farmers" because it lacked a live biometric link. Subsidies often leak to non-farmers *(Uduji et al., 2019).*

The Fix (India PM-KISAN):

By linking its farmer registry to Aadhaar (National ID), India successfully removed **over 11 million ineligible beneficiaries** in a single audit. The NDFR adopts this rigorous logic-based entitlement model to protect public funds *(Ministry of Agriculture & Farmers Welfare, India, 2021).*

- **Offline verification:** Crucially, the verification logic needs to sit on the edge, with the system's 'brain' residing on the local device, enabling transactions to occur instantly in the field even without a network signal *(GovStack, 2024).* Agro dealers should be able to scan a farmer's QR code or validate a USSD token without active internet connectivity, syncing the ledger only when connectivity is restored. This prevents "connectivity exclusion" in remote villages.

Best practice

Case study - Reforming subsidies with logic

Country: Indonesia (Kartu Tani)

Challenge: Leakage of subsidized fertilizer to ineligible large commercial estates.

Solution: Implemented a digital entitlement system where subsidy quotas were dynamically calculated based on the registered land size of each smallholder.

Impact: Reduced diversion of fertilizer by **roughly 40% in the first two years** *(Government of Indonesia, 2024).*

- **Logic-based Allocation:** Unlike flat distribution models, the engine should enable "Smart Subsidies," dynamically capping quantities based on land size to prevent over-supply that fuels the black market.

2.2.4. Verifiable Credentials (VCs): The trust layer

This is a necessary technical upgrade from the "central database" model.To reduce reliance on constant connectivity, the NDFR will issue Verifiable Credentials (VCs) to the farmer (W3C, 2022).

- **What it is:** A digital "Certificate" that the Ministry cryptographically signs. These include permanent attributes (e.g., "Good Agricultural Practice" or "Land Use Right") and transactional tokens (e.g., "e-Vouchers" for inputs).
- **The Benefit**: The farmer holds this record in their own data wallet (or printed QR card). They can present it to a bank, off-taker, or agro-dealer to prove their eligibility or creditworthiness. The partner can verify the claim instantly using the Ministry's public key—no API integration or central server downtime can block the transaction. This turns the farmer into the owner of their own data, rather than just a record in a government file.
- **The Sync & reconciliation**: Once connectivity is restored, the "edge" device synchronizes the transaction batch with the central ledger (see Section 3.1.2). This "Store-and-Forward" mechanism ensures that every e-voucher redemption is reconciled against the master database, preventing double-spending and ensuring the full cryptographic auditability required by the Data Governance protocols in Section 6.5.

2.3. Technical reference matrix: Identity & Trust Standards

Standards and specifications for ensuring integrity and inclusion.

Item	Type	Description & Nigeria Relevance	Authority/Link
ISO/IEC 19794	Standard	*Biometric Interchange:* Mandatory for compatibility with NIMC (NIN) to prevent duplication.	ISO/IEC
W3C DIDs	Standard	*Decentralized Identifiers:* The foundational standard allowing farmers to own a digital ID independent of the registry.	W3C
W3C VCs	Standard	*Verifiable Credentials:* Format for digital "Trust Tokens" enabling offline verification by third parties.	W3C
USSD / GSM 03.38	Specification	*Low-Tech Transport:* Mandatory character sets ensuring inclusion for feature phone (non-smartphone) users.	ETSI
Tiered KYC	Policy	*Inclusive Onboarding:* Allows "Provisional" (Tier 0) entry with minimal ID to prevent exclusion.	CBN
Multi-modal Auth	Innovation	*Inclusive Biometrics:* Supports combinations of Fingerprint and Voice Biometrics to overcome literacy and physical barriers.	FIDO/NIST
Offline Sync (ARP)	Protocol	Automated Reconciliation Protocol; manages the secure "Store-and-Forward" of offline field transactions to the central ledger	GovStack
Cloud-Native Maturity	Framework	Adheres to the '12-Factor' principles to ensure the registry is portable, scalable, and follows DevOps best practices	12factor.net

3.0 SECURE & INTEROPERABLE ARCHITECTURE – PILLAR 2

(Focus: The Data triad, interoperability, and offline-first resilience)

3.1 A "data triad" architecture

To avoid the monolithic "Silo trap" of previous eras, the NDFR will be architected not as a single giant database, but as a federated system of three distinct, linked data domains. This "data triad" model decouples static data from dynamic data to ensure high system performance and easier maintenance. It achieves this by adhering to the Twelve-Factor App methodology (Wiggins, 2011/2022), which separates the system's configuration from its codebase, enabling seamless scaling and cloud-native resilience.

3.1.1 Decoupling data domains

The architecture should physically and logically separate the three core domains to ensure scalability and allow each layer to be optimized for its specific technical requirements.

- **Identity domain** *(The "Who" – Static and transactional):* This layer stores Personally Identifiable Information (PII) and acts as the caching layer for the Foundational Identity mandates established in Section 2.1. It should remain lean,

static, and anchored to the NIN to avoid duplication of foundational identity efforts.

- ***Transaction capabilities:*** In line with the Data Empowerment and Protection Architecture[2] (DEPA) identity layer, this domain should support eKYC (for paperless bank onboarding) and eSign (for digitally signing contracts), transforming the ID from a passive record into an active economic tool (Kathuria, 2021). To ensure global interoperability, these capabilities are delivered via the OpenAPI Specification (OAS 3.0), enabling third-party financial institutions to verify identity as a secure, machine-readable service.

Geospatial and spatio-temporal domain: (The "Where" – Dynamic land use): This layer stores the polygon boundaries of farm plots, distinguishing between the Legal Boundary (Tenure) and the Functional Plot (Actual Cultivation).

- ***Standardization for Trade*:** To meet the technical requirements for export traceability—specifically the EU Deforestation Regulation (EUDR)—all boundaries should be captured and stored as GeoJSON Polygons using the WGS84 standard
- ***Dynamic attributes:*** It integrates with Earth Observation data (NASRDA) to track "Greenness Indices" (NDVI) and Crop Masks, allowing the system to detect fallow land and crop rotation without physical re-verification. This data is the prerequisite for the EUDR Compliance and Traceability use cases defined in Section 5.2.1.

Production and asset domain (The "What" – Dynamic): This layer records high-frequency transactional data— such as the producer grows or rears, inputs received, and harvest and sale volumes. It includes Herd Registries for livestock and Vessel Registries for fisheries.

- ***High velocity handling:*** To manage massive spikes in transactional data during harvest and subsidy cycles, this domain will use Asynchronous Messaging (Kafka/RabbitMQ) to ensure high-volume traffic does not impact the performance of the Identity or Geospatial layers.
- ***Value integration:*** This dynamic data is the engine of the ecosystem: beyond building credit scores (Finance), it powers precision advisory services (Productivity), aggregates volumes for market offtake (Markets), and informs national food security planning (Analytics).

[2] DEPA - https://indiastack.org/data.html

Best practice

Case study - The Federated Model]

Country/State: Karnataka, India (FRUITS)

Strategy: Instead of building a massive new database, the FRUITS registry acts as a federation hub. It links the farmer's ID to the existing Land Registry (Bhoomi) and the Education Department.

Impact: Allowed for instant validation of land ownership for loans and automated scholarship payments to farmers' children without manual verification *(Government of Karnataka, 2021).*

3.1.2 The "Blind intermediary" model

In line with DEPA, the registry should act as a "data switch" rather than a "Data store." Its primary function is to facilitate a secure handshake between independent systems (e.g., a bank and a cooperative) without permanently storing sensitive data.

- ***Federated Sovereignty:*** Under this model, the NDFR acts as a Metadata Registry rather than a primary storage vault. This ensures that State ADPs and private partners maintain full custody and sovereignty over their specific databases while "publishing" only the necessary pointers to the national hub.
- ***Honeypot Mitigation:*** The decentralized "Blind Intermediary" approach minimizes the security risk of a central "Honeypot" by ensuring that sensitive PII is not consolidated in a single, vulnerable repository.
- ***Privacy by Design:*** This model adheres to the Privacy by Design mandates outlined in the ORGANS principles (Ownership, Rice-level granularity, Governance, Anonymization, Notice, and Security), ensuring that the technical architecture supports the policy goals outlined in Chapter 6.1.
- ***Zero Trust Governance:*** To operationalize these protections, the system should consider adopting the Zero Trust Architecture standards defined in NIST SP 800-207 (Rose et al., 2020). This security framework requires continuous verification of every system requesting a 'data switch,' ensuring that no entity—internal or external—is granted implicit trust based on its network location

3.2 The interoperability interface

To ensure the NDFR functions as an ecosystem rather than a silo, it should pursue semantic and technical interoperability across all federal and state systems.

3.2.1 Semantic interoperability (Vocabularies and ontologies)

To ensure a "Maize producer" in Kano is classified identically to one in Ebonyi, the system must move beyond simple text labels to complete semantic alignment.

- **Standardised vocabulary**: The NDFR should adopt the AGROVOC (FAO) thesaurus or G8/G20 Open Data definitions to ensure consistent naming conventions for crops, locations, and inputs across all states.
- **Ontologies (Objects, states, and relationships)**: Beyond naming, the architecture should model agricultural logic and account for the sector's subdomains. It needs to define Objects (e.g., Farm, Producer, Crop), their States (e.g., Planted, Flowering, Harvested), and the Relationships that bind them (e.g.,

Farm X hosts Crop Y, which requires Input Z). This semantic structure allows disparate systems to "understand" the data context, not just read the text.

- **AI readiness**: This semantic structure renders the NDFR "AI-ready" by design. By structuring data into machine-readable knowledge graphs rather than static tables, the registry becomes a clean "training ground" for future predictive models (e.g., yield forecasting, pest outbreak prediction) without requiring expensive retrospective data cleaning.

3.2.2 API-first: UFSI for the "FMAFS Data Bus"

The system should implement the Unified Farmer Services Interface (UFSI) in accordance with a strict API-First Development Paradigm. This approach treats the API as a "first-class citizen," with the interface contract designed and documented using the OpenAPI Specification (OAS 3.0) before any backend code is written. This ensures that the registry is "headless" and ready to serve multiple consumers simultaneously.

- ***Federated Connectivity:*** The UFSI serves as the standardized gateway for the federated network. By decoupling the interface from the underlying database implementation, it provides a "plug-and-play" infrastructure for diverse nodes—such as a State-level ADP registry or a private FinTech wallet—to participate in the national ecosystem without losing their institutional autonomy.
- ***Operational logic:*** This acts as the central API gateway that allows disparate systems (e.g., State ADP databases, Private Fertiliser Wallets) to "plug in" to the national spine without rebuilding their internal architectures. By decoupling the interface from the database implementation, the UFSI ensures that federal and state systems can evolve independently while maintaining a stable connection.
- ***Logic flow:*** The UFSI acts as the secure gateway for the Entitlement Engine signals defined in Section 2.2.2, providing the technical rails for real-time verification and subsidy distribution.

Global evidence: This mirrors Estonia's X-Road model, which connects decentralised government databases through a secure data exchange layer, ensuring that citizens provide data only once ("Once-Only Principle") *(Information System Authority, Estonia, 2024).*

3.2.3 Public data utility (AgroDataCube)

For non-PII data, the system should implement the "AgroDataCube" model. This framework publishes anonymised, aggregated data (e.g., regional yield heatmaps) as an open utility, enabling researchers and startups to build applications on government data without compromising producer privacy.

- ***The "Data Refinery" Logic:*** Unlike raw data dumps, this utility functions as an Automated Data Pipeline, cleaning and structuring heterogeneous sources (satellite, soil, census) into machine-readable formats.

Global evidence: The Netherlands pioneered this with their AgroDataCube, which acts as a "Data Refinery," processing raw satellite and soil data into clean APIs for the private sector, fostering a vibrant agri-tech ecosystem (Ministry of Agriculture, Nature and Food Quality, Netherlands, 2024).

3.2.4 The developer sandbox (Enabling self-onboarding)

To operationalise the "Private sector force multiplier" mandate (See Chapter 4.2.2), the architecture should include a Developer Sandbox.

- ***Technical testing**:* This is an isolated clone of the registry—a Staging Environment populated with synthetic (non-real) data where fintechs and aggregators can test their API integrations without risking the integrity of the live national ledger.
- ***Self-onboarding**:* This component enables the "*Self-onboarding*" policy, allowing partners to validate their software, test "Edge cases," and receive automated compliance certificates before applying for live access. This reduces the administrative burden on FMAFS and accelerates the deployment of value-added services to farmers.

3.3 Geospatial integrity & EUDR compliance

The architecture should support high-fidelity geospatial data to meet international trade requirements.

3.3.1 Earth observation for remote verification

The NDFR should integrate with NASRDA (National Space Research and Development Agency) systems to overlay farm coordinates with satellite imagery. This allows remote verification of "*Greenness indices,*" confirming that a farm is active without sending a human agent to the field. This spatial integration shall adhere to the Open Geospatial Consortium (OGC) standards, ensuring that NASRDA's Earth Observation data is seamlessly interpretable by the NDFR's mapping modules

3.3.2 Polygons for land parcels

To address the technical requirements for export traceability—specifically the EU Deforestation Regulation (EUDR)—the system must capture GeoJSON Polygons (the farm's shape) rather than simple GPS points. This is mandatory for crops destined for European markets (Cocoa, Rubber, Coffee).

> **Cryptographic trust**: To ensure these compliance records are tamper-proof, the system should utilise cryptographic proofs (such as Verifiable Credentials) for all polygon data. This provides the immutability benefits of a distributed ledger, ensuring that a "*Deforestation-Free*" certificate cannot be retroactively altered, securing the nation's "*Ticket to trade*" in high-value markets.
>
> **Cluster evidence**: Ghana integrates its registry with a National Digital Addressing System to give every farm plot a precise digital identity, which is critical for monitoring climate compliance and resolving land disputes (Government of Ghana, 2023)

Best practice

Case Study - Geospatial Controls

Region: European Union (IACS)

Strategy: The Integrated Administration and Control System (IACS) uses a Land Parcel Identification System (LPIS) based on aerial photography.

Impact: Allows automated verification of subsidy claims against the exact land area, eliminating "Ghost farms" and ensuring cross-compliance with environmental standards *(European Commission, 2023).*

3.4 The connectivity challenge: Offline-first architecture

A purely cloud-based system will fail in Nigeria's rural hinterlands; therefore, the technical architecture should prioritize "Offline-first" capabilities to ensure 100% operational uptime regardless of network availability.

Best practice

Case Study - Reaching the Unconnected]

Country: Nepal (Offline Logistics)

Strategy: Extension agents use cached tablets to register farmers in remote, unconnected terrains.

Impact: Ensures operations continue in "dark" network zones, with data syncing only when agents return to connectivity *(Ministry of Agriculture & Livestock Development, Nepal, 2023).*

3.4.1 Store-and-forward protocols.

Mobile applications used by extension agents and trusted nodes shall function fully without a cellular signal, adhering to the Android *Offline-First* development paradigm (e.g., using Android WorkManager for background task scheduling).

- ***Local data persistence***: Data (registrations, subsidy redemptions) is encrypted and stored locally on the device ("Cached") using an Embedded NoSQL Edge Database (e.g., Couchbase Lite or Realm). This ensures that no data is lost during power or signal outages.
- ***Intelligent Synchronization***: This cached data is automatically synced ("Forwarded") to the central server only when the device detects a stable network. This process utilizes Differential Data Synchronization (e.g., Couchbase Sync Gateway), which transmits only the modified data fragments ("Deltas") to minimize data consumption and battery drain in rural hinterlands.
- ***Operational Inclusivity***: This architecture provides the technical rails to deliver the device-agnostic inclusivity promised in Section 2.2.1, ensuring that lack of connectivity does not results in a denial of service in Nigeria's rural hinterlands.

3.4.2 Inbound synchronization: Local caching and conflict resolution

While Section 3.4.1 manages data uploads, this subsection addresses how the device stays updated with national records and handles data discrepancies.

- **Registry "Lite" Downloads:** To facilitate offline lookups, mobile devices should perform a Scoped Synchronization of the relevant Local Government Area (LGA) registry. The device downloads an encrypted, Local Cache of producer records (e.g., using an Embedded NoSQL Database like SQLite). This allows agents to verify identities and entitlements instantly without a network ping.
- **Deterministic Conflict Resolution:** During the synchronization handshake, the system must resolve "Data Collisions" where records have been updated on both the device and the server. The NDFR would utilize the following logic:
    - *Dynamic Fields:* Employs "Last Writer Wins" (LWW) logic for high-frequency data, such as a producer's current crop growth stage or bags of fertilizer collected.
    - *Static Fields:* Flags discrepancies in critical "Source of Truth" data (e.g., land boundaries or NIN-linked names) for manual adjudication by a central administrator. This prevents unauthorized or fraudulent modifications from being automatically merged into the national ledger.

Global evidence:

Bangladesh integrates IoT sensor networks into its registry architecture. This requires the system to handle high velocity "live" data streams (weather, soil moisture) alongside offline batch updates, proving the need for a robust hybrid connectivity model (World Bank, 2024b)

3.5 Technical reference matrix: Architecture specifications & protocols

The NDFR shall adhere to the following standards to ensure security, interoperability, and scale.

Component	Type	Purpose and Nigeria relevance	Authority / Link
Unified Farmer Services Interface (UFSI)	Protocol	Standardised API gateway allowing Nigerian agri-techs to plug into the national registry spine.	GovStack
GraphQL	Specification	Query language for APIs that allows apps to request exactly the data they need, saving bandwidth in rural areas.	GraphQL
GeoJSON / WGS84	Standard	Mandatory format for defining land boundaries (Polygons) to meet EUDR export compliance.	IETF
Async Messaging	Architecture	Acts as a high-capacity "buffer" to handle massive transactional spikes (e.g., e-voucher distribution) without crashing core services.	RabbitMQ CNCF
Offline-First (Store-and-Forward)	Architecture	Functional requirement ensuring field apps work in "Dark" zones by queuing data locally until a signal is found.	Android Offline
Sunbird RC	Platform	Open-source registry framework (building block of India's AgriStack) for managing verifiable credentials.	Sunbird
Edge Synchronization	Protocol	The technical mechanism (e.g., Couchbase Sync) that automates data conflict resolution and secures "Delta-syncs" to save bandwidth.	GovStack / Couchbase
Cloud-Native Maturity	Framework	Adheres to the '12-Factor' principles to ensure the registry is portable, scalable, and follows DevOps best practices	12factor.net
Zero Trust Architecture	Standard	Eliminates the "Honeypot" risk by requiring continuous verification of every system handshake.	NIST SP 800-207

4.0 INCLUSIVE PARTNERSHIPS – PILLAR 3

(Focus: The ecosystem – Government, Private sector, civil society, and development partners)

4.1 Dynamic ecosystem governance and accreditation

Figure 3: NDFR dynamic ecosystem for co-creation

The agricultural landscape in Nigeria is dynamic, with new agri-fintechs, NGOs, and logistics providers emerging each year. Therefore, the FMAFS will not rely on a static "*Whitelist*" of partners. Instead, it will institutionalise a "*Continuous ecosystem evaluation*" mechanism.

- *The mechanism:* The NDFR governance body should conduct a real-time landscape assessment biannually to identify emerging actors. This "*Living map*" ensures that the registry evolves with the market.

4.1.1. Checklist: Dynamic partner accreditation framework

To ensure safety without stifling innovation, potential partners (whether cooperatives, NGOs, or tech start-ups) should be evaluated against a dynamic "Readiness matrix" rather than a rigid typology.

- ***Data sovereignty:*** Does the partner agree to the "Data blind" consent model, ensuring they do not scrape data without specific transaction consent?
- **Value addition**:
  - Does the partner provide tangible services (credit, inputs, market access) to the farmer, rather than just data mining?

    - Does the partner commit to refreshing farmer data during their own commercial transactions, acting as a distributed validator for the national registry?
- **Technical maturity**: Can the partner system consume/produce JSON data via RESTful APIs?
- **Last-mile capability**: Does the partner have operational rails (e.g., Village-Based Advisors, rural agro-dealer networks, or active USSD subscriber bases) that can serve as the primary onboarding and service-delivery node for the NDFR in rural LGAs?
- **Legal compliance**: Has the partner signed the standardised Data Sharing Agreement (DSA) referencing the Nigeria Data Protection Act (NDPA) 2023?

4.2 The private sector engine

To achieve national scale, the registry will leverage the infrastructure of Mobile Network Operators (MNOs) and the private-sector innovation, transforming these entities from simple vendors into active infrastructure partners.

4.2.1 The telecommunications sector (MNOs): A multi-functional partnership

Mobile Network Operators (MNOs) are not just communication providers; they are critical infrastructure partners. As mandated by the National Stakeholders, the collaboration should extend beyond basic access to cover the core functions of the Digital Public Infrastructure:

- **Access and inclusion (zero-rating)**: To ensure the NDFR is accessible to the poorest farmers, MNOs should implement reverse billing protocols. This ensures that access to the NDFR (via USSD or web) is zero-rated for the farmer, removing the "Airtime barrier" to entry and ensuring the registry functions as a public utility.
- **Identity and verification:** The NDFR will leverage the MNOs' existing SIM registration database as a secondary verification layer. Since SIM cards are already linked to the NIN, this provides a rapid, low-cost method to cross-verify a farmer's digital identity during onboarding.
- **Payment and value transfer**: With the rise of Payment Service Banks (PSBs), MNOs are now financial institutions. The NDFR should integrate directly with these mobile money rails to facilitate Direct Benefit Transfer (DBT) for unbanked farmers, ensuring subsidies are disbursed directly to mobile wallets.
- **Future and ancillary data services:** The NDFR ecosystem will be designed to accommodate unforeseen digital services (e.g., MNO-provided network stability metrics, geofencing data, or bespoke advisory push channels). The architecture will be prepared for future integrations, including MNO data into Alternative Credit Scoring models based on subscriber behaviour, provided the highest level of farmer consent is obtained, and strict NDPA compliance is enforced.

Best practice

Case study - The Mobile-First Registry

Country: Tanzania (M-Kilimo & Mobile Money)

Strategy: Partnered with Mobile Network Operators (MNOs) to use mobile money transaction history as a proxy for economic activity.

Impact: Created dynamic financial profiles for millions of unbanked farmers, allowing them to access credit based on their mobile wallet history rather than traditional collateral *(GSMA, 2021a)*.

4.2.2 The private sector as a force multiplier

The private sector has a financial incentive to capture accurate "Know Your Customer" (KYC) data. The NDFR should harness this motivation to reduce government expenditure.

- **Commercial aggregators and off-takers:** Aggregators are profit-driven entities connecting farmers to markets. The NDFR allows them to query the database to identify production clusters for contract farming, acting as a B2B matchmaking platform..

  Global evidence: Thailand's "Smart Farmer Registry" acts as a matchmaking platform, allowing food processing companies to identify clusters of farmers growing specific raw materials and enter into supply contracts

- **Operationalising the "Open API" mandate:** To enable scale, the FMAFS should adopt a "Self-onboarding" best practice for its API marketplace. Rather than manually approving every partner, the system should provide a public "Sandbox" environment. Innovators can register, test their code against the Unified Farmer Services Interface (UFSI), and submit for accreditation only when technically ready.

  Global evidence: India's National Farmers Database (NFD) promotes an open API ecosystem that enables accredited private partners to innovate on top of the platform, driving digital agriculture services without the government building every app (Ministry of Agriculture & Farmers' Welfare, Government of India, 2021)

- **Agri-fintechs' contribution and CAC reduction**: The NDFR can act as a public utility, lowering Customer Acquisition Costs (CAC). In exchange for contributing clean data, private partners gain access to the identity verification layer to onboard customers, subject to appropriate consent mechanisms.

Proof point: The ThriveAgric model demonstrates this scale; the NDFR should accredit such private networks as "Trusted Nodes" to feed data directly into the national system.

4.3 Leveraging intermediaries: The "Trusted node" model

Sustainable enrolment cannot rely solely on government agents. The NDFR should empower "*Trusted nodes*"—entities with existing economic relationships with producers—to act as registration agents.

- Farmer cooperatives (the "First mile" aggregators): Cooperatives serve as the primary point of contact for production, hence the "first-mile" designation. They should be empowered to register their own members to aggregate demand for inputs.

  *Global evidence: **Vietnam** utilises cooperatives to aggregate smallholder data for Global G.A.P. certification, reducing individual compliance costs (World Bank, 2024c).*

  Best practice

  Case Study- Recognizing Collective Tenure

  Country: Bolivia (Indigenous Territories Registry)

  Strategy: Instead of forcing individual titling, the registry documents "collective territories" managed by cooperatives and indigenous groups.

  Impact: This ensures that producers farming on customary or communal land are not excluded from the digital economy, validating the cooperative as the legal entity for credit *(Caldecott, 2021).*

- **Commodity associations (The "Quality" gatekeepers):** Associations (e.g., Cocoa Association of Nigeria) operate at the national level to enforce standards. They should be accredited to register farmers specifically for traceability and export compliance.

  Global evidence: Australia offers a definitive partnership model where the registry is managed by the industry body, Meat & Livestock Australia (MLA). This industry-led governance ensures the system evolves at the speed of the market, securing global premiums for Australian beef *(Meat & Livestock Australia, 2023)*

*Global evidence: **Scotland** uses its registry to track the "Scottish Beef" brand. Only calves registered within 8 months are eligible, protecting the brand's premium status (Scottish Government, 2023).*

- **Agro-dealers as digital agents:** Agro-dealers are often the only formal point of contact for rural farmers, serving as last-mile service hubs. The NDFR transforms them into "Digital agents" capable of performing Tier 0 (Provisional) registration at the point of sale.

4.4 Development and social impact partners

Non-commercial actors play a critical role in reaching the "last mile" and ensuring resources are not wasted through duplication.

4.4.1 The non-profit sector: Implementation partners (NGOs)

Non-Governmental Organisations (NGOs) often operate their own digital solutions for extension or data collection (e.g., TechnoServe, Sasakawa). These databases historically remain siloed after grant funding expires.

- **Integration strategy:** NGOs operating digital agriculture tools will be treated as "Catalytic Nodes." They should integrate their existing apps with the NDFR APIs to push data to the national spine, rather than maintaining parallel databases. This allows them to act as "gap-fillers," utilizing their field networks to "mop up" underserved populations in remote areas and onboard them into the national infrastructure via the Offline-First protocols established in Chapter 3.4.
- **The incentive:** In return for data integration, NGOs gain access to the NDFR's deduplication engine, ensuring they do not count beneficiaries already served by other programmes, thereby improving their donor reporting. This transforms them from isolated implementers into active contributors to the NDFR, the enduring national asset and single source of truth.

4.4.2 Donor coordination: The "Single registry" mandate

To prevent the fragmentation identified in the GESS post-mortem, the FMAFS should enforce a "Single registry" mandate.

- **The rule:** All donor-funded agricultural interventions (IFAD, World Bank, AfDB, etc.) should utilise the NDFR for beneficiary selection and deduplication.

Best practice

Case study - The Power of Coordination]

Country: Zambia (ZIAMIS)

Strategy: Implemented a "Single Registry" policy where all partners had to screen beneficiaries against the national database.

Impact: Reduced beneficiary duplication **by 20%** and ensured resources were distributed equitably across districts, serving as a model for donor alignment. *(Africa Development Bank, 2024).*

- **Harmonisation:** Donors will "lock" beneficiaries against specific interventions in the registry (e.g., "Farmer A has received IFAD fertilizer"), preventing double-dipping and ensuring resources reach underserved areas.

4.5 Inter-agency collaboration: The "Whole-of-Government" stack

While the FMAFS is the custodian of the registry, its success depends on deep integration with other government agencies responsible for providing core components of the Digital Public Infrastructure. The NDFR will support various integration layers to guard against fragmentation and maximise utility:

- **Identity & security layer:** The system must anchor to the NIMC (National Identity Number) to deduplicate records. NITDA and the NDPC audit technical compliance.
- **Sectoral harmonisation layer:** The NDFR serves as the unified infrastructure for sister ministries to manage sectoral data. The Federal Ministry of Marine and Blue Economy will utilise it to register fishers, and the Federal Ministry of Livestock Development will leverage it to implement the NLTP (National Livestock Transformation Plan) by managing pastoralist herds and disease control.
- **Social & resilience layer:** The registry will interoperate with the NASSCO-managed NSR (National Social Register) for "Cash+" interventions, enabling targeted social protection. NAIC (Nigeria Agricultural Insurance Corporation) integrates here to de-risk the sector through index-based products.
- **Financial & commercial layer:** Integration with the CBN and NIBSS is mandatory to validate BVNs and facilitate secure subsidy payments. The Corporate Affairs Commission (CAC) and the Federal Inland Revenue Service (FIRS) link here to validate businesses and promote the formalisation of commercial farmers.
- **Environmental & resource layer:** NASRDA provides satellite verification services for land mapping and EUDR compliance. River Basin Development Authorities (RBDAs) integrate to verify water access rights and optimise dry-season support.

4.6 Partner expectations matrix

To normalize the ecosystem, partners are categorised by their Function rather than their legal status. This matrix defines the technical expectations for each role.

Functional role	Typical actors	Technical expectation	Data protocol
Data Originators	Cooperatives, NGOs, Agri-FinTechs, Aggregators	*Write Access:* Support bulk upload (CSV/API) or offline-first mobile entry.	*Onboarding consent:* Must obtain explicit farmer agreement to be registered in the national spine.
Service Providers	Banks, Insurers, Agro-Dealers, Off-Takers	*Read/Write Access:* Query APIs for verification and write back transaction logs (e.g., credit history).	*Transaction consent:* Requires specific, time-bound tokens to view PII or update records.
Value Validators	Commodity Associations, Quality Control Agencies	*Update Access:* Ability to append "Verifiable Credentials" (e.g., Organic Cert) to a profile.	*Certification consent:* Farmer agrees to the audit and public display of status.
Infrastructure Hosts	MNOs, PSBs, Cloud Providers	*Transit Only:* Provide secure rails (USSD/IP) without inspecting the data payload.	*Service terms:* Standard usage terms; strict firewall between registry and commercial data.
Strategic Observers	Donors, CSOs, Research Institutes	*Read-Only (Aggregate):* Access to anonymised dashboards for M&E and oversight.	*Public task:* Data use covered under national development mandate (Anonymised).

5.0 DIGITAL USE CASES – PILLAR 4

(Focus: Value layers enabled by foundational DPI – Productivity, markets, finance, and analytics)

5.1 Sustainable farm productivity and resilience

To drive sustainable productivity, the NDFR will shift agricultural extension from "Generic broadcasting" to "Precision advisory." By combining the geospatial domain (location) with the production domain (crop cycle), the system should enable hyper-localised intelligence.

5.1.1 From generic to contextual advisory:

Instead of broadcasting general advice (e.g., "Plant cassava now"), the NDFR should enable contextual advisory. The system should facilitate combining farmer profile data with external variables (such as soil health and weather) to generate specific recommendations.

Implementation: The registry should expose an API that allows agri-tech partners to query a farmer's location and crop

Nigeria context: This enables integration with the Agricultural Development Programmes (ADPs). Agents can query the registry to find all "Cassava farmers in Benue" affected by a specific blight, enabling precise targeting of interventions.

Best practice

Case study - Data-Driven Extension

Country: Ethiopia (Digital Farmer Registry)

Strategy: Equipped Development Agents (DAs) with tablets containing farmer profiles. Before a visit, the DA reviews the farmer's past production and specific challenges

Impact: A process evaluation found that 82% of extension workers reported reduced workload and improved service quality. It transformed extension from a generic service to a personalised consultancy *(Sebsibie et al., 2023).*

Demand-Driven Discovery (Beckn Protocol): Moving beyond push-messaging, the system could also enable a "help desk" model. Using the Beckn Protocol, a farmer can broadcast a specific query (e.g., "Image of diseased leaf") which the network routes to available experts—whether government agents or private agronomists—creating a responsive market for advisory services.

5.1.2 Climate-smart agriculture (CSA) and early warning:

To build resilience against climate shocks, the registry will ingest real-time environmental data.

Mechanism: The NDFR should integrate with NiMet (Nigerian Meteorological Agency). If NiMet predicts a flood in a specific LGA in Jigawa, the system filters for farmers within that geospatial polygon and pushes a targeted warning via SMS or IVR.

Innovation: The system should support hyper-localised pest prediction using AI to map "Ecological niches" for pests such as Fall Armyworm, enabling preemptive action.

Best practice

Case study - IoT for Resilience]

Country: Bangladesh (Digital Agriculture Platform)

Strategy: Integrated IoT sensors and satellite data into the registry architecture to monitor microclimates.

Impact: Provided real-time advisories on soil moisture and salinity to smallholders. This data-driven approach reduced crop losses by up to 30% in pilot districts by enabling proactive rather than reactive pest management *(World Bank, 2024b).*

5.2. Inclusive markets & value chains

To unlock inclusive markets, the NDFR will serve as the digital infrastructure that connects smallholders to the broader economy. It should serve as a verification layer that supports regulatory compliance, enables efficient discovery, and delivers premium differentiation.

5.2.1 Traceability for compliance (EUDR and sanitary requirements)

Access to high-value markets such as the EU now requires proof of zero deforestation and sanitary safety. The collection of geospatial polygons and health records is a crucial technical requirement for this "*Ticket to Trade*."

Compliance alert! Ticket to trade: *Without the NDFR's geospatial validation, Nigerian cocoa and rubber exporters risk losing access to the EU market. The registry should function as the National Traceability Engine, issuing the digital proofs required by international regulators.*

The workflow: When a Nigerian farmer sells cocoa, the system should facilitate retrieving the farm's polygon, overlaying it with satellite forest maps, and issuing a Verifiable Credential. For livestock, it should enable tracking animal health to prevent the spread of disease.

Global evidence: Argentina uses its RENSPA registry to track sanitary compliance for beef exports. In the event of a disease outbreak, the system instantly identifies exposed farms, preserving market access for the rest of the sector.

Best practice

Case study - The Export Premium] Country:

Country: Pakistan (Rice Sector Registry)

Strategy: Developed a commodity-specific registry to track the Basmati rice supply chain from farm to mill.

Impact: Ensured authenticity and quality, leading to an 18% increase in export values in the first year and protecting the Geographic Indication (GI) status in global markets *(Government of Pakistan, 2023).*

5.2.2 Digital marketplaces: An Open Commerce Network

The registry should be accessible as a "Digital phonebook" for off-takers, reducing search costs. Furthermore, to truly unlock value, it should function not just as a directory, but as an Open Commerce Network for both goods (crops) and services (mechanisation & logistics). Crucially, this transition is subject to privacy and consent mechanisms. Whether an off-taker is "looking up" a farmer or a farmer is "broadcasting" a request for a tractor, the registry ensures that data is only shared when the user explicitly consents to the specific transaction.

Protocol: The NDFR should implement the Beckn Protocol to enable this secure, decentralised discovery. This transforms the registry into a two-way switch.

> ***Outbound (Selling Produce):*** It allows commodity exchanges (e.g., AFEX, Gezawa) to broadcast a "buying intent" (e.g., "Need 5,000 bags of Maize in Kaduna"). This signal is routed to registered farmers who can consent to share their details and accept the offer.
>
> ***Inbound (Sourcing Services):*** It allows farmers to broadcast a "service intent" (e.g., "*Need 5-ton truck*" or "*Need tractor for ploughing*"). This signal is discoverable by logistics providers and equipment owners across the network, creating a gig-economy for rural services without government management of a fleet.

NDFR as the Trust Anchor: In this network, the registry functions as the trust layer. It attaches a Verifiable Credential to every transaction:

- ***For the Buyer*:** Proving the seller is a genuine farmer with valid land tenure.
- ***For the Service Provider*:** Validating the farmer's identity and location to reduce the risk of service delivery failure.

Global evidence: South Africa's Free State Province Online Farmer Register allows registered farmers to list their products on a public platform. This visibility connects them directly with bulk buyers, bypassing predatory middlemen. However, although the platform connected farmers to buyers via a central portal, it lacked logistics integration. India's ONDC (Open Network for Digital Commerce) is a promising new standard for this integration (Dittrich et al., 2025[3]). By using open protocols, ONDC

[3] Yvonne Dittrich et al., "Beyond Platforms: Growing Distributed Transaction Networks for Digital Commerce" (Working paper, IT University of Copenhagen, April 24, 2025), 5.

bundles relevant transactions, allowing a farmer to sell produce and instantly book a delivery partner in a single digital workflow.

Case study - Matchmaking for Contract Farming

Country: Thailand (Smart Farmer Registry)

Strategy: Built a national agribusiness platform on top of the registry that allows food processors to identify clusters of farmers growing specific raw materials.

Impact: Reduced transaction costs for setting up reliable outgrower schemes and enabled data-driven contract farming, expanding market access for smallholders *(Manalili and Capiña, 2023).*

5.2.3 Brand integrity and premium differentiation

Beyond commodities, the registry should enable "*De-commoditisation.*" It should help validate the product story (e.g., "Sokoto Red Goat" or "Organic Ginger"), allowing the farmers to command a price premium.

The mechanism: Consumers scan a QR code on the final product, which queries the NDFR to display the specific farm of origin and its safety standards, building immense consumer trust.

Case study - Transparency as a Marketing Tool

Country: Finland (Farm Register)

Strategy: Leveraged the national registry to underpin the "Food from Finland" brand strategy. The system provides verifiable digital storytelling about origin and safety.

Impact: Allowed Finnish products to command a significant price premium in export markets by satisfying the consumer demand for transparency and food safety *(Government of Finland, 2024).*

5.3 Inclusive digital finance

Financial institutions do not lend to smallholders because they are "invisible." To address this, the NDFR should make farmers visible and bankable by establishing verifiable economic identities that can enable the de-risking of the sector.

5.3.1 Input subsidy reform: The "Entitlement engine."

An immediate flagship use case for the Nigerian NDFR is the digitalization of subsidies. The registry needs to function as an entitlement engine.

The entitlement logic: The system calculates subsidy eligibility based on static and historical parameters, such as size, crop type, and production history. It then issues a cryptographically secure digital voucher (token).

Verification & fraud prevention: Verification happens at the point of sale (agro-dealer) using the Farmer's ID, ensuring the subsidy reaches the intended beneficiary and creating a closed-loop audit trail

Best practice

Case study - Eliminating Ghost Beneficiaries

Country: Rwanda (Smart Nkunganire System)

Strategy: Linked the farmer's ID to a digital subsidy entitlement. Farmers receive an SMS voucher, verified in real-time by agro-dealers.

Impact: Drastically reduced "Ghost beneficiaries" and improved the timeliness of input distribution, contributing to consistent sector growth and donor confidence *(MINAGRI, 2023)*

Towards an open fulfillment network: Operational reviews of GES and NAGS-AP confirm that relying on proprietary redemption terminals creates critical bottlenecks (AfDB, 2022). When designated devices fail, access is impeded. By shifting to a Beckn-enabled (Bring Your Own Device - BYOD) model, the NDFR eliminates hardware dependency—allowing any agro-dealer's verified smartphone to function instantly as a universal redemption terminal.

5.3.2 Credit scoring: Building the "Trust score."

The registry should provide the "complementary data" needed for credit scoring.

The data points: By tracking historical production and input usage, the registry builds a "Trust score" for the farmer. Evidence from South Korea shows that the National Agricultural Cooperative Federation (NACF) uses this unified profile to pre-approve equipment loans without physical collateral (NACF, 2023).

5.3.3 Crop and livestock insurance mechanisms

To mitigate climate and biological risks, the NDFR needs to serve as the verification layer for index-based and indemnity insurance, thereby reducing the administrative costs that have traditionally made agricultural insurance unaffordable.

Crop insurance (Index-based triggers): The system should support parametric insurance by linking registry data (yield history + location) with satellite weather data.

Rapid response: The Philippines leverages its RSBSA registry to overlay typhoon paths with farm polygons, triggering rapid insurance payouts weeks ahead of traditional schedules *(Government of the Philippines, 2024).*

Dynamic pricing: Bangladesh integrates IoT sensor data into its registry architecture to monitor microclimates. This allows insurers to adjust premiums dynamically based on real-time risk assessments and trigger automated payouts for verified weather events, increasing insurance penetration among smallholders *(World Bank, 2024b)*

Livestock insurance (Traceability-based): For the livestock sector, the registry should track individual animal health and movement to mitigate risk to herds.

Global evidence: Uruguay's National Livestock Traceability System (SNIG) tracks the lifecycle of every bovine. This individualised data allows insurers to offer policies against disease outbreaks and theft, as the asset (the cow) is digitally verified and traceable from birth to market *(Land Group, 2023)*.

5.3.4 Social protection and "Cash+" transfers

The NDFR must interoperate with the National Social Register (NSR).

Strategy: This linkage enables *"Cash+"* programmes that bundle social transfers with agricultural support. In Morocco, the National Agricultural Registry (NAR) uses socio-economic classification to automatically enrol vulnerable farmers in compulsory health insurance, directly linking agricultural status to social protection *(Yahya, 2025)*.

Best practice

Case study - Shock-Responsive Intelligence]

Country: Malawi (Unified Beneficiary Registry)

Strategy: Used registry data to identify vulnerable farming households in drought-prone districts.

Impact: Enabled the government to trigger emergency cash transfers rapidly during climate shocks, using the registry as a targeting tool for social protection rather than just agriculture *(Government of Malawi, 2022).*

5.4 Integrated data and analytics

This thematic layer addresses the strategic utility of data. The relevance of a registry is significantly diminished if it is regarded as a "Data graveyard." The NDFR should be seen as an active intelligence engine for producers and their cooperatives, program implementers, and policymakers.

5.4.1 Participatory data updating and access (The Producer's view)

To maintain a "Living registry" and empower the producer, the system should allow users to both update their status and access their records, functioning as an "Economic passport."

The innovation: The system should support interaction through WhatsApp Bots and Interactive Voice Response (IVR). Farmers can use these tools to update

Best practice

Case study - Solving Data Decay

Country: Ethiopia (Digital Farmer Registry

Strategy: Moved away from static data collection by embedding "Continuous update cycles" into the routine workflows of the agricultural sector.

Impact: Ensured that data remained current and operationally useful for advisory services, preventing the "Data decay" that plagues static census models *(Sebsibie et al., 2023)*.

their crop status ("I just planted Soybeans") or to view and download their digital profile and transaction history for use with third-party service providers.

5.4.2 Organisational intelligence (Producer groups)

Data empowers cooperatives to transition from social groups to business enterprises. By aggregating member data, they gain negotiating power.

The application: The NDFR dashboard should allow accredited cooperatives to view the aggregate input requirements of their members (e.g., "Total fertilizer needed: 500 tonnes"). This replaces guesswork with data-driven procurement.

Best practice

Case study - Analytics for Collective Bargaining]

Country: Vietnam (National Farmer Database)

Strategy: Cooperatives use the national registry to forecast total input needs for their members and negotiate bulk purchases from suppliers.

Impact: Lowered input costs for smallholders by an average of 15-20%, proving that aggregated data directly correlates to profitability *(World Bank, 2024c)*.

5.4.3 Resource management (The Program Implementer's view)

For Government Agencies and Program Implementers (NGOs) managing scarce resources, the registry provides a macro-dashboard for operational optimisation.

Mechanism: By aggregating real-time production data (e.g., crop water requirements), agencies can optimise the distribution of inputs and water to ensure sustainability.

Best practice

Case study - Precision Resource Allocation]

Country: Egypt (Nile Water Management)

Strategy: Integrated the farmer registry with the national water management grid. The system uses registered crop data to calculate the exact water demand for each irrigation zone.

Impact: Enabled the transition from wasteful flood irrigation to quota-based allocation, improving water use efficiency by 25% in the Nile Delta *(World Bank, 2024d).*

5.4.4 Strategic planning, M&E, and foresight (The policy view)

For policymakers and donors, the registry serves as the ultimate Monitoring & Evaluation (M&E) and foresight tool. It shifts reporting from "*Estimated beneficiaries*" to "*Verified reach and traceable outcomes*."

Donor alignment: It provides a unified M&E framework in which all development partners track progress against the same indicators and unique farmer IDs, eliminating double-counting

Demographic foresight: The registry serves as a radar for emerging trends, enabling the government to anticipate crises before they become irreversible.

Best practice

Case study - Demographic Foresight

Country: Japan (Farmland Bank System)

Strategy: Used registry analytics to identify aging farmers with no successors before they retired. The system automatically flags "at-risk" plots and markets them to young "Agripreneurs" through a consolidated land bank.

Impact: Slowed the rate of farmland abandonment and facilitated the transfer of over 500,000 hectares to the next generation, ensuring long-term sector sustainability *(Japan Compliance, 2025).*

5.5 Technical reference matrix: Use case standards

NDFR implementation needs to align with the following standards, protocols and models, to ensure data is usable for trade, animal health and policy.

Item	Type	Description & Nigeria relevance	Authority / Implementer
Beckn	Protocol	Provides the API standards for decentralized, consent-driven discovery and fulfillment, ensuring the digital registry ecosystem is scalable and open	Beckn Foundation
GS1 Standards	Standard	Global barcode standard for tracking produce, essential for Nigerian exports to meet EU traceability requirements.	GS1
FHIR	Standard	Adapt healthcare standards for livestock, crucial for tracking animal diseases like PPR across Nigerian states.	HL7
ISIC Rev. 4	Standard	Classification for economic activities, ensuring Nigerian value chains are coded to global export standards.	UN Statistics Division
OData	Protocol	Standard protocol for querying registry data, enabling researchers to generate real-time food security analytics.	OData
ONDC	Network Model	Enables an unbundled, competitive market structure for agri-commerce, preventing vendor lock-in and maximizing farmer market access.	ONDC / India DPI
WhatsApp/Chatbot	Digital Public Good	Allow farmers to update crop data via familiar chat apps, increasing engagement and data freshness.	Glific

6.0 DATA GOVERNANCE, ETHICS & POLICY – PILLAR 5

(Focus: Operationalising the "Universal Safeguards" and NDPA 2023)

6.1 The "Blind intermediary" architecture

To address the historic trust deficit between citizens and government databases, the NDFR will adopt the "Blind Intermediary" architecture (pioneered by India's Account Aggregator model) and leverage the Data Empowerment and Protection Architecture (DEPA) framework (NITI Aayog, 2020). This approach ensures that the registry facilitates service delivery without becoming a tool for surveillance, in line with the Nigeria Data Protection Act (NDPA) 2023 and global Universal DPI Safeguards (UN Tech Envoy & UNDP, 2024)

To solve the historic trust deficit between citizens and government databases, the NDFR will adopt the "Blind intermediary" architecture (pioneered by India's Account Aggregator model). This approach ensures that the registry facilitates service delivery without becoming a tool for surveillance, in line with the Nigeria Data Protection Act (NDPA) 2023.

> **The mechanism:** The Registry acts as a "Traffic signal" for consent. It manages data permissions to enable data flow between a farmer (data provider) and a service provider (data user, e.g., a bank). Still, it does not see, store, or decrypt the data payload itself.
>
> **Specification:** The system should separate the "Consent flow" from the "Data flow." Data must flow securely from the source (e.g., cooperative database) to the user (e.g., insurer) via encrypted tunnels, without persisting in the central registry
>
> **Impact:** This ensures "Privacy by design," preventing the creation of a central "Honeypot" of sensitive financial or personal data that could be hacked or misused.

6.2 The "Techno-legal" framework

Data governance cannot rely solely on policy documents; it must be enforced by code. The NDFR will implement a "Techno-legal" framework in which legal rights are baked into the software architecture.

6.2.1 Operationalising the NDPA 2023

The ORGANS framework for Electronic Consent Artefacts (Open, Revocable, Granular, Auditable, Notice-based, and Secure) summarizes the core principles of user consent in modern data-governance models *(NITI Aayog, 2020*[4]*)*. It provides a mnemonic for evaluating whether a consent system meaningfully empowers users while ensuring transparent, accountable, and secure data sharing. The NDFR should implement

[4] DEPA book -> NITI Aayog. *Data Empowerment and Protection Architecture: Empowering People with Control over Their Data*. New Delhi: Government of India, 2020. https://www.niti.gov.in/sites/default/files/2020-09/DEPA-Book_0.pdf

ORGANS, ensuring that the privacy mandates of the Nigeria Data Protection Act are technically enforceable (See Chapter 4.1.1 for how partners use these tokens):

- ***O**pen standards:* Use interoperable XML/JSON formats to ensure consent tokens are readable across different platforms.
- ***R**evocable:* Producers must have a USSD or mobile app mechanism to revoke access instantly.
- ***G**ranular:* Consent is specific (e.g., "Share my crop history but NOT my bank balance"), preventing blanket data grabs.
- ***A**uditable*: Every data access request is logged in WORM Storage (Immutable Ledger) to create a tamper-proof audit trail. This audit trail includes the Automated Reconciliation Protocol (ARP), which validates offline e-voucher redemptions against the master ledger before financial settlement to prevent fraud and ensure system integrity.
- ***N**otice:* The producer receives an SMS notification whenever their data is accessed, ensuring transparency.
- ***S**ecure*: End-to-end encryption using AES-256 and TLS 1.3 to protect the consent artifact itself.

Best practice

Case study - Data empowerment and protection

Country: India (Data Empowerment and Protection Architecture - DEPA)

Strategy: Introduced "Consent Managers" as a new class of institution. These managers facilitate data sharing (e.g., sharing tax history with a bank for a loan) but remain "Data blind," unable to read the user's financial details.

Relevance: Nigeria could adopt this distinction to operationalise the NDPA 2023, ensuring the FMAFS facilitates service delivery without becoming a surveillance entity *(NITI Aayog, 2020).*

6.2.2 Producer sovereignty

The system should implement "Producer-managed digital identities," in which the producer holds the private key (or a proxy PIN) for their data wallet. This technically prevents unauthorised third-party sharing, ensuring the producer remains the ultimate owner of their digital footprint.

6.3 Universal safeguards: Safety and inclusion

To mitigate the risks of digital exclusion and harm, the NDFR will adopt the principles of the Universal DPI Safeguards Framework *(UN Tech Envoy & UNDP, 2024)*. This ensures that the registry is not only a technical tool but a protective infrastructure for all Nigerian producers.

Safeguard 1 – Do no harm (physical and digital safety): The registry should protect producers in conflict-affected zones (e.g., Northeast Nigeria). Data on land rights and location in conflict zones must be flagged as "Sensitive." Access

to this data shall be restricted to essential government personnel only, preventing its use for targeting or displacement.

Best practice

Case study - Data for Peacebuilding

Country: Colombia (Land Restitution Unit)

Strategy: The registry created a specific track to document "abandoned claims" and land rights for populations displaced by civil conflict.

Impact: This allowed the government to facilitate post-conflict land restitution and prevent land grabbing, turning the registry into a tool for social justice and peacebuilding *(Government of Colombia, 2023)*

Safeguard 2 – Do not exclude (offline and analogue access): Technology should not be a barrier to access. The NDFR should maintain parallel analogue (paper-based) registration channels for later digitisation. Trusted intermediaries (Village heads, cooperatives) will use "*Trusted witness*" protocols—a model successfully deployed in Uganda for registering displaced populations (UNHCR & FAO, 2023)—to validate the identities of producers who lack documentation, ensuring IDPs and women with customary land rights are included.

Safeguard 3 – Effective remedy and redress: A registry is only as trusted as its error-correction mechanism. The system should include a Grievance Redressal Module (GRM). If a producer is wrongly excluded from a subsidy or contests their land boundary, they should be able to log a ticket via USSD/IVR. The system should track this ticket to resolution and issue escalation alerts if it is not resolved within a mandated timeframe (e.g., 7 days).

Best practice

Case study - Inclusion of Displaced Populations

Country: Uganda (Digital Farmer Registration System)

Strategy: Incorporated flexible registration modalities to include Internally Displaced Persons (IDPs) and refugees. The system documents land access arrangements between refugees and host communities, reducing conflicts.

Impact: Increased investment in soil conservation by refugee farmers and improved social cohesion in host communities *(UNHCR & FAO, 2023).*

6.4 Civic tech oversight and accountability

Transparency builds trust. The FMAFS should move beyond internal audits to institutionalise Civic tech oversight and engage Nigeria's vibrant civil society ecosystem to audit the registry's performance. This approach aligns with international standards for Digital Accountability, which emphasize maintaining public trust in digital platforms through independent verification and transparency *(World Bank, 2021).*

6.4.1 The watchdog model

The NDFR should publish an anonymised "Open data dashboard" accessible to accredited Civil Society Organisations (CSOs) and media. This allows third-party monitors to verify government claims regarding coverage and distribution [CJIDP].

Best practice

Case study - Combating Illegal Activity through Oversight

Country: Mexico (National Registry of Fisheries and Aquaculture)

Strategy: Registers all legal fishers and vessels to combat Illegal, Unreported, and Unregulated (IUU) fishing. Authorities cross-reference catches at landing sites with registered vessels and their reported areas of operation.

Impact: Significantly improved the monitoring and control of fishing activities, demonstrating how a registry can serve as a tool for regulatory enforcement and transparent resource protection *(Government of Mexico, 2025).*

Metrics: The dashboard will report on system performance (e.g., "Number of grievances resolved," "Subsidy delivery times," "Regional enrolment balance") without revealing personal producer data.
Access: Verified partners can use this data to conduct independent impact assessments, providing additional assurance that the registry meets its stated productivity goals.

6.4.2 Participatory auditing

The governance framework should mandate regular "Data dives" where civic tech partners (e.g., BudgIT, Dataphyte) review anonymised transaction logs to identify exclusion patterns or regional skews.

Validation: This independent validation serves as a check against data politicisation and ensures that the "Sync & Reconciliation" processes described in Section 2.2.4 operate fairly across all geopolitical zones.

Reporting: Summaries of these audits should be presented annually to the National Assembly and the public to ensure continuous improvement and political neutrality.

6.5 Technical reference matrix: Governance and security standards

The NDFR shall adhere to the following standards to ensure compliance with the NDPA 2023 and global best practices

Item	Type	Description and Nigeria relevance	Authority / Link
Electronic Consent	Spec	Digital records of farmer consent (XML/JSON), ensuring compliance with the Nigeria Data Protection Act (NDPA).	DEPA/ORGANS
Blind Intermediary	Architecture	Privacy architecture that prevents data misuse: the registry connects pipes but does not "see" the data payload.	Sahamati
WORM Storage	Spec	"Write Once, Read Many" logs for audit trails, ensuring no official can secretly alter a farmer's record.	NIST
ISO 20022	Standard	Global standard for financial messaging. Mandatory for registry payments to CBN and commercial banks.	NIST
PKI (X.509)	Standard	Cryptographic security for signing credentials, ensuring the authenticity of FMAFS documents.	IETF
ISO 27001	Standard	International security standard ensuring the registry meets global best practices for info security.	ISO/IEC
AES-256 / TLS 1.3	Standard	Military-grade encryption for Data-at-Rest and Data-in-Transit, securing farmer data against cyber threats.	NIST

7: STRATEGIC IMPLEMENTATION FRAMEWORK

(Focus: Institutional governance, capacity, and financing mechanisms)

7.1 Institutional, legal, and governance framework

To ensure the NDFR survives political transitions and avoids the "Project trap" (in which systems die after donor funding ends), it needs to be anchored in an enduring institutional and legal framework. This framework operationalises the stakeholder inclusion and legal alignment mandates defined at the National stakeholders Workshop.

Best practice

Case study - Cross-ministerial synergy

Country: Morocco (National Agricultural Registry)

Strategy: The government integrated the farmer registry directly with the social protection sector.

Impact: Instead of building a separate database for health, the system uses the farmer's registry classification to automatically enroll vulnerable smallholders in the Compulsory Health Insurance (AMO) scheme *(Yahya, 2025).*

A Cross-ministerial Steering Committee: Since the NDFR would have to serve as the unified infrastructure for crops, livestock, and fisheries, promoting cross-ministerial collaboration in the governance of the registry. A Steering Committee, chaired by the FMAFS, will include the Federal Ministry of Livestock Development and the Federal Ministry of Marine and Blue Economy to ensure sectoral alignment. It may also include key enablers such as NIMC (Identity), CBN (Financial Integration), and Galaxy Backbone (Infrastructure) to ensure interoperability. Furthermore, the committee may include the Office of the National Security Adviser (ONSA) and NITDA to oversee cybersecurity and data standards, provide high-level political oversight, and enforce interagency cooperation.

A Multi-stakeholder Governance Board: Trust is built through inclusion. This board would include representatives from the private sector (eg, AgriTechs, FinTechs, or MNOs), farmer associations (AFAN), and civil society. Their mandate will be to review data usage policies and ensure the "User-centric" focus is maintained.

Operational management (functional unit): A dedicated Digital Registry Secretariat could be established within FMAFS. This unit manages the day-to-day technical operations, vendor SLAs, and partner onboarding, ensuring continuity beyond political cycles.

Legal operationalisation (NDPA 2023): Data governance needs to move from policy documents to operational reality. To achieve this, the digital registry secretariat could

establish a Data Compliance Desk. This unit would be responsible for conducting annual privacy audits in strict adherence to NDPA requirements and relevant standards from NITDA (Security), NIMC (Identity), and the NDPC (Privacy). Furthermore, the Desk should ensure that all partners—both public and private—comply with the ORGANS consent framework.

Best practice

Case study - Legislating interoperability

Country: Netherlands (Base Registries)

Strategy: Enforced a "Collect once, use multiple times" legal mandate.

Impact: Required all government agencies to pull data from the central registry rather than re-surveying farmers. This reduced administrative burden and ensured a single source of truth across the sector *(European Commission, 2024).*

Standards enforcement: An Inter-Agency Technical Working Group (TWG) should be convened to enforce the technical standards defined across the five pillars. This holistic enforcement prevents 'Vendor lock-in' and ensures state-level initiatives remain interoperable with the national spine.

7.2 Operational sustainability: Capacity and finance

The NDFR will not be sustained without money and skilled people. This section details the operational requirements to keep the registry "live" and funded.

Extension agent transformation: With a functional NDFR, the role of the extension agent shifts from "*Paper form filling*" to "*Digitally enabled advisory.*" Training curricula should address data privacy, digital device management, and the interpretation of dashboard insights for farmers.

Change management: Transitioning from analogue to digital workflows requires managing resistance. The FMAFS should implement a "Digital champions" programme to identify early adopters within the State ADPs to mentor their peers and demonstrate the value of the new tools.

Public budgeting: The FMAFS needs to secure a dedicated budget line for "Digital infrastructure maintenance" (hosting, security patches, call centre operations), distinct from capital expenditure. This ensures the registry remains live after development partners exit.

Best practice

Case study - Industry-led funding

Country: Australia (National Livestock Identification System)

Strategy: The government transitioned the registry's management to an industry-owned body, Meat & Livestock Australia (MLA), funded by producer levies.

Impact: This ensured the system's financial longevity was not dependent on political budget cycles, allowing it to evolve at the speed of the market *(Meat & Livestock Australia, 2023).*

Cost-recovery models: While farmer access will remain free (zero-rated), the system will monetize the commercial utility provided to the private sector. To this end, the NDFR should introduce tiered API pricing for banks, insurers, and aggregators to consume value-added services—such as credit scoring and KYC verification—generating revenue to offset operational costs.

7.3 Implementation roadmap and impact measurement

To ensure success, the FMAFS should not attempt a "Big Bang" national rollout. Instead, the NDFR will follow a Phased Implementation Strategy rooted in the "*Minimum Viable Product*" (MVP) methodology.

Infrastructure readiness and continuous assurance: Readiness should not be treated as a one-time event. To reduce operational risks, the system requires constant assessment of secure hosting, geospatial tools, and connectivity. The assessment must align with *secure-by-design* principles and use centralised monitoring and analytics for real-time decision-making throughout the rollout.

Phase 1 – Foundation and MVP

Strategic focus: Establishing the "*Data triad*," cleaning existing data, and integrating the Foundational Identity (NIN).
Goal: To create a "*Golden record*" for a limited cohort of farmers (e.g., 250,000) in pilot states, proving the system's integrity before scaling.
Key activity: An "identity-first" validation. Deploy the offline-first mobile app to a small group of trusted intermediaries (e.g., 50 cooperatives) to test the "Trusted node" enrolment model, ensuring that data capture, synchronization, and NIN verification function seamlessly before adding financial services.

Phase 2 – The pilot: Layering services

Strategic focus: Proving value through one high-value loop (the subsidy loop).
Goal: To operationalise the Entitlement Engine and demonstrate that the registry can deliver subsidies (fertiliser/seeds) without leakage.
Key activity: E-Voucher rollout. Distribute digital tokens (QR/USSD) to the pilot cohort and activate the Point-of-Sale (POS) validation app for accredited agro-dealers.

Phase 3 – Ecosystem scale-up

***Strategic focus*:** Opening the Unified Farmer Services Interface (UFSI) to the private sector.

Goal: To transition the government's role from "App builder" to "Orchestrator," allowing banks, FinTechs, AgriTechs, and off-takers to drive further enrollment.

Key activity: Open the API marketplace. Publish the UFSI documentation and Sandbox environment. Accredit the first wave of private sector partners (agri-fintechs) to "plug in".

Best practice

Case study - Managing the Transition at Scale

Country: Indonesia (Kartu Tani Program)

Strategy: Phased the transition from physical fertiliser distribution to digital entitlements. Instead of a "Big bang" switch, they ran the digital system in parallel with the manual one during the pilot phase.

Impact: This phased approach allowed the government to register over 14 million farmers and gradually accredit 30,000 kiosks, avoiding a catastrophic disruption to the fertiliser supply chain *(Government of Indonesia, 2024)*

Monitoring, evaluation, and learning (MEL): NDFR success will be measured by *Outcomes* (service delivery) rather than just *Outputs* (number of registered farmers). The MEL framework should track "*Active use*" metrics, such as the percentage of registered farmers who redeemed an e-voucher and the reduction in detected "Ghost beneficiaries".

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Annex 2 - Catalogue of national case studies

Country	Registry / System	Key Lesson
Argentina	RENSPA	The system tracks animal health to secure beef exports during disease outbreaks.
Australia	NLIS	Industry-led management by the meat association ensures market-speed innovation and premium pricing.
Bangladesh	Digital Ag Platform	The platform integrates IoT sensors for climate advisory and uses offline protocols for remote connectivity.
Bolivia	Collective Titles	The registry documents collective territories to respect indigenous land tenure within the digital system.
Brazil	Cadastro Único	Integrating with the social registry allows "Active Search" strategies to enroll vulnerable populations.
China	Rural Land Registry	The system uses digital "Land Use Rights" as collateral where formal titles are missing.
Colombia	Land Restitution	Documenting abandoned claims facilitates post-conflict restitution and peacebuilding efforts.
Egypt	Nile Water Management	The system calculates water quotas based on registered crop types to optimise irrigation.
Ethiopia	Digital Farmer Registry	Digitised agent workflows reduced workload by 82% and improved advisory quality.
European Union	IACS / LPIS	Aerial photography (LPIS) is used to verify land parcels for subsidies, ensuring zero "Ghost farms."
Finland	Farm Register	A transparent public registry builds consumer trust for "Trusted Origin" food brands.
Ghana	Digital Addressing	Integrated national digital addressing gives every farm a precise, verifiable identity.
India	AgriStack (NFD)	The government promotes an "Open API" ecosystem that enables private partners to innovate on top of the platform.
India	DEPA	A "Blind Intermediary" architecture ensures the registry facilitates service delivery without surveillance.
India	FRUITS (Karnataka)	A federated model links farmer ID to existing land records without centralising data.
India	PM-KISAN	Mandatory e-KYC linked to National ID removed millions of ineligible beneficiaries from subsidy rolls.
Indonesia	Kartu Tani	A phased rollout of digital fertiliser cards prevented supply chain disruption during scaling.
Japan	Farmland Bank	Registry analytics are used to predict aging farmer exits and consolidate land.

Country	Registry / System	Key Lesson
Kenya	KIAMIS	The project started with a simple MVP for identity and fertiliser to build trust before scaling.
Malawi	UBR	Registry data identifies vulnerable households in drought zones to trigger emergency cash transfers.
Mexico	Fisheries Registry	Cross-referencing catch data with the vessel registry combats illegal, unreported fishing.
Morocco	National Ag Registry	Registry classification automatically enrols vulnerable farmers in compulsory health insurance.
Nepal	Offline Logistics	Extension agents use cached tablets to register farmers in remote, unconnected terrains.
Netherlands	AgroDataCube	The government publishes anonymised registry data as a utility for private sector innovation.
Netherlands	Base Registries	Legislation enforces "Collect once, use multiple times," reducing administrative burden.
Pakistan	Rice Registry	A commodity-specific registry protects geographic indications to secure export premiums.
Peru	Rural Registry	Mandated joint-titling for spouses increased women's documented asset ownership to 55%.
Philippines	RSBSA	The system overlays typhoon paths with farm polygons to trigger rapid, automated insurance payouts.
Rwanda	Smart Nkunganire	A digital entitlement engine eliminated ghost beneficiaries and improved input distribution speed.
Scotland	ScotCh Beef	The system verifies age and origin of calves to maintain premium export status.
South Africa	Free State Register	A public registry platform connects registered farmers directly to bulk buyers.
South Korea	NACF Registry	The cooperative uses production history to pre-approve equipment loans without physical collateral.
Tanzania	M-Kilimo	The system partners with mobile operators to use mobile money history as a credit proxy.
Thailand	Smart Farmer	The platform identifies production clusters to help processors set up contract farming.
Turkey	National Farmer Registry	Data-driven targeting of subsidies delivered a 10-15% increase in agricultural productivity.
Uganda	Farmer Registration	Flexible protocols allow the inclusion of refugees and IDPs in national systems.
Uruguay	SNIG	Mandatory livestock tracking ensures 100% sanitary compliance for high-value beef exports.

Country	Registry / System	Key Lesson
Vietnam	Farmer Database	Cooperatives use aggregated member data to negotiate bulk discounts on inputs.
Zambia	ZIAMIS	A single registry mandate reduced beneficiary duplication across donor projects to less than 5%.

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Implemented by: