An Integrated Food Sustainability Operating System (iFoodSOS)
for Sustainable Food Security

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Executive Summary

A Food System encompasses actors and their interlinked value-adding activities in the production, aggregation, processing, distribution, consumption, and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded. The impact of the Russia/Ukraine War on agriculture has been the puncturing of the global Food System. If a data-driven Global Food, Observatory Platform were to exist, to bring together countries, as actors in the Food System, the realization of an optimized food economy would be possible. Such a food economy would employ a harmonious and intelligent data ecosystem with a strong emphasis on the engagement of data actors.

Achieving this harmonious ecosystem calls for an Integrated Food Sustainability Operating System (iFoodSOS). The iFoodSOS is a Blockchain driven data intensive approach to capture, validate, and store, transactional data, creating a data exchange for use amongst global stakeholders in value-adding activities, intelligently and analytically supporting the deployment of data use processes that yield the much-needed digital innovation. The analytics creates precise reports and insights for informing policymakers and agricultural actors who constitute the much-needed secure food economy.

The iFoodSOS will analyze activities involved in transitioning food products from pre-production; production; harvesting, post-harvest handling; processing, and distribution; ending with nutrition-driven consumption where the impact wellness comes in as wastages are managed. The Global Open Data for Agriculture and Nutrition (GODAN) promotes the use of Findable, Accessible, Interoperable, and Re-usable (FAIR) data, which is the bedrock of the Integrated Food Sustainability Operating System that promotes the co-creation efforts; of data use case actors, involved in the World Bank Group supported Food Systems Observatory Platform. Data sourcing in iFoodSOS-data use case development and support and the design thinking-anchored decision-making guides the GODAN Framework. The Framework extensively assesses the stages of the Food System, where Africa serves as the initial geographical focal point, with a kick-off pilot in Kenya. To actualize the framework, a think-tank of researchers and agile-driven experimenters engaged in the modeling of different use cases across the agricultural value chain shall provide the basis for interaction with the iFoodSOS.

To ensure that a recurrence of food challenges wrought by the ward do not recur for Africa, the iFoodSOS will integrate the critical effort of the [Country Agribusiness Partnerships Framework (CAP-F)](#) to link agribusiness value-chain players while realizing the CAADP-based NAIP. The iFoodSOS, therefore, operationalizes each country's national medium-term plan, and articulates the implementation of the AU inspired sectoral strategies. In Kenya, the Agricultural Sector Transformation and Growth Strategy (ASTGS) spearheaded by the Ministry of Agriculture, Livestock, Fisheries and Cooperatives (MoALF&C)'s Agricultural Transformation Office (ATO), will domesticate the iFoodSOS, and deliver data and associated use cases as a digital public good through
- A standardized data and M&E framework to measure programmatic baselines for agricultural production; and
- Open source software to support the adoption of the standardized data framework.

The iFoodSOS shall be the anchor data use case to house the framework for aggregating data from multiple data producers in the Food Systems, birthing a harmonious ecosystem of data actors, and data consumers alike, within the agricultural sector. Using iFoodSOS, decision-makers at national and continental levels in NEPAD will efficiently make decisions with optimized analytics and data exchange that the operating system will provide.

The iFoodSOS formulation will use an evolving needs approach and employ the agile methodology that involves the capture and use of key food systems data points. A team composed of policy actors in Health and Nutrition, Agriculture, Education, Planning, and Research at policy level, together with Academia, the Private Sector, Development Partners, and Farmers at national and subnational levels, will work with digital data experts to actualize the iFoodSOS. The data experts will draw from practicing technologists in Blockchain, Data Science and Data sourcing, Artificial Intelligence, Software Engineering, and organizational reengineering.

This will make the GODAN-inspired iFoodSOS to be rich with innovation and practicability in addressing real-world challenges in the demand and supply continuum that provides a window of access only to authorized data users, and acknowledged data owners, as per the [Digital Green FarmStack](#) Data Access Protocol.

FarmHub/FoodFarmacy Economic Microcosm

In order to harness the iFoodSOS elements consistent, delivery of the right quality of food to the household needs to be put in place, thereby calling for household planning that rarely happens in most communities. A capacity-building paradigm that promotes planning at the household level that cascades into planning at higher levels results. This will ensure that when excess production or deficits, occur in inputs or cereals as has happened due to the ongoing war the household level will trigger a digital message to the right levels with areas of excess storage releasing produce to the areas of deficits. The aggregated household position presents higher administrative levels with a measured food position whose condition changes when deliberate investments in storage infrastructure happens. At the heart of this measurement is the identification of individuals in households and their contribution to the family goals. The capacity-building programme that brings together families growing the same commodity, or livestock, to plan, and learn, about the delivery of a joint vision of their common agricultural undertaking creates opportunity for joint learning using an appropriate household learning methodologies for the shared vision. The delivery of such a programme happens using local people and with multiple outcomes in mind which the GODAN's Programme for Capacity Development in Africa (P4CDA) has formulated through the GODAN Champions Agribusiness and Marketing Cooperative Society. This uses localized *FarmHubs*, and *FoodFarmacies*[1], to support a holistic co-creation of visionary farmers', and/or family, goals on health, nutrition, education, income, etc.

FarmHubs/FoodFarmacies support data capture at the household level thereby promoting a jointly owned agribusiness links of farmer's produce to consumer markets. It also supports the aggregation, which promotes economies of scale in procuring inputs, services, and markets. The capture of records then becomes beneficial to the household, which then delivers beneficial outcomes to planning at the household level as well as upstream at the ward, county, and national levels. This further promote the food, nutrition, and economic dimensions using the cooperative-based value chain agenda, for data-driven analytics that makes understand/response to the needs of farmers in cooperatives possible. This promotes the capacity of the cooperative to attract new members; and hence a vehicle for joint investments and engagement with policy institutions legal entities which generates tax revenue from multiple wards/regions promoting the necessary measures for macroeconomic level revenue planning.

The forgoing market-driven capacity building, with an avenue for engagement with policy institutions, presents a pathway for development programmes of governments and partners to; effectively-participate in strengthening farmer-based organizations. This creates avenues for investing in food and nutrition security infrastructure, which then gets coordinated using the iFoodSOS, whose value gets to be more visible and appreciated, particularly during crises associated with epidemics or wars, as is currently the case. Such investment helps promote farmer-driven investment in processes and systems for aggregating transactional data at pre-production, production, harvesting, post-harvest, value addition, distribution, and nutrition anchored consumption for accuracy within the value chain layers thereby promoting grassroots-driven, aggregated, economic planning.

The common practice in agricultural discourse is to; always mention markets since agricultural produce in many cases wastes in the hands of producers, without creating a framework for consumers to link directly with their producers. This creates the case of a farmer identification system, without which, the assessment of the need for farm inputs, services, food, and nutrition; as well as assessing their incomes to guide the application of incomes for investment is not possible. A model for reaching the farmer on what they need to do, with a message from consumers, on nutrition demand is necessary to inform targeted messaging on the production of foods and feeds. This increases the potential for measuring consumer-orders linked incomes without undue engagement of market intermediaries, who at times inflict food quality challenges to the food system.

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[1] The FarmHub and FoodFarmacy concept is explained in the next page

Since each country and/or region has its own operating models of supporting agriculture, there is a need, to assess existing capacity of actors in the diverse value chains within the food systems from funding, technology, staff, partnerships, etc. GODAN's P4CDA has evolved a sectoral transformation model with clearly defined socio-economic pillars that help assess and/or promote the creation, and support, of i) a **Structural** framework, behind which ii) evidence or data-driven **Strategic** agenda integrates. This is backed by iii) a **Systems** thinking, that drives an adaptive iv) **Staff,** who consistently require to update their v) **Skills,** which only a localized and focused vi) leadership **Style** can support for vii) **Shared** value, to participatorily leverage local resources and innovation of the people, viii) for **Sustainability**. Figure 1 therefore presents the Kiringai's 8Ses, commonly called the GODAN's K.8Ses for promoting sectoral transformation at the national, subnational, and regional levels.
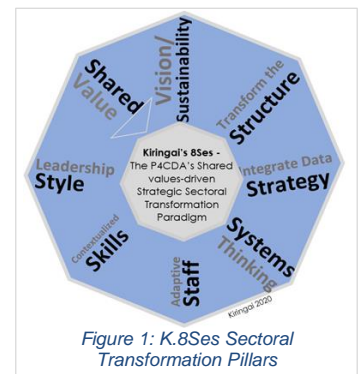

Figure 1: K.8Ses Sectoral Transformation Pillars

The FarmHub/FoodFarmacy Model

The GODAN P4CDA has been working with the Communication Commission to explore how its model of the FarmHub/FoodFarmacy can help drive investment in the infrastructure in the ICT space. Out of the engagements, the focus on the Kenya Ministry of ICT (MICT) ICT Masterplan 2022-2032 has come to define the growth areas in the digital space to be the delivery of Ward level infrastructure using ICT Hubs. MICT, therefore, seeks to create 1,450 Ward-based ICT Hubs for youth-based innovation engagement to revamp its existing fiber infrastructure. While the ministry can deliver the fiber infrastructure, the physical infrastructure to host the ICT hubs would require an investment that would present a challenge for a government-only rollout. GODAN's P4CDA model of the FarmHub and FoodFarmacy, therefore, leverages private sector-driven household investment in assets, expertise, capabilities, and resources so much needed at the MICT Ward-based Hubs. Seed funding from development stakeholders including development partners therefore needs to help create a Social Impact Investment Bond (SIIB), a key element to make FarmHub/FoodFarmacy investments possible. This can help local people as producers, or consumers, who do not have the lump sum investment making households, fail to create the FarmHub/FoodFarmacy investment envisaged in Figure 2.

Support for the MICT agenda dovetails the GODAN Programme for Capacity Development in Africa (P4CDA) work, which has since 2018 established the FarmHub/FoodFarmacy framework to anchor the GODAN Champions Agribusiness and Marketing Cooperative. The cooperative was a pilot of the GODAN Action project of the CTA in Kangema, Murang'a that anchors the FarmHub/FoodFarmacy initiative. It promotes the transformation of community engagement by combining ICT technologies with economic development paradigms using an agricultural value chain dimension and integrating youth/private sector innovation. The FoodFarmacies provide the demand end of the economic system. We present the FarmHub/FoodFarmacy framework in Figure 2 below:

Figure 2: FarmHub/FoodFarmacy Implementation Model

The model promotes the adoption of a framework for farmers' investment in physical infrastructure to link consumers, to farmers, using a co-created digital logistics infrastructure for raw, or value-added, produce. The value-added production with localized investment in a common manufacturing facility owned by local shareholders is integral to the FarmHub. It encourages local people or those in the diaspora, with financial linkage and diverse income sources to invest in the data-seeking infrastructure of community agribusiness, which iFoodSOS will transform, or establish anew. P4CDA will work with communities to promote a social Impact Investment Bond (SIIB) guarantee by governments, implemented through the county governments, and supported by development partners, or private sector foundations.

Connecting the Dots - Leveraging Existing Initiatives

A great many initiatives exist with a focus in supporting the food system. Many of these initiatives however fail the framework test of the K.8Ses driven integration; because they exist in silos, which makes actionable data sourcing a challenge. In creating the digital framework behind GODAN P4CDA's FarmHub/FoodFarmacy, the consideration anchors on the diverse efforts of governments, development partners, farmers, consumers, researchers, and academics, with value chain roles played by a private sector that has for long reaped where the farmers' plant, without paying the farmers for it. This scenario promotes the need to infuse the iFoodSOS.

The genesis of the FarmHub/FoodFarmacy model, as a structural foundation to infuse the iFoodSOS, prompts the digital thinking to address the high poverty levels of producers and the unaffordable high prices of food, and feeds, to consumers. The poorly optimized supply chains call for a Blockchain technology, which has not existed before, and which, if tapped now, drives equity to the supply chain, while driving traceability within the food system. This human-centered thinking prompted the P4CDA design of a hands-on collaboration with academia, youths, government, and development partners to explore how best to address the food and nutrition challenge.

GODAN's mandate, which promotes the creation of networks of knowledge workers and organizations involved in actions that promote access to data, information, and the commensurate decision-making capacity, and deriving from an innovative use of data through analytics, drives the creation of use cases that help realize global goals. GODAN's search for partners notes that grassroots organizations that host and own data, presents opportunity to development programmes. This focus on data sourcing frameworks and technologies promotes the desire by the World Bank to use the GODAN frameworks to address the global food security agenda, more so addressing value chain investment through data seeking FarmHubs and FoodFarmacies. This advises promotes evidential decision trail on nutrition actions, associated with agriculturally produced foods.

The evidential dimension of the GODAN effort illuminates the agenda of the World Bank Group's Global Food Systems Observatory Platform initiative behind which the creation of the iFoodSOS anchors. The OS promotes the use of digital identification of supply chain actors. It anchors on the structures that the pilot site in Murang'a County, promoted through GODAN Champions Cooperative. The cooperative emerged from the P4CDA effort in empowering farming and capacity building efforts at the household level. This provides hope that an end-goal of integrating the diverse efforts existing in farmer associations and their linkage to market/legal systems is possible. The proposed actions to connect the dots are as listed in the table below:

1. Regional Assessment and Geo-ecological Agricultural Mapping	Every region has its own potential that anchors on its geo-ecology. Assessment for crops best suited to the soils and climate of regions will guide the GODAN Data Cube anchored regional zoning based on the socio-economic potential of such crops, or livestock. This guides investments.
2. Assessment of existing Farmer/Nutrition support Organizations	Enormous investments have created grassroots farmer organizations, but governance failed due to a lack of transparency and systems. GODAN's P4CDA K.8Ses infuses governance in existing cooperatives (or other associations) seeking to drive the FarmHub/FoodFarmacy agenda such as *Ndumberi Dairy, Data Transformation Committee of the MoALF&C, ATO, Boehringer* Incubation initiative, etc.
3. Exploring youth engagement in extension	P4CDA formulates Youth-Led Extension and Advisory for Development (YouLead) initiatives that support agriculture and sustainable development actions using a TVET supported programme through the **Impactathon School of Agriculture** and other government and private TVET initiatives

4. Integrating nutrition, health, and agriculture to data sourcing	Jointly with the Ministry of Education, P4CDA is evolving a Health, Experiential Education, Agriculture, and Nutrition for Data Sourcing (HEEANDS) curriculum to promote agriculture; using knowledge and nutrition dimensions. Nutrition and health drive food production, yet this does not happen. We shall explore what FarmHub/FoodFarmacy can help change through iFoodSOS.
5. Integrating academia and research to promote sustainability	In a region where agriculture drives economic development, academics should promote sectoral engagement by making faculty examine their students experientially through agriculture, health, and nutrition. GODAN's partnership with universities creates Centers for Agriculture and Nutrition, Data Analytics, and Innovation (CANDAI) to promote policy impact. Murang'a University has established a School of Agriculture anchored on CANDAI
6. Innovations-driven Data use cases for iFoodSOS	The FarmHub/FoodFarmacy frameworks drive the market agenda for agriculture. The iFoodSOS brings together co-creators of data use cases who benefit from aggregated data from diverse sources of research, academia, farming, and policy actions. Transactions in the food systems anchor delivery of measureable, digital identity-driven transactional engagement for traceability supported by youths, research, and/or academia-driven use cases develops as applications or decision support platforms.

Implementation of the Integrated Food Sustainability Operating System (iFoodSOS)

The integrated Food Sustainability Operating System will be the driving engine towards food security. iFoodSOS adopts an umbrella approach that houses data use cases produced by all data actors involved. The primary objective will be creation of a unified view of the Food System for all actors involved. This bird's eye-view shall empower data actors in the Food System, to:
- Perform automated analysis of data to achieve food sustainability; and
- Be a catalyst for a harmonious system of data actors involved in Food Systems.

The end result will be a digital good that applies FAIR principles to achieve food security.

Adoption of FAIR Principles by iFoodSOS

Principle	Adoption in iFoodSOS
Findable	iFoodSOS shall adopt inclusive media and tools to support widespread reach.
Accessible	iFoodSOS components should be multiplatform to support widespread adoption.
Interoperable	iFoodSOS should adopt open standards to allow for inter-sectoral applications.
Reusable	iFoodSOS should encourage additional use cases to be built on it as an open system.

Features of the iFoodSOS

Feature	Description
Data Capture	This entails the ability to collect data in its most raw form from a data actor.
Data Validation	Data collected will be cleaned and its authenticity ascertained.
Secure Data Storage	iFoodSOS shall possess secure facilities for storage of data collected.
Data Analysis	Data handled by iFoodSOS should be interpretable in a clear format to convey meaning.
Reports Generation	Stakeholders who rely on iFoodSOS shall create reports from analyzed data.

Software Architecture of the iFoodSOS

The iFoodSOS derives from the operating system model applied in computers to avail a platform where different programs can leverage a shared environment to implement a myriad of use cases. According to the National Institute of Standards and Technology of the United States of America (NIST), an Operating System is software that runs the computer and is the first program loaded when a computer comes on. To actualize an operating system (OS), a kernel must be present at all times to give life to the system's memory. As such, developers build applications to communicate

with the operating system, thereby extending the capabilities of the computer in a harmonious interaction between hardware and software.

Understanding Components of the iFoodSOS

The iFoodSOS mimics the computer operating system to deliver a harmonious engagement of actors who leverage data in a smart way hence delivering a FAIR system to guarantee Food Security. The integral components include the following:

| iFoodSOS Components	Description
Africa	The environment where GODAN will deploy iFoodSOS
Kernel	Technical components that iFoodSOS requires as a minimum to come to life.
The Blockchain	Data immutability component to guarantee true data on iFoodSOS.
Data Actors	Key stakeholders that inform data behavior across the key stages of the Food System.
FarmHubs	Farmer facing component that informs data collection at the Cooperative/Household level.
Food Farmacies	Consumer facing component that informs data collection at the Market level.
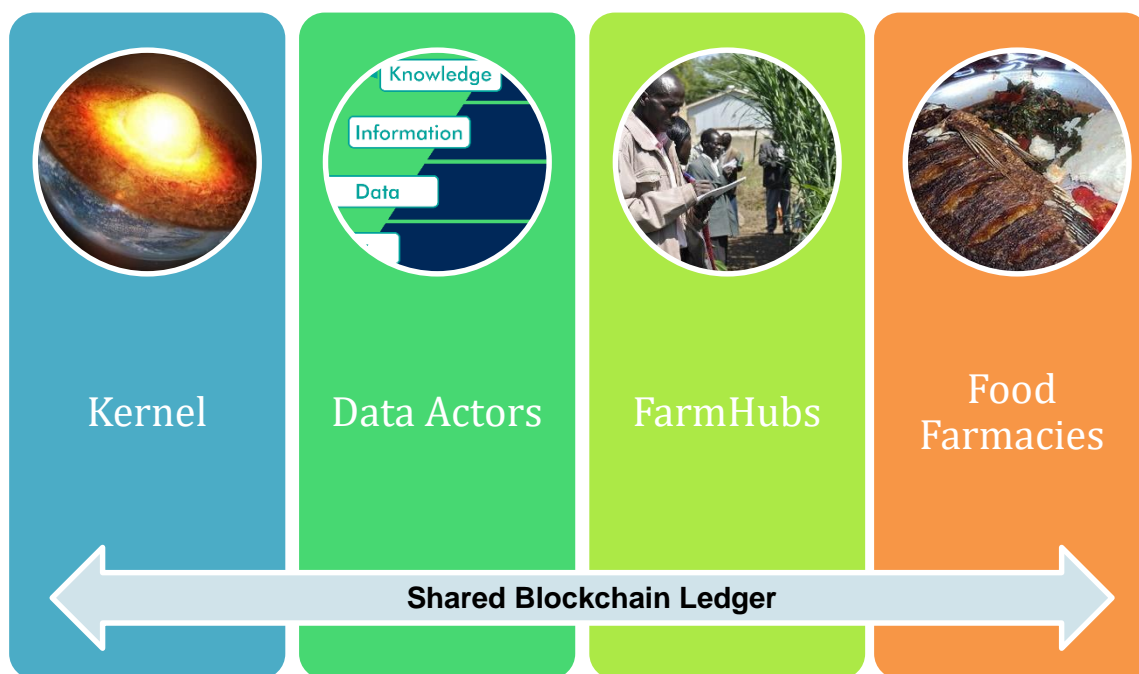
Figure 3: Integrated Food Sustainability Operating System (iFoodSOS)