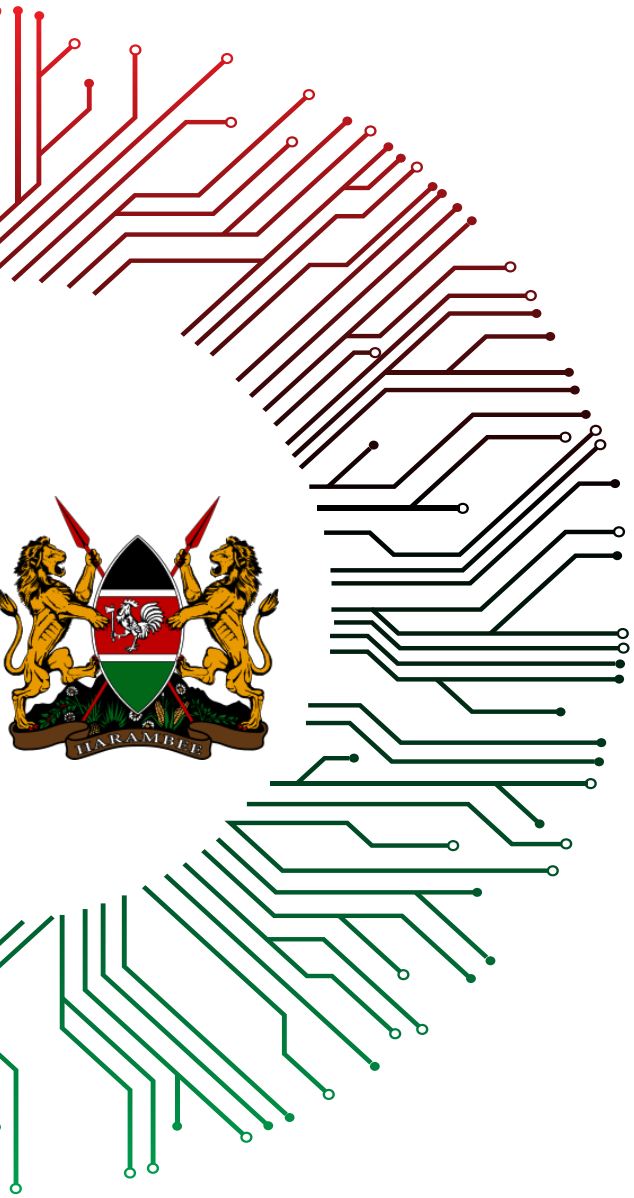


Digitization and Coordination of Kenya's Agricultural Sector Data

Implementing the Agricultural Sector Transformation and Growth Strategy (ASTGS) – Flagship 8 on data and innovation

Last updated Jul 8, 2019

Ministry of Agriculture, Livestock, Fisheries and Irrigation

Full report

ACRONYMS

AGRF	African Green Revolution Forum
APIs	Application Programme Interface
ASDSP	Agricultural Sector Development Support Programme
ASTGS	Agricultural Sector Transformation and Growth Strategy
ATO	Agricultural Transformation Office
D4Ag	Digital for Agriculture
ESPs	Extension Service Providers
FEWS NET	Famine Early Warning Systems Network
GIEW	Global Information and Early Warning System
GoK	Government of Kenya
GODAN	Global Open Data for Agriculture and Nutrition
IoT	Internet of Things
JASSCOM	Joint Agricultural Sector Steering Committee
KALRO	Kenya Agricultural & Livestock Research Organization
KAOP	Kenya Agricultural Observation Platform
KCSAP	Kenya Climate Smart Agriculture Project
KCEP-CRAL	Kenya Cereals Enhancement Programme – Climate Resilient Agricultural Livelihoods Window
MOALFI	Ministry of Ag, Livestock, Fisheries and Irrigation
MoICT	Ministry of Information and Communications Technology
MoITC	Ministry of Industry, Trade and Co-Operatives
NAAIAP	National Accelerated Agricultural Inputs Access Programme
NAIP	National Agriculture Investment Plan
NARIGP	National Agricultural and Rural Inclusive Growth Project
PLEWS	Predictive Livestock Early Warning System
RATIN	Regional Agriculture Trade Intelligence Network
RCMRD	Regional Centre For Mapping Resource for Development
SFRTF	Strategic Food Reserve Trust Fund
SQL	Structured Query Language
SSF	Small-scale farmer
TVET	Technical and Vocational Education and Training
WEF	World Economic Forum
ZIAMIS	Zambia Integrated Agriculture Management Information System

TABLE OF CONTENTS

Note: As per guidelines from the Ministry of Agriculture, Livestock, Fisheries and irrigation style guide, spelling across this document follows Oxford English Dictionary (OED) conventions (i.e. organization, industrialization)

EXECUTIVE SUMMARY

The goal of Kenya's Agricultural Growth and Transformation Strategy (ASTGS) is to create a vibrant, commercial and modern agricultural sector that supports 100% food security in the context of devolution. Data and digital solutions play an important enabling role in this transformation, and should support the sector to achieve its primary objectives: to (1) *increase small-scale farmer, pastoralist and fisherfolk incomes for ~3.3mn households and impact ~15mn Kenyans*[i]; (2) *increase food available year round by unlocking >500,000 acres of agricultural production and agro-processing across priority value chains*[ii]*; (3) boost household food resilience and reduce the number of food-insecure Kenyans to zero*[iii].

The expansion of agriculture technology and digital for agriculture (D4Ag) solutions has the potential to dramatically improve agricultural, income and livelihoods. Kenya is at the forefront of digital innovation and technological adoption in Sub-Saharan Africa (SSA), and is already home to more than 100 distinct D4Ag solutions (~25% of all D4Ag solutions identified in SSA).[iv] Despite the abundance of D4Ag solutions in Kenya, many of them struggle to scale, and do not sufficiently add value to the end users – including farmers (i.e. most applications have <30% active users).[v]

Successful digital solutions address both digital and non-digital barriers to scale. Government has an important role to play in this ecosystem, particularly for solutions that operate like public goods by investing in middle ware (e.g., farmer registers – including of livestock and digital agronomy data), and accelerating implementation of forward-looking data policies (e.g., data privacy, drone commercialization). This work focuses on digital interventions that government is well placed to champion and drive, not solutions that the private sector and other players can implement successfully themselves.

Accordingly, the Ministry of Agriculture, Livestock and Fisheries (MoALFI) has identified seven priority digital use cases aligned with the primary ASTGS outcomes. A use case is simply a project with a clear beginning and end that applies digital or advanced analytics solutions to achieve a measurable benefit. The use cases are designed to be stand-alone but interoperable with their own costs, target impact metrics, and timelines to implementation.

Increase small-scale farmer incomes

Use case 1: **Target eligible farmers with e-incentives by accelerating farmer registration process**, and use analytics on performance (e.g., yield) to improve the incentive scheme. This solution uses digital tools (e.g., e-voucher) to identify the right

[i] Incomes are currently ~KES 400/day (~KES 145k/yr) -- FAO Family Farming Data Portrait data. Without a transformation, could grow to 170k (~KES 465/day) by 2023 based on historical trends. Transformation estimated to contribute an incremental ~35% to 229k (~KES 625/ day)

[ii] Equivalent to ~KES 400Bn GDP boost across economy in 5 years

[iii] 2.7m is the average between the chronically food insecure population (~1.3m in ASAL), and those who are food insecure during emergencies (~4m). Zero food insecure people assumes 100% coverage of the average food-insecure population (taking % of population that is food-insecure from 2008-2017 and extrapolating to the 2022 population)

[iv] Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

[v] Ibid

farmers, distribute and monitor performance of the national e-incentive scheme proposed in ASTGS. The tool will increase the likelihood that nationally issued farmer subsidies reach the farmers most in need by eliminating arbitrage opportunities in the current system including: (1) a digital farmer register managed by MoALFI; (2) e-vouchers that allow Treasury to send funds directly, and empower farmers to spend it on inputs of their choice with appropriate guidance from extension officers; (3) and finally traceability to ensure that agro-dealers are paid in a more timely fashion for non-counterfeit goods.

- *Target impact by 2023:* register 1.4m farming HHs, and ~2,300 agro-dealers
- *Annual cost: ~KES 0.5B for solution (~1.2B total by 2023)*[vi]

Use case 2: **Improve farmer practices** including input use and optimal planting and/or harvest time through **customized e-extension** that incorporates current and predictive data (e.g., weather analytics, pest/disease trends, yield, pricing). This solution effectively expands the farming practice resources available to farmers, by equipping a wide range of Kenya Agriculture and Livestock Research Organization (KALRO) vetted Extension Service Providers (ESPs) with access to a searchable portal of Kenya's 20+ digital agricultural information solutions, that they can curate when they meet with farmers. ESPs are incentivized to log their farmer visits onto the platform to help improve the service and allow MoALFI and KALRO to mine helpful data for decision-making. ESPs include extension officers, village-based advisors, private sector field officers, model farmers and even entrepreneurial youth like members of the 4-H foundation.

- *Target impact by 2023:* assist >0.5m farmers per year, and register a total of 2,300 extension service providers
- *Annual cost:* KES 50M (~KES 280M total).

Boost household food resilience

Use case 3: **Monitor emergency food reserve stocks using a more robust national Food Balance Sheet (FBS).** This solution calls for digital inventory monitoring to track government stock (e.g., 1D barcodes), satellites[vii] to collect accurate production data, proxies for informal / fraudulent trade (e.g., tax and customs receipts), and finally predictive analytics to generate future stock needs. A more robust FBS will help MoALFI and the Strategic Food Reserve Trust Fund (SFRTF) to reduce food shortages during emergencies through better informed decisions on stock location, and advanced planning for future quantities of stock required. It will also reduce the cost of procuring stocks under duress.

- *Target impact by 2023:* Identify opportunities to reduce volatility in stocks purchased for SFR by 50%[viii]
- *Annual cost:* KES 0.2B by year 3. Total cost ~KES 0.7B,

vi An additional ~KES total 8.4B is required for the actual e-voucher disbursement (of which anticipate that the existing KES 5B p.a. in NAAIAP and other programs will be repurposed), and ~KES 5B for farmer and extension agent registration which is partially covered in KCSAP.
vii Publicly available (e.g., NASA), or contracted from private sector provider
viii 2016-2018, volatility was >70% (SD/mean volume purchased of maize), compared to ~30% 2013-2016

Use case 4: **Make more dynamic trade and price stability decisions using an Early Warning System (EWS) for food price inflation.** This solution integrates data with early warning components (e.g., production, meteorological, soil quality, pest and disease trends, trade, FEWS NET etc), to indicate likely changes in the price of food -- including maize flour, milk, and rice to start. An EWS for price inflation will provide a single-source of information on food price inflation, and help MoALFI, the SFRTF and Cabinet make more cost effective and targeted interventions to trade commodities and stabilize food prices in good time with less distortion to market mechanisms (e.g., trade on futures contracts in advance vs. use emergency reserves to curb escalating prices in the moment).

- *Target impact by 2023:* Identify opportunities to reduce volatility in food prices by 50% to match regional averages
- *Annual cost:* KES 8M in maintenance by year 3. Total cost ~KES 40M

Use case 5: **Improve value chain selection using an agricultural land optimization model that responds to specific outcomes** (e.g., protect and or/ boost yield), with a focus in ASAL areas where droughts will likely worsen in the coming years. This solution models various potential scenarios of land use based on several layers of information including environmental data including soil pH, economic data e.g., export potential, and any local constraints in switching (e.g., presence of market infrastructure). A land optimization model will help MoALFI and the agriculture executives in ASAL counties select and allocate the highest potential value chains to very specific areas of land within their geographies during the ASDSP value chain selection process. Once can repurpose the tool for other objectives in the future (e.g., predict crop failures).

- *Target impact by 2023:* Identify value chains with potential to double small-scale farmer yields
- *Annual cost:* KES 120M by year 3 when in all 30 ASAL counties. Total cost ~160M

Cross-cutting support

NB: The following two use cases do not have individual target outcomes. They are generated using the above five use cases as a baseline.

Use case 6: **Support M&E using a dashboard that streamlines data collection, verification and visualization of ~10 outcome focused transformation KPIs** linked to the above use cases. More than 10 visualization efforts exist today that capture Kenya's agricultural sector data from >200 data sets. But many of them are inactive or outdated because the cost of maintaining them with their current scope is too high. This dashboard is a simple tool that MoALFI can manage and is focused on the KPIs that MoALFI Senior Leadership use most often to make decisions (e.g., level of post-harvest losses). Once streamline the data collection, aggregation and validation of these ~10 KPIs, can then cascade the approach within MoALFI and to the counties. Can also then roll-out a more granular back-end project tracking tool that builds in the process indicators and milestones that support the outcomes visualized on the front-end dashboard.

- *Annual cost:* ~KES 20M (total cost ~KES 50M),

Use case 7: **Establish standards and protocols for shared-access national agriculture data platform,** using the above data (uses case 1-6) as the baseline. **Start with GoK data, then expand to include private sector data.** Users with access to the platform can create new knowledge and insights for their interventions from massive volumes of interoperable data that they would not otherwise be able to access cost-effectively (e.g., Zambia's Agriculture Management Information System – ZIAMIS).

- *Annual cost:* ~KES 20M, all already World Bank under KCSAP

These use cases are designed to be fully interoperable – to connect and exchange data in an organized way, within and across organizations, regardless of the data's origin or destination. The appendix defines how to acquire different data sets from multiple sources onto a common platform, assesses the ability of GoK institutions to integrate with each other and provides governance guidelines around security, data polices and standards. Ultimately, the Kenya National Bureau of Statistics (KNBS), and KALRO emerge as leading institutions in the sector for MoALFI to partner with to set security protocols including secure search, data management policies including who has access to data and data centres, and other standards for data quality including publishing a data dictionary.

MoALFI will also need to partner broadly with other public institutions to tap into their collective capabilities to collect, integrate, analyse and distribute data. In particular, MoALFI needs access to a data architect, data scientist, data engineer in addition to the subject matter experts in the various state department Agriculture Statistics Units. In the short-term, MoALFI may need to hire short-term support and/or seek secondments from MoICT. However, in the medium-term, it is critical to build these skills at (1) the national level through formal training, field work and on-the job coaching; (2) the county level – particularly for data collection through technical training and certification, experiential learning (e.g., refining ToRs with private sector solution providers), and train-the-trainer models where higher capacity counties help train others.

The Kenya Agricultural Sector Results framework identifies the key outputs, outcomes and impact that the use cases align to, and is calibrated for Vision 2030, CAADP, the SDGs and other commitments. ASTGS aligns with this framework, and the use cases directly support its implementation, with use case 6 *(the visualization dashboard)* providing a focused set of ~10 KPIs to manage and streamline M&E processes overall. However, it is important for the private sector technology solution providers to also track and confirm the progress of each use case (e.g., demand via number of data requests), and be measured accordingly.

Finally, the Agricultural Transformation Office (ATO) is the proposed delivery mechanism for the use cases, facilitating delivery teams comprised of government, private sector and development partners who have specific technical knowledge or the authority to allocate funding towards implementation. The delivery teams should meet

monthly, and act as advisors to the Cabinet Secretary and Chief Administrative Secretary (CAS) who will chair the ASTGS Steering Committee every ~8 weeks.

1. THE DIGITAL FOR AGRICULTURE (D4AG) LANDSCAPE

The amount and variety of data being generated in the world is unprecedented, creating vast new opportunities for businesses and governments that can tap into data insights for decision making. More than 90% of the data that exists today was created in the last two years, and the digital universe is expected to double every two years.[ix1,2] For users of data – from the government to farmers – the key question is no longer "what data", but "data for what"? See *Box 1* for key definitions.

Box 1 – Key definitions

Advanced analytics: Use of advanced techniques (e.g., machine learning) to generate insights for better decision making. These insights would be impossible to replicate in scale, accuracy or scope with conventional methods (e.g., linear regressions, agricultural statistics and other forms of market intelligence). *See Appendix 1 for more details.*

Big data: Aggregated very large data sets (including internal and third-party data) in a combination of different data types (e.g., structured, unstructured).

Digital:

- Electronic technology that generates, stores and processes data in binary terms that can be quickly processed by a computing device. Compared to analog technology that conveys data as electronic signals of varying frequency.
- Increasingly, users of digital, particularly in government use a broader definition that goes beyond the use of a technology, to consider: (1) the *capabilities* required to build citizen and business facing innovations (e.g., E-citizen portal), and (2) the *enablers to innovation* across government systems (e.g., Kenya Open Data Initiative).

Digitization: The process of changing information from analog to digital form (e.g., shift manual records of agricultural statistics to a digital format).

Digitalization: The use of digital technologies to change an organizational process to identify new sources of value and/or revenue (e.g., automation in the work place, moving extension delivery to online/mobile platforms).

Digitalization for Agriculture (D4Ag): The use of digital technologies, innovations, and data to transform business models and practices across the agricultural value chain to achieve greater income for small-scale farmers, improve food and nutrition security, build climate resilience and expand inclusion of youth and women in the sector.

Digital Transformation: A continual process where organizations adapt to, or drive disruptive changes using digital tools in their customers and markets, improve

ix Digital universe growth is measured in terms of zettabytes, projected to grown 25% p.a. between 2009—2020 (IDC, 2014)

operational efficiencies and boost organizational performance (e.g., MoICTs Digital Blue Print).

Middleware: Also known as digital for agriculture infrastructure. Includes agriculture sector specific data, hardware, and software that digital solutions in agriculture rely on to source information and deliver services to farmers and other agriculture intermediaries (e.g., farmer registries, pest and diseases databases)

Use case: A project (i.e., a clear beginning end, with a pilot to test and measure impact) that applies advanced analytics to achieve a measurable benefit (e.g., selecting high-potential value chains using a predictive land optimization model).

SOURCE: Adapted from Gartner's IT Glossary[3]; CTA / Dalberg – Digitalization of African Agriculture, 2019; McKinsey Analytics Platform; McKinsey.com[4]

Food systems the world over are decades behind other sectors in adopting digital technology and innovation. Globally, since 2010, ~USD 14B has been invested in food systems start-ups, compared to ~USD 145B in Healthcare.[5] The complexities of the agriculture and food sector have historically prevented these innovations from happening – from low farmer productivity due to inadequate infrastructure, information and financial inclusion, to the lack of transparency along supply chains that reduces consumer trust. Further, agricultural data and statistics are required for innovation to flourish, but accurate agricultural data can be difficult to collect and agricultural sector baselines are at times contentious. For example, the number of formally employed agricultural workers is ~330,000 but farmers deriving most of their income from farming is much higher at ~8.6 million.[6]

However, the expansion of Digital for Agriculture solutions (D4Ag) has the potential to transform the sector and improve farmer production, income and livelihoods– from mobile service delivery that can reduce food losses by 2-5%, to big data for insurance that could increase farmer income by up to 2%.[x7]

Players and opportunities in the D4Ag space

Kenya is at the forefront of the digital for agriculture space in Sub-Saharan Africa – more than 25% of the ~400 active and distinct solutions identified are in Kenya.[8] These solutions can be grouped into five areas – financial services (15+), market linkages (20+), supply chain management (10+), advisory and information (20+) and data analytics and intelligence (10+). The D4Ag space is developing rapidly, ~60% of these solutions have come online in the past three years. Nonetheless, each category has headroom to improve and offer more tailored solutions for end-users (e.g., integrating and/or bundling solutions for business sustainability). *See Appendix 18 for full detail*

Out of the ~100 distinct D4Ag solutions identified in Kenya, only a handful of them are run by government. Most of the solutions are driven by private sector and development partners, however the Government of Kenya (GoK) can and should play

x Impact estimates based on 2030-time horizon

a significant role in shaping the D4Ag agenda. GoK, through MoALFI, can play a role in coordinating D4Ag and facilitating data management lifecycle e.g., providing data, facilitating data collection and analysis. Most of the government solutions are driven by Kenya Agricultural and Livestock Research Organization (KALRO) offers mainly advisory and information services to farmers. KALRO has three e-agricultural platforms such as Kenya Agricultural Observation Platform (KAOP) website and ~30 mobile applications covering ~30 value chains. [9] Additionally, government can focus on creating an environment for data management (i.e., open access data, data protection laws etc.) and providing middleware to enable D4Ag solutions to scale. The rest of this section focuses on D4Ag solutions provided by private sector and development partners. For a further analysis of the government's capacity to facilitate the data management lifecycle, see *Chapter 3*.

Challenges to scale D4Ag solutions

More than 60% of the solutions that exist in SSA today came to market in the past three years. Up to 20-30% of farmers in Kenya are touched by more than one digital solution.[10] However, despite the abundance of D4Ag solutions in Africa, and Kenya in particular, many of these solutions have struggled to scale. 20 solutions alone – many that offer bundled solutions that touch multiple parts of the D4Ag ecosystem -- account for ~80% of all registrations on the continent. Further, the number of active users across D4Ag solutions examined is 15-30% on average. [11]

These numbers suggest two things. First, scaling these technologies requires all parts of the agriculture innovation ecosystems to work -- the digital and non-digital aspects-- from technology infrastructure (e.g., physical, research), to regulation, delivery systems (e.g., financing) and end-use support (e.g., pricing). And second, that not all solutions provide value to the farmer end-users, and many are not commercially viable. The agriculture community broadly speaking is still identifying what it takes to be a successful and impactful D4Ag solution (e.g., Syngenta Foundation's Internal Impact Review Tool).[12]

It is clear nonetheless that government has a key role to play in coordinating the ecosystem for solutions to scale and provide value to the farmer. Therefore, the rest of this document focuses on government-led and government-championed interventions. A review of >150 reports sources and interactions with over >250 stakeholders highlighted the following digital and non-digital barriers to scale, and lessons from governments around the world that have successfully addressed them.

The five digital barriers to scale range from access to technologies to people with the skills and capacity to implement digital solutions:

- *Digital literacy and access to basic technologies* amongst farmers is limited in certain parts of the country. Access to technology and digital literacy is expanding rapidly, with ~50% mobile penetration anticipated for rural African mobile subscribers by 2030. Today, most Kenyan farmers are located in rural parts of Kenya, where broadband access and 3G penetration today is significantly lower than in urban areas (i.e. <20% compared to >60%).[13] Also, youth under 35 years

old comprise ~70% of D4Ag users and are the most digitally literate segment of the population. [14] But they engage in farming and farming activities at much lower rates than their older peers.

- *Data accuracy and usability* varies significantly. MoALFI is further behind than other Ministries in their digitization journey (e.g., compared to Treasury and Public Finance), and so continues to incur high manual enumeration costs. Low data accuracy further limits use of D4Ag solutions. Of Kenya's ~100 distinct D4Ag solutions, ~15-30% of registered users are active. Of KALROs'~30 apps, downloads range from ~100k (Indigenous KALRO Chicken), to 1-2 users. More accurate, granular and tailored data (e.g., local languages) is critical to boost usability.
- *Data management systems* also vary significantly in standards and complexity across the ecosystem, particularly in government[xi].[15] A lot of agricultural data is collected and processed manually, and few institutions have the capacity to integrate and store data in the cloud (e.g., KALRO and KNBS), so data remains siloed. A notable data systems gap is "middleware" – public goods like farmer registries that government should provide to scale digital solutions. Individual enterprises can invest in their point solutions, but do not have incentives to do it for the full D4Ag ecosystem.
- *Monetization and private sector involvement* are a work in progress. Farmers are unwilling to pay for D4Ag solutions – particularly advisory services that comprise ~20% of solutions in the space. They trust their agrovets to provide free, timely, and tailored advice. Furthermore, several large firms are keen to enter the D4Ag space with solutions targeting SSF farmers (e.g., latest entry is the IBM Watson Decision Platform for Agriculture).[16] But they struggle to commercialize their solutions at scale because the value proposition to the users is not clear (e.g., better crop data requires more precise satellite imagery at 10ft level versus 30ft).
- *Digital skills and expertise for agriculture* are in short supply – across the ecosystem, but particularly in government. ~50% of surveyed D4Ag enterprises reported human capital as a key growth challenge, and 1 out of 3 firms cited an "inadequately skilled workforce" as a business constraint.[17] Without intervention, this barrier will only heighten. The sophistication of D4Ag solutions available is rapidly evolving, and outpaces the readiness of government to influence the D4Ag agenda -- including Internet of Things (IoT), block chain and machine learning. MoALFI does not have any data scientists on staff. Three-quarters of PhD qualified researchers, and about half of all BSc and MSc qualified researchers at KALRO are >50 years old and soon to retire.[18]

The four primary digital barriers to scale range from the macro complexities of the food system, to the on-the-ground needs of farmers in the last mile.

- *Food system complexity:* Globally, food systems are decades behind other sectors in innovation. Since 2010, ~USD 14B has been invested in food systems start-ups, compared to ~USD 145B in Healthcare because of the complexities of sector including, low farmer productivity due to inadequate infrastructure and the lack of

xi A comprehensive review of ICT Infrastructure is available from KALRO (2019), and is therefore not a focus of this report

transparency along supply chains that reduces consumer trust. Africa is no different. While start-up equity funding to agriculture grew 3x between 2016-2017, <10% of start-up funds raised in Africa go to agricultural enterprises, and the most recent equity funding growth represents a single enterprise.[19]

- *Policy and regulation* to support D4Ag solutions is still quite nascent – there are no common standards for data management, sharing and privacy, including for open data. While the 2018 Data Privacy Bill is a step in the right direction, outstanding concerns around third-party liability and appropriate consent from farmers and other providers of primary data are yet to be addressed.
- *County readiness* for agricultural transformation varies notably across Kenya (e.g., few counties spend the CAADP recommended 10% of their budget on agriculture).[20] Counties are the bedrock of implementation in Kenya's agricultural transformation, and D4Ag solutions are simply enablers and accelerators of a system wide transformation.
- *Last mile service delivery* is still required for farmers to not only gain familiarity and trust with D4Ag solutions, but also to implement the recommendations of this tools. Digital solutions are designed to strengthen, not replace extension officers and other farmer-facing agents. In Kenya, there continues to be a shortage of ~4000 extension officers to reach a farmer ratio of 1:600.[21]

Several countries around the world have tried to address both these digital and non-digital barriers to scale. *Appendix 2* captures the experience of ~10 global at-scale solutions (>0.5million users).

Six implications emerge from these experiences for MoALFI to consider as it determines the role it can play to support at-scale D4Ag solutions. See *Box 2*

Box 2: Lessons MoALFI can learn from governments to scale D4Ag solutions

1. Invest in **use cases that bring together the capabilities of multiple players, value chains and applications** in ways that the private sector cannot. MoALFI is in a unique position to design digital solutions for ecosystem-wide challenges *(digital and non-digital)*. But, complexity of these solutions should **account for digital literacy, tech access and county readiness.**
2. **Set the ecosystem priorities for investments in middleware and data management** (e.g., farmer registration)**.** This will help to coordinate existing efforts and avoid duplication and/or poorly scoped investments; MoALFI needs to work closely with MoICT and plans in the Digital Blue Print.
3. Build clear **feedback mechanisms** into each use case that improve **adoption and usability of the proposed solutions**. The D4Ag space is new and quickly evolving; gathering market intelligence is critical to improve the solution design, ensure farmers have granular enough data that is useful for them, and to **align the sector around a common "ground truth".**
4. Create **incentives to share, and pair local knowledge** (e.g., county agricultural officers, start-ups in the field) **with big technology capabilities**

(e.g., recent investments from large input and tech companies in D4Ag) – *for example* link big tech companies to local Research Universities conducting development research vs. commercial R&D. The private sector, and development partners are critical collaborators to government on this point.

5. **Attract young talent across the ecosystem:** from **data experts** (including data scientists, engineers and architects) at the Ministry, to extension officers in the last-mile. Within the Ministry, it is critical to build up, but also to broaden the capability set **beyond agricultural statistics.**
6. **Use platform as a GODAN champion, to work with MoICT and Office of the Deputy President on data policies and regulations** – specific to agriculture (e.g., farmer registration privacy, open data for GODAN), and more broadly (e.g., amendments to Data Privacy Bill, 2018). Given the realities of devolution, it is important for data regulation to be mindful the nuances of implementation in the sector.

2. THE SEVEN USE CASES

Selecting and prioritizing use cases

Use cases were selected and prioritized in a three-step process:

- *Generated a long list of ~80 use cases* based on the three primary ASTS objectives and the interventions that government, private sector and development partners make to impact the objectives:
  - *For example*, to increase small-scale farmer (SSF) incomes, ecosystem players need to facilitate access to finance. Government can intervene by determining which farmers need e-incentives, and administer them. Private sector can intervene by determining creditworthiness of farmers, and then design affordable products specific to their needs.
  - Note that the ASTGS had already identified three potential use cases: (1) administer and track performance of e-incentives (2) monitor and evaluate performance of SSFs and SMEs in the accelerator programme (3) monitor and forecast buy/sell needs for the Strategic Food Reserve (SFR).
- *Filtered out ~50 use cases of two types:*
  - First, the primarily non-digital in function (e.g., streamline Treasury policy approvals for food subsidies). While digital tools could improve the impact of this category of use cases, they are not the big "unlock".
  - Second, use cases likely to scale without direct government intervention, based on expert interviews and our extensive market scan for scalable solutions (e.g., providing market intelligence for private sector value chain player investments).
- *Prioritized the remaining ~30 use cases for impact and feasibility:*

- Impact *(high, medium, low)* indicatively evaluated based on the potential number of farmers and/or counties impacted. Where relevant, also used potential KES generated from the use case.
- Feasibility is based on five qualitative criteria: available and usable data; available and scalable technology; MoALFI (or relevant government institution) has capacity to execute; cost ranking;[xii] and the relative level of risk.[xiii] The Principles for Digital Development informed this feasibility assessment.[22] *See Appendix 3 for more detail.*

This process identified seven use cases that are each detailed in the next section including the challenge addressed, the proposed solution design, the budget, feasibility, and key milestones. Specific policy requirements of the use cases are also articulated below, but it is important to continue lobbying for the Draft Agriculture Policy (Feb 2019) to be signed. It outlines policy statements and articulates the position of national and county governments on issues important to the use cases – including information and data management, extension, research and development, and human resource development.

Note that several use cases did not make it through the prioritization process for use cases that were not primarily digital in their function, or that MoALFI was not particularly well placed to champion. For example, use cases focused on:

- Supporting market linkages -- the big unlock for commodity exchanges in Kenya and the region is not a digital tool to facilitate market linkages; it is a policy issue well addressed with the Warehouse Receipts Bill (2019).
- Visualizing agricultural output to help aggregation for producer off-take, a use cases that several private sector players current provide. The biggest barriers to farmer aggregation here are not digital in nature, they concern the governance and management issues with co-operatives and Farmer-Based Organizations (FBOs) in specific value chains
- Monitoring performance of private-sector driven solutions (e.g., of the SME accelerators in ASTGS). These can be more efficiently address through direct contractual arrangements with these providers to share the data MoALFI requires

Finally, it is important to note that MoALFI, through the Agriculture Statistics Units, is currently implementing a Roadmap to Improve Agricultural Statistics in Kenya (2019). Sample activities include developing a master sampling frame, strengthening coordination with KNBS, and reviewing the Statistics Act 2006 to accommodate issues of open data, big data, cloud sourcing et cetera. Improved agricultural statistics methods play a pivotal role in providing baseline high quality, timely, reliable and accessible data for M&E overall, as well as to specifically support the data needs of the use cases.

xii Used a rank of high, medium, low relative to the other solutions to narrow down from ~30 to ~7 use cases. But detailed costing estimates are provided for the 7 use cases in this document

xiii Risk identifies if there are legal or policy constraints to the solution, if there are external dependencies, and the level of political will to implement

Defining the use cases

Increasing small-scale farmer, pastoralist and fisherfolk incomes

Use Case 1: Accelerate farmer registration and target eligible farmers with e-incentives, and use analytics to improve the incentive scheme

A. Challenges

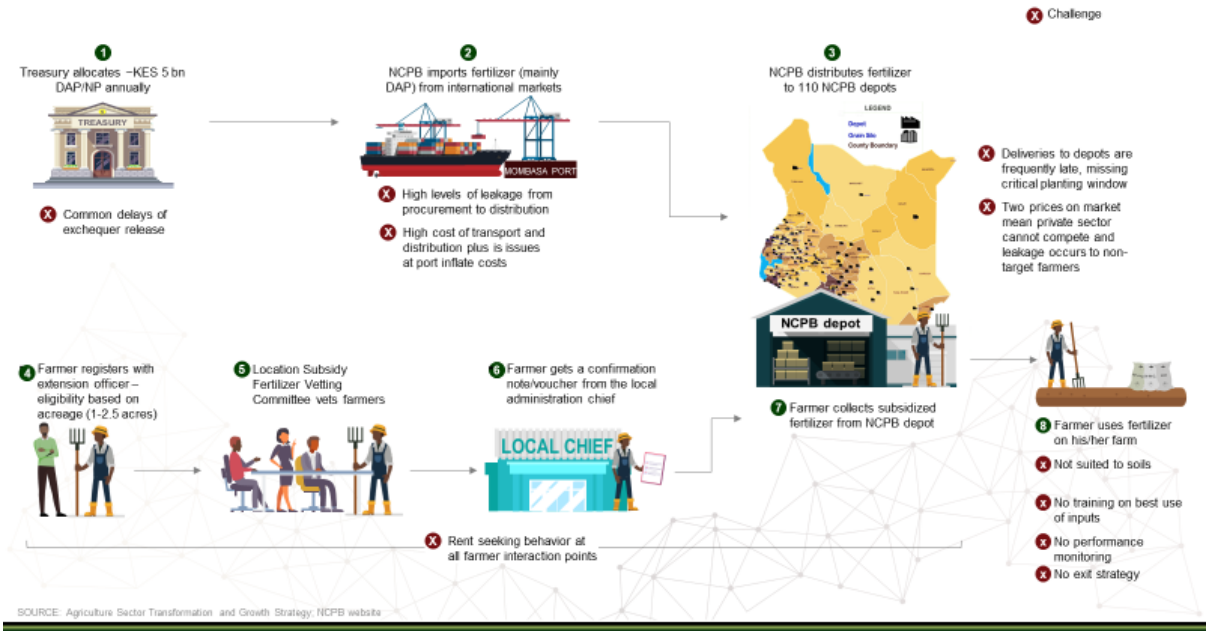
A key intervention MoALFI can make to impact small-scale farmer incomes is to increase willingness and ability of farmers to invest in yield improvements – particularly buying the right inputs at the right time, and using them in the right way. Since 2009, the National Accelerated Agricultural Inputs Access Programme (NAAIAP) has been the main government-led inputs support scheme that aims to increase affordability, and therefore usage, of fertilizers. Under NAAIAP, the government has invested KES ~5 billion per year to subsidize the price of fertilizer for high-needs farmers with 1-2.5 acres of land.

This current approach has four major challenges:

- *Most farmers can only access government-issued inputs (primarily fertilizer), that is not necessarily suited to the soil.* Further, farmers may not have the knowledge for best practice fertilizer use. Despite 12%+ fertilizer use, maize yields have remained at ~1.5 T/ha for more than a decade.[23] Improper use of fertilizer has resulted in widespread increase in soil acidity in Kenya, which has in turn resulted in reduced yields.
- *Two different fertilizer prices on the market create arbitrage opportunities that harm the farmer.* Approximately one third of subsidies do not reach the targeted farmers, and are instead bought in bulk by cartels who sell the fertilizer at market rates, nullifying the cost benefits to SSFs.[xiv] In addition, the private sector cannot compete with the subsidized fertilizer prices. So, there is low investment in retail outlets and higher commercial fertilizer prices.
- *At each stage of the current process, the farmer is vulnerable to extortion*, e.g., the vetting committee or local chief's office may demand something in return for approving the farmer and releasing the voucher.
- *Delays in fertilizer delivery:* There are delays across the delivery process from the point of release of funds from the exchequer, processing through the port, distribution to the NCPB depots, and farmers collecting from depots to farm. The average farmer travels 40 kilometres to a depot.[24] These delays result in farmers missing the critical window to use fertilizer (*see Figure 1*). *(For further detail, see ASTGS Chapter 4.)*

xiv Additional leakage occurs at procurement and distribution points

FIGURE 1: CURRENT NATIONAL ACCELERATED AGRICULTURAL INPUTS ACCESS PROGRAMME (NAAIAP)



B. Proposed solution

To address these challenges, MoALFI can re-direct the KES ~5 billion inputs support budget to an e-incentive system that involves sending each individual farmer, pastoralist and/or fisherfolk a mobile phone-based e-voucher of specific monetary value. This restructuring of the inputs support system has the potential to target high-needs farmers and put the decision back into their hands to utilize the e-incentive for the inputs and value chains s/he prioritizes for his/her crops, livestock and fish. It will also eliminate the two-tiered pricing system and associated leakage and undermining of private sector fertilizer manufacturing.

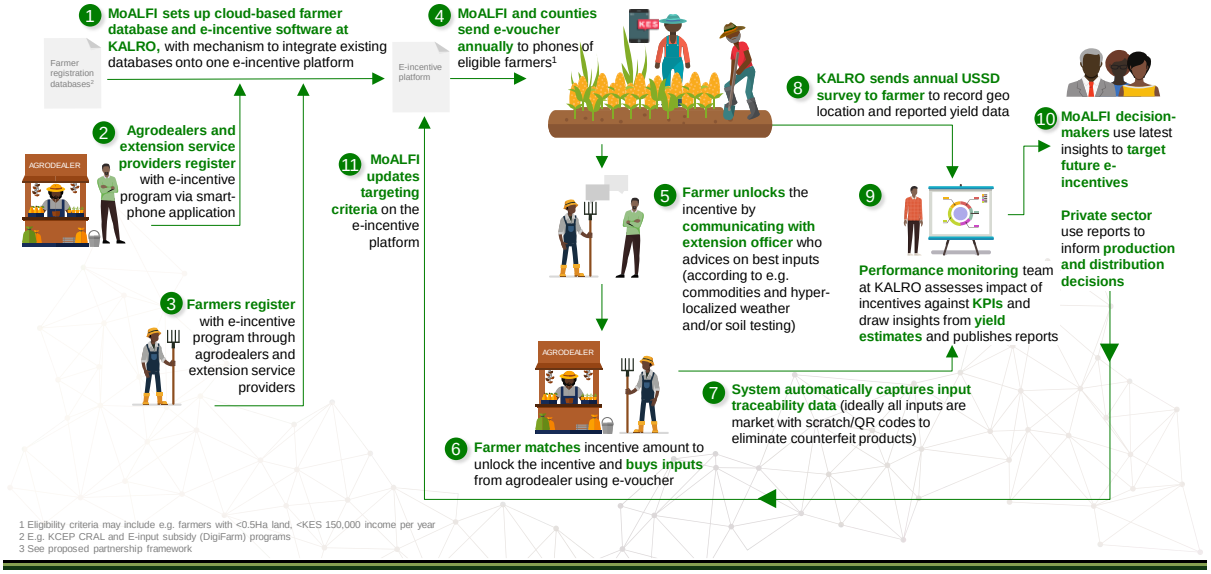
Key elements of the e-incentive system include (*see Figure 2)*:

1. **MoALFI sets up cloud-based farmer database and e-incentive software at KALRO:** several entities providing digital agriculture solutions and subsidies already have farmer databases, the largest of which include KCEP-CRAL and Digi-Farm. Various government initiatives, including Huduma Namba, the Agricultural Census and farmer registration, are also underway or in planning stages. However, there is no single, consolidated database of farmer profiles. E-incentives can be strongly leveraged to drive farmer registration onto a single platform. Using ID numbers as unique identifiers, current farmer databases can be combined and expanded through registration for e-incentives. KALRO is best placed to host such a database, given its strong IT capabilities and infrastructure (*see Figure 2*). KALRO should work closely with MoICT to ensure integration with the planned in-house and outsourced farmer registration process.

   This database will be dynamic, updated each season with any new/different farmer profile details, or corrected/validated at point of farmer interaction with extension

service providers or agrodealers. The database will allow for segmentation of farmers according to eligibility criteria, e.g. landholding size, income level, food insecurity level. Over and above the farmer database, the software for managing the e-incentive programme end to end will be set up and housed at KALRO, leveraging on KALRO's institutional and technical ICT capacity. This will require a dedicated unit of software engineers, data managers and analysts, co-locating within existing knowledge base and development partners programs at KALRO.

FIGURE 2: PROPOSED SOLUTION - TARGET ELIGIBLE FARMERS WITH E-INCENTIVES



2. **Farmers register with the e-incentive programme through USSD**: farmers will be informed through a nationwide series of radio, TV and newspaper notifications that registration with the programme is a prerequisite to receiving e-incentives. Registration can be completed through feature phone-friendly and cost-effective USSD system, offered in multiple languages, with Kenya's two to three largest telecom providers. Registration should aspire to identify all farmer assets (i.e. eventually incorporate livestock tagging). *See Box 3 below for the current state of farmer registration in Kenya.*

3. **Agrodealers and extension service providers (ESPs) register with e-incentive programme via smart phone application**: licensed agrodealers and recognized extension service providers (e.g., county extension officers, private sector companies with field agents, village-based advisors/lead farmers with references from well-recognized programmes such as One Acre Fund) will be given a window to register with the programme each season via a smart phone application. Agrodealers will be assured of automatic payment in full during the transaction with farmers and prior to release of inputs. Fulfillment of this promise is crucial, as breakdown of trust at the agrodealer level has potential to fundamentally undermine the programme in the short and long term. MoALFI should conduct spot checks of registered agrodealers and ESPs (~5% recommended) by GPS location to confirm legitimacy

4. **Treasury sends e-voucher to phones of eligible farmers**: the e-incentive platform will utilize Kenya's largest two to three mobile money platforms to send farmers an e-voucher with specific monetary value of approximately KES 5,000 (as per ASTGS).
5. **Farmer unlocks the incentive by communicating with extension officer who advises on best inputs:** the e-incentive programme will provide farmers with details of a number of local extension service providers. The farmer must communicate with a provider to receive tailored advice on the selection and best practice use of inputs based on the commodities farmed, plus hyper-localized soil and weather information. On receipt of this advice, the farmer is issued with a code to unlock the incentive. The programme will initially start in a small set of value chains to ensure the burden on implementation is manageable and to enable the analytics team to determine causality.
6. **Farmer matches incentive amount to unlock the incentive and buys inputs from agrodealer using e-voucher**: the farmer is given details of 3-5 agrodealers in the vicinity. S/he must deposit matching funds with the agrodealer (by cash or mobile money) and provide the extension service provider code to unlock the incentive. The farmer then uses the e-voucher to procure inputs. The agrodealer is required to countercheck the farmer profile information upon purchase of the inputs. MoALFI will track input prices to measure impact of incentives on the farmer. As the agrodealer enters the e-voucher code into the e-incentive smart phone app, the corresponding funds are released into the agrodealer's mobile money account.
7. **System automatically captures input traceability data**: initially, the agrodealer may be required to manually enter information regarding the price, type and quantity of inputs procured. Over time, ideally all inputs will be marked with codes (e.g., scratch or QR codes), serving two purposes – (1) automated traceability of inputs, and (2) elimination of counterfeit products. Such a traceability system will need to be designed to account for the fact that agrodealers often must break down bags to sell farmers quantities they can afford. Such a system can also be set up to assist the agrodealer with inventory management.
8. **KALRO sends USSD survey to farmer to record geo location and yield data**: after harvest, a USSD survey is sent to farmers to collect reported yield data (and equivalents e.g., kgs/head of cattle, tonnes of fish landed per species). The survey must be answered from the farm itself, allowing geo-tagging data to be entered into the e-incentive platform, further triangulating the farmer profile.
9. **Performance monitoring team at KALRO assesses impact of incentives against KPIs and draws insights from yield estimates and publishes reports**: key metrics (number and geographic distribution of farmers reached; yield of value chains produced/reared; income from agricultural output; type, quantity, price and geographic location of inputs procured) will be analyzed and assessed against KPIs by the KALRO e-incentive team. This data will be collected directly by the e-incentives software and the USSD surveys. Results of the analysis

will be published in reports and sent to MoALFI decision makers (e.g., ATO, extension leaders), and non-personally identifiable data made publicly available.

10. **MoALFI decision makers use latest insights to target future e-incentives:** private sector uses reports to inform production and distribution decisions: insights will drive key decisions within MoALFI relating to targeting future e-incentives, such as revisions to farmer eligibility criteria, number of farmers targeted, and amount of incentive per farmer. For the private sector (including local agrodealers), details of input demand segmented by input type and geography, as well as locations of registered agrodealers, can be used to inform production and distribution for the following season.
11. **MoALFI updates targeting criteria on the e-incentive platform:** once MoALFI has decided how to adapt the mechanism to better target farmers, the database will be updated with the new criteria and segmented accordingly for the next season's e-incentives.

Box 3– Current state of farmer registration in Kenya

Understanding who the farmers are, where they are and what value chains they produce will help MoALFI, as well as private sector and development partners, tailor the right solutions to the right farmers. Kenya has not conducted an agricultural census since independence in 1963.[25] Agricultural indicators, including farmer profiles, are mainly determined through estimates and sample surveys.

However, government, the private sector and development partners are currently engaged in farmer registration efforts collecting key farmer data. These data include farmer national ID number, name, mobile number, location, size of land, value chains grown. While these efforts cover most counties, there is no unified national farmer registry – so duplication is likely. *See Appendix 9 for further detail.*

- *GoK:* By 2020, GoK aims to complete three national registrations with dedicated farmer modules including: Huduma Namba *(ongoing),* the population census in August 2019, which will both provide a sampling frame to conduct the farmer registration pending funding of ~KES 3bn.
- *Private sector:* Through D4Ag solutions farmer profiles are collected via registration for e-advisory services and/or index insurance.[26] For example, Digifarm, in partnership with MoALFI, registered ~1 million farmers.[27] Farmer-Based Organizations (FBOs) like KENAFF have ~2 million farmers registered.
- *Development partners*, through programmes in partnership with GoK, have funded at least three additional programmes with similar farmer data, targeting a total of ~2.5 million farmers registered by 2022, including KCSAP, KCEP-KRAL, NARIGP.[28]

MoALFI can launch use case 4 on the existing programmes by development partners – these programmes are already funded, and MoALFI has access to the data – starting with KCSAP counties to avoid overlap with KCEP-CRAL programme design. To scale the use case, MoALFI can work with organizations with wide customer reach and

operational capability such as mobile virtual network operators (MVNOs), and focus on counties that are most responsive to support of this kind (e.g., "Counties that Count"). For example, the Nigerian government partnered with Cellulant to provide subsidies on agro-inputs to farmers with a 90% success rate. [29] MoALFI would need to implement data sharing agreements with MVNOs recognizing that previously held data may not be publicly available. The use case(s) can start with these as the GoK national farmer registration process plays out.

The end-to-end digital solution to meet this design requirement already exists – Cellulant has rolled out a similar programme in Nigeria, whilst the UN Food and Agriculture Organization (FAO) has set up software to manage a complex e-incentive programme in Zambia. Safaricom has also established suitable software in Kenya, whilst KCEP-CRAL has is currently providing subsidies via direct debit cards. These initiatives in Kenya are occurring in parallel to non-digital inputs support programs at national and county level *(See Appendix 5).*

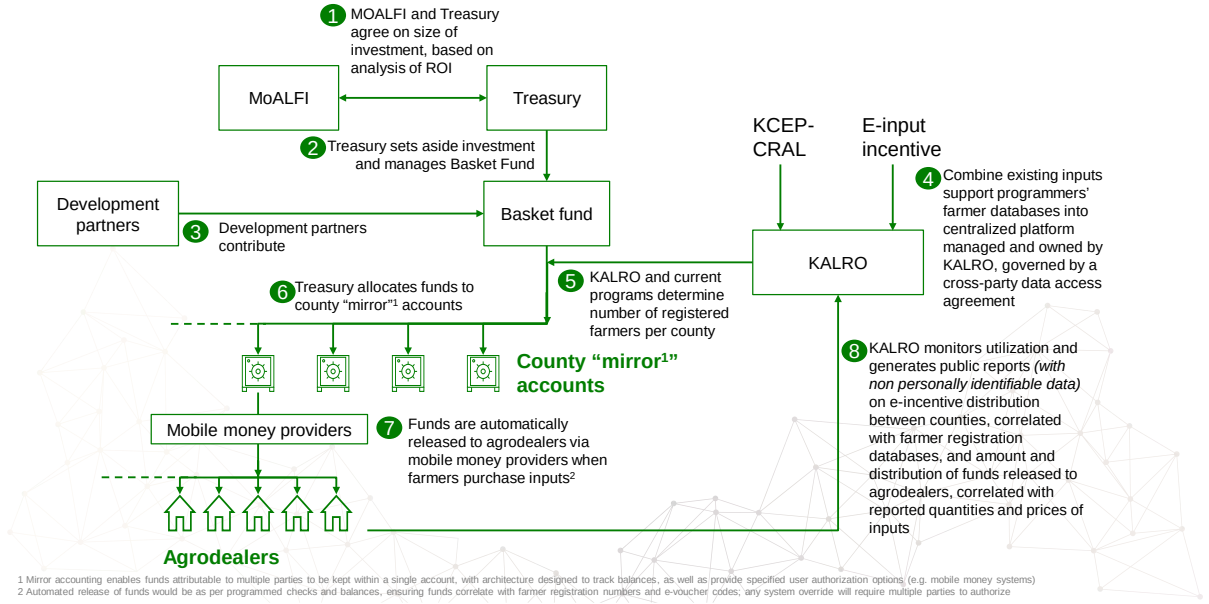
The challenge with multiple concurrent inputs support systems within Kenya is two-fold. Firstly, programmes may have conflicting policy objectives and eligibility criteria, with risk of jeopardizing outcomes (e.g., exit strategy of one may be undermined by another). Secondly, inefficiencies in expenditure exist, such as subsidizing already subsidized inputs, providing the same farmer with multiple subsidies (likely leading to leakage), and collecting the profile data for the same farmer on multiple databases.

Ideally, efforts will be streamlined and coordinated to eliminate these inefficiencies, using the following steps:

- Get buy-in from KCEP-CRAL and counties – to share farmer databases going forward, as well as data on the type and amount of subsidies issued.
- Draw up a cross-county, cross-party data sharing and protection agreement.
- Develop a partnership framework between MoALFI and existing programmes, counties and other stakeholders (e.g., other relevant Ministries, development partners, mobile money providers and agrodealers) (*see Figure 3 for proposed partnership framework).*

The proposed partnership framework requires MoALFI and the Treasury to agree on a budget for the e-incentive programme, based on projected Return on Investment at the national and farmer level, providing a specific incentive amount to a set number of farmers. The agreed amount is then set aside in a "Basket Fund", a dedicated account for both government and development partner funding, with checks and balances for any release of funds, based on number of farmers registered on a centralized database. This database will sit within KALRO, with input from existing/past programmes such as KCEP-CRAL and the E-input Subsidy Programme, as well as any county databases. Access rights to this database will be agreed and documented.

FIGURE 3: PROPOSED PARTNERSHIP FRAMEWORK



Funds will be allocated from the Basket Fund to county "mirror" accounts according to the number of registered and eligible farmers in that county. Known for its use in mobile money systems, mirror accounting negates the need, risk and cost of physically moving large amounts of money. Instead, it enables funds attributable to multiple parties, in this case the counties, to be kept in a centralized account, here the Basket Fund, but accounted for separately – in mirror accounts. As with mobile money systems, the architecture will be designed to track the balances and will require specified authorization to release the funds from each mirror account.

Partnership agreements will be set up with Kenya's largest mobile money providers and a mechanism established to allow for instantaneous release of funds from county mirror accounts to registered agrodealers' mobile money accounts during the transaction with farmers. There needs to be a clear agreement for transaction fees between Treasury, these mobile money providers and the nominated bank that hosts the mirror fund so that these costs remain sustainable.

Finally, the proposed framework includes performance monitoring, led by KALRO. Two key indicators need to be measured and publicized to maintain accountability of the system: (1) e-incentive distribution between counties, correlated with farmer registration databases, and (2) e-incentive distribution to agrodealers, correlated with reported quantities and prices of inputs sold to farmers.

The e-incentives programme will initially start in a small set of pilot counties where there are no other incentive programmes (to avoid competition, duplication and undermining of exit strategies), but in collaboration with programmes about to be launched, including KCSAP, which has significant funding secured and a roll out plan.

Impact

Measure	Target	Rationale
Objective (impact)	Increase small-scale farmer incomes for ~1.4m households by 40%	60% farmers reached, with average income increase of 40% across six key value chains, assuming subsidies close 25% of the gap to potential yield[30]
Outcome	~1.4m farmers registered and receiving incentives	As above
	~2,300 agrodealers and extension service providers registered and active	Farmer registration onto the system assumes a ratio of 600 farmers to one extension officer / agrodealer

Feasibility

Overall, implementation of this use case will be moderately difficult, given significant efforts required to transition from existing programs, reduce cartel activity, coordinate multiple parties (including national and county governments, development partners, telecoms companies and other private sector service providers, agrodealers, extension service providers and farmers). The actual digital solution itself, however, is relatively easy to deploy if farmers are registered. Software already exists for similar incentive systems in other countries (e.g., Zambia and Nigeria). More specifically:

1. *Data availability:* farmer profile data is available but incomplete and fragmented, and requires compiling of databases and further registration of farmers.
2. *Technology:* software has already been developed for similar incentive systems in other countries (e.g., Zambia and Nigeria), but will take approximately three months to set up, and therefore a pilot could not be launched within 8-12 weeks. Sample solution providers include the FAO, Cellulant and Safaricom.
3. *Execution capability:* KALRO is best placed to host such a digital platform, given the strong capability and infrastructure of its IT hub. However, issues of farmer data ownership and access rights should be defined by MoALFI (e.g., if data is collected as part of national census it is owned by government, if otherwise it is owned by the farmer and their consent is required to share with third parties)
4. *Cost:* The software could potentially be transferred free of charge to Kenya from Zambia, but sensitization and registration costs are relatively high.
5. *Risks:* The greatest risk overall to the programme is on of coordination – all the stakeholders need to participate equally, in particular -- data privacy of farmers must be protected with amendments to the Data Protection Bill (2018), extension officers need to provide timely and accurate advice to farmers to unlock the e-voucher, agrodealers need to be paid on time with strong accountability between Treasury and the banks supporting the mirror funds at the county level, or the agro-dealers will lose trust in the new system. Finally, as MoALFI transitions between different input support programmes, farmers need to trust the new system to deliver better outcomes than their predecessors.

What does this mean for the counties?

- 1.4 million farmers registered across the counties.
- Private sector catalyzed by e-incentives, leading to increased opportunities for SMEs and corresponding job creation.
- Transparency on disbursement of funds directly from treasury, as well as performance of the incentive scheme

C. Budget proposal (KES M)

		YEAR 1 (2019/ 2020)	YEAR 2 (2020/ 2021)	YEAR 3 (2021/ 2022)	YEAR 4 (2022/ 2023)	TOTAL
A	OBJECTIVE 1: Set up cloud-based farmer database and e-incentive software	72.6	10.6	11.2	11.7	**106.1**
B	OBJECTIVE 2: Register farmers, agrodealers and extension agents	1.7	5.8	7.4	2.9	**17.8**
C	OBJECTIVE 3: Send out e-vouchers, annually (incremental to the KES 5B p.a already in MoALFI budget for subsidies)	334.9	-	310.2	2,600	**3,300**
D	Project Monitoring & Evaluation	0.2	0.2	0.2	-	**0.7**
E	Personnel Costs	62.4	65.5	105.8	111.1	**344.9**
F	Office Supplies & Administrative costs	23.7	4.2	21.7	136.8	**186.5**
H	Partner Meetings/Workshops	2.0	1.6	-	-	**3.6**
I	Project Equipment	0.8	0.8	-	-	**1.6**
	Total Budget	**498.4**	**88.8**	**456.6**	**2,900**	**3,900**
	Total Technology Costs only (less objective C)	**163.5**	**88.8**	**146.4**	**262.5**	**661.2**

D. Key milestones

- ***Determine funding and partnership framework:*** Identify funding amount ring-fenced for incentives from recent World Bank loan. Use this amount as guidance to draw up a tender. Agree on incentive mechanism and partnership framework between national and county governments and other parties.
  - Responsibility: MoALFI, together with Treasury
  - Start date: Q3 2019
- ***Conduct competitive tender process:*** Release tender, evaluate applicants, negotiate contract, award contract.
  - Responsibility: MoALFI, together with Treasury
  - Start date: Q4 2019
- ***Set up e-incentive platform and prepare for pilot:*** Set up data-sharing platform with existing farmer database holders (KCEP-CRAL, KCSAP, NARIGP, DigiFarm) and define standards and protocols. Agree on national e-incentive KPIs (e.g., % yield increase). Agree on incentive mechanism (e.g., government matches farmer deposit on approved inputs) and socialize concept with farmers, agrodealers and extension providers. Set up e-incentive platform with capability to register farmers, agrodealers and extension officers, issue e-incentives and monitor input procurement. Identify pilot counties, based on number of farmers registered, and draw up.
  - Responsibility: MoALFI, together with implementing partner
  - Start date: Q3 2020
- ***Roll out pilot:*** Register farmers, agrodealers and extension workforce. Send e-incentive to farmers two months prior to planting. Run first round of KPI analysis and adjust accordingly.
  - Responsibility: Implementing partner
  - Start date: Q1 2021
- ***Scale up:*** Scale to remaining counties and transition all existing inputs support programmes onto unified e-incentives programme.
  - Responsibility: MoALFI, together with implementing partner
  - Start date: Q1 2022

Use case 2: Improve farmer practices including input use by providing customized e-extension and advisory services that incorporate current and predictive data (e.g., meteorological advisories and analytics, pest/disease trends, yield, pricing)

A. Challenges

Within the overall ASTGS objective to increase small-scale farmer incomes, a key driving factor is increasing productivity. Even if a farmer has access to the right inputs at the right time, s/he needs to know how to maximize the inputs to achieve high yields. Without this knowledge, investment in the right inputs can go unrewarded, disincentivizing further investment. Extension services are therefore critical to farmer willingness to invest in increasing productivity, yet small-scale farmers widely report that they are not supported in decision making and agronomy.

Providing high-quality, affordable extension and advisory services at scale to smallholder farmers, pastoralists and fisherfolk is a challenge faced by many governments – and one that lies at the heart of agricultural transformation. Whilst there are 4,000-4,500 extension officers and over 20 digital advisory and information services in Kenya, both digital and non-digital factors constrain farmers from accessing extension.

On the non-digital front, the cost of last-mile service is high and county extension officers are often over-scoped, understaffed and insufficiently resourced and/or incentivized to provide services at the individual farmer level. While the FAO recommended ratio of extension officers: farmers is 1:600, the current situation in Kenya is far worse – up to 1: 5000 in some cases. Similarly, it is far more cost-effective for private sector field officers to connect with farmers and provide relevant extension services at the aggregate level – either through cooperatives, lead farmers or farmer-based organizations.

Farmers are often unsure who their local county extension officer is or how to reach them. They are more likely to rely on advice from their local agrodealer, given their regular interactions with them, typically over a long period of time.

Layered over these practical constraints are the challenges farmers face in accessing and interacting with digital extension, or "e-extension", defined here as "Digital service providing information geared to improving farming practices relevant to specific (location/value chain) and evolving (weather/disease/ markets) farmer needs". For instance, most farmers do not have the right hardware or lack the required digital literacy to utilize websites or apps, requiring face-to-face support from extension service providers (including county extension officers, private sector field agents / sales force, agrovets/agrodealers, Village Based Advisors, Lead Farmers) to bridge this gap.

Secondly, for farmers and extension service providers who have the right hardware, there is no easy way to understand which digital services are best suited to their needs (compatible with their devices, relevant to their value chains, affordable in the long term), and whether the information is reliable. Finally, once a farmer has signed up to

an e-extension service, s/he may not know how to implement the recommendations correctly (e.g., the recommendation may be to apply a particular fertilizer for a commodity, but failure to match soil requirements and/or overapplication can lead to seedling damage and yield loss). Human interaction is required to help farmers translate information delivered via digital means into practices that will lead to improved outcomes.

B. Proposed solution

This use case aims to address these issues by providing a means to expand the extension workforce and equip them with access to Kenya's ~20[xv] digital agriculture information solutions. [31] To achieve this, KALRO could take the lead in training and providing a means to incentivize a wide range of extension service providers, including village-based advisors, lead farmers, county extension officers, private sector field officers and even entrepreneurial youth (e.g., members of 4-H Foundation Kenya from university, and youth from specific Technical and Vocational Education and Training – TVET programmes), to give customized advice based on e-extension. A web-based portal will be set up, specifically designed to give registered extension service providers access to the digital agriculture information solutions available, as well as private sector stewardship (training) materials.

An initial (1-2 year) proof of concept phase will be required to bring e-extension organizations and private sector input providers on board, during which all programme costs, including incentives, will need to be subsidized or fully covered. Once proof of concept is demonstrated, subscription fees will be introduced to e-extension organizations and private sector input providers to ensure the sustainability of the model. Fees charged would need to correspond to potential savings of private sector in sending promotors and agents into the field.[xvi] The value proposition to these parties is two-fold:

- Access to a large farmer profile database (based on appropriate farmer consent) to inform service development and targeting decisions.
- Potential to leverage the wider extension service provider workforce to dramatically expand reach of e-extension services, with costs of subscription fees significantly lower than equivalent costs of individual field-based promotors.

The proposed solution involves the following key components *(See Figure 4 below)*:

1. **MoALFI sets up e-extension portal at KALRO***:* e-extension organizations will be invited to sign up to the portal. Quality control personnel at KALRO will conduct rapid spot check assessments of content to see that recommendations match current best practice. Those accepted will have their metadata entered into the platform, enabling the website to search for services according to factors such as location, value chain, type of service and cost. Once a service has been selected, the portal will provide links to the website or app, or USSD registration codes and

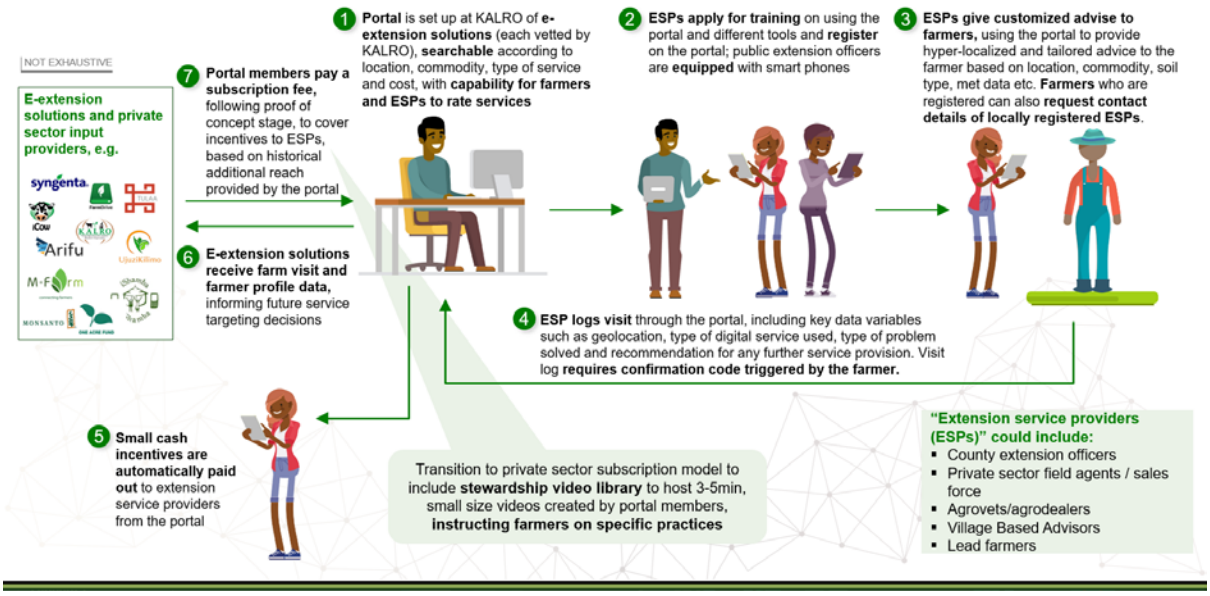
xv This refers to 20+ distinct solutions - KALRO has 32 mobile apps alone, but given their similarity in nature, these are counted here as one

xvi E.g., Salary of a promotor plus cost of bi-annual replacement motorbike = KES ~162,500/month. So, one extension service provider could be incentivized KES 13,000/month if reaching 600 farmers. Subscription fees could be variable and based on the number of farmers being provided with the relevant private sector service per month.

helpline numbers as appropriate. The portal will also allow users to rate the e-extension service providers, as well as give feedback on the portal itself.

2. **MoALFI coordinates with counties to train extension service providers and counties equip extension officers**: extension service providers (e.g., private sector field agents, county, village-based advisors, lead farmers, heads of cooperatives and entrepreneurial youth) will attend training with two key components: (1) utilization of the portal, led by KALRO and (2) familiarization with the variety of e-extension solutions, with training sessions delivered by the e-extension providers themselves (potentially like a trade show, with multiple stands, each paying a small fee to contribute to the cost of the overall training event). MoALFI and the counties will also need to coordinate and align on budget allocations to equip extension officers with smart phones, either directly or via low-interest loans. Ideally this use case leverages the database of registered extension service providers for use case 4, the e-incentives scheme, to send out invitations and advertise training dates.
3. **Extension service providers give customized advice to farmers, using the portal:** Ideally this use case leverages both the database of extension service providers and the database of farmers in use case 4 on e-incentives to (1) give farmers contact details of their local extension service providers (e.g., via USSD) and (2) give extension service providers details of local registered farmers. Once the farmers and extension service providers have connected, the extension service providers can give customized advice, either during a farm visit or over the phone. The extension service provider will use the portal to search for suitable e-extension services based on the farmer's location, value chain, and specific needs and utilize these services to offer hyper-localized and tailored recommendations the farmer can implement.
4. **Visit is logged in to the system**: codes from both the extension service provider and the farmer are required to log the visit into the system. The visit log will include key data variables such as geolocation, type of digital service used, service mode (in-person, call, message), type of problem solved (e.g., presence of disease, choice of input, use of input), rating of quality of service provided and recommendation for any further service provision.
5. **Incentives are automatically paid out to extension service providers from the portal***:* as soon as the farm visit has been logged, the extension platform sends the incentive to the extension service provider directly, e.g., via a mobile money platform.
6. **E-extension providers receive reports on farm visit and farmer profile data:** the portal management team will send monthly reports of farm visit data (as per point 4) and farmer profile data to the subscribed e-extension organizations, who can utilize the information for future service targeting decisions. Service ratings will also be reviewed, and the portal will reserve the right to remove an e-extension organization should ratings be low.

FIGURE 4: PROPOSED SOLUTION - CUSTOMIZED E-EXTENSION WITH SUPPORT FROM BROAD RANGE OF EXTENSION SERVICE PROVIDERS (ESPS)



Once at scale and self-sustaining, a third phase could involve partnering with an already existing call centre (e.g., KALRO, Digi-Farm, iShamba) to assist both extension service providers and farmers to navigate the portal or get specific advice based on information provided by one of the e-extension services. In addition, the portal could host short, compressed videos instructing farmers on specific practices, with content developed by e-extension providers or private sector input providers for product stewardship purposes.

Specific enablers are required to support this digital solution, including:

- Early coordination with counties to get buy-in and align plans, given that extension is a devolved government function.
- Setting up agreements with:
  - Counties, to incorporate county extension officers into the database and training programme
  - Extension service providers, clearly stipulating data-sharing policies, requirements to receiving incentives and consequences for breaching the agreement

The ethos of this use case is fully in line with the National Agriculture Sector Extension Policy 2012, which states that the government should:

- Establish an integrated and dynamic database for the sector and improve access and use of information and experiences generated.
- Use ICT and mass media for wider coverage and enhanced sharing of information.
- Invest in building capacity of extension service providers, extension clientele and relevant institutions.

- Promote decentralization by using clientele groups (e.g., common interest groups, smallholder associations) and public outreach for cost-effectiveness.
- Harmonize standards for packaging user-friendly extension messages.

Impact

Measure	Target	Rationale
Objective (impact)	Provide small-scale farmers greater access to extension services	
Outcome indicator	Ratio of extension service providers to farms is less than or equal to 1:600, i.e., ~2,300 extension service providers registered	Calculated based on ASTGS targets for 1:600, from current level of up to 1:5000 in certain areas[32]
	~1.4m farmers served through the platform over 3 years (~0.5m per year)	E-incentives programme aims to target 1.4m farmers, who will each be required to connect with extension service providers
	Subscriptions cover costs of platform and are sufficient to incentivize extension service providers	Platform should become self-sustaining after proof of concept phase

Feasibility

The greatest limiting factor to successful implementation of this use case is attaining critical mass in terms of buy-in from the e-extension service providers, which will have to be achieved during the proof of concept phase in order to move to a self-sustaining model. The software requirements, however, are readily available and relatively simple to set up. More specifically:

- *Data availability:* 20+ public (e.g., KALRO) and private sector (e.g., iShamba, DigiFarm) entities generating digital content, which is highly usable but not regulated.
- *Technology:* All digital components of the solution exist and are in use. In addition to examples of D4Ag advisory services solutions above, there are many potential providers of B2C technology that could support a two-sided platform like the one described here including: ScienceSoft, inGenium, Octal, Digitalism and Weblieu. The use case could be piloted within 8-12 weeks.
- *Execution capability:* Training of extension agents could be a bottleneck given the number of extension service providers required to hit the 1:600 ratio to farmers. It is most viable if the portal is housed at KALRO with a dedicated person managing the portal, given its IT capabilities.
- *Cost:* Costs are relatively low; greatest cost is training of all extension service providers.
- *Risks:* Liability for KALRO relating to delivery of incorrect advice and maintaining quality control of extension information and extension agents as expand the net

beyond the providers identified in the National Agriculture Extension Policy – NAEP (2012). The NAEP still requires amendments to be devolution fit. To mitigate some of these risks, counties need to be actively involved in the solution (e.g., providing feedback on solutions), given that extension is a fully devolved function.

What does this mean for the counties?

- Burden on county extension workforce is significantly lifted due to great number of extension service providers and access to latest advisory information on a wide range of farming practices.
- Job creation amongst entrepreneurial youth.

C. Budget proposal (KES M)

		YEAR 1 (2019/ 2020)	YEAR 2 (2020/ 2021)	YEAR 3 (2021/ 2022)	YEAR 4 (2022/ 2023)	TOTAL
A	OBJECTIVE 1: Build e-extension portal	-	186.3	2.6	2.8	**191.7**
B	OBJECTIVE 2: Enable workforce, pilot and scale	-	2.1	8.9	17.8	**28.8**
C	OBJECTIVE 3: N/A	-	-	-	-	**-**
D	Project Monitoring & Evaluation	-	0.2	0.2	0.3	**0.7**
E	Personnel Costs	-	8.0	19.0	33.3	**60.3**
F	Office Supplies & Administrative costs	-	9.9	1.6	2.7	**14.2**
H	Partner Meetings/Workshops	-	0.5	0.6	0.6	**1.7**
I	Project Equipment	-	0.2	-	-	**0.2**
	Total Budget	**-**	**207.2**	**32.9**	**57.4**	**297.5**

Note: Some elements of the use case fall under KCSAP subcomponent 3.3, clause 85 on market advisory (e.g., "package data acquired from databases into actional advisory messages for different agro-meteorological zones"). *Before begin implementation of the use case in 2020/2021, re-align with KCSAP programme leads on design needs*

D. Key milestones

- **Phase 1: Sensitization and preparation.** Coordinate with counties to get buy-in and align plans, given that extension is a devolved government function. Set up agreements with (1) counties, to incorporate county extension officers into the database and training programme; and (2) extension service providers, clearly stipulating data-sharing policies, requirements to receiving incentives and consequences for breaching the agreement.

- Responsibility: MoALFI, together with KALRO
- Start date: Q4 2020

- **Phase 2: Launch proof of concept phase.** Build searchable portal cataloguing e-extension services, with capability for farmers to rate services. Train public and private extension workforce on portal and range of services. Set up incentives for village-based extension agents, including youth, to utilize the portal. Equip extension officer workforce with tablets/smart phones. Monitor and evaluate portal utilization, service provision and incentives.
  - Responsibility: MoALFI, together with KALRO
  - Start date: Q2 2021
- **Phase 3: Scale and move to sustainability.** Scale and transition to private sector subscription model including video library and mini call centre.
  - Responsibility: MoALFI, together with KALRO
  - Start date: Q1 2022

Boosting household food resilience

Use Case 3: Monitor emergency food reserve stocks and determine quantities of new stocks to buy from the FBS

A. Challenges

During food security emergencies, e.g., drought, ~4 million Kenyans are at high risk and in need of government support. Government often provides physical stock from the national Strategic Food Reserves and/or tries to reduce or cap prices. There are several challenges with the existing SFR system *(See Appendix 6 and the ASTGS for detail)*. The lack of a stock monitoring system makes it difficult to make critical decisions about stock management during times of need, particularly to identify silos with available stock and the associated quantities.

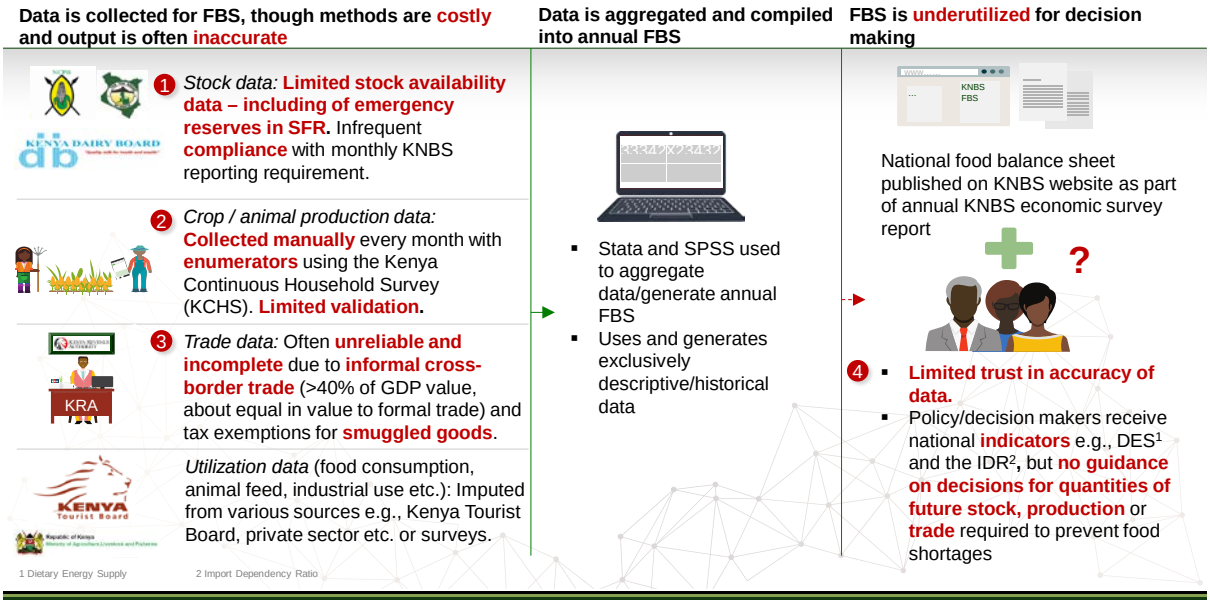
On an ongoing basis, Kenya uses the national food balance sheet. This contains information on all the food available in the country, e.g., through local production, imports and stocks, as well as all the food utilized within the country, e.g., through food consumption, animal feed, industrial use, etc. The Kenya National Bureau of Statistics has published annual food balance sheets since 2005. However, KNBS relies on historical data collected through enumerators, which is costly to obtain and often inaccurate. Getting accurate data on food imports is also challenging, largely due to tax fraud and informal trade that is difficult to account for. *See Figure 5 for more details.*

As a result, MoALFI, the Strategic Food Reserve Trust Fund (SFRTF) and other government agencies have limited trust in the accuracy of the data and are unable to make accurate projections about production, consumption and trade. They underutilize the FBS, which could be a tool for making decisions about food pricing, disbursement of stocks and food trade policies. Information from the FBS on the nutritional quality of food in the country could also help the government prevent

malnutrition and make decisions about value chains to invest in e.g., investing in beans to increase protein intake in certain regions.

Finally, the East Africa Community (EAC) Regional Food Balance Sheet (RFBS), supported by USAID, was set up in 2013 to highlight trade opportunities, facilitate greater regional market linkages and accelerate regional value chain integration. It is designed as an extension of FBS of the five EAC Partner States, and focuses on key staples - maize, rice, wheat, millet, sorghum, and beans. The RFBS system went through piloting phase and actual implementation but has not been fully operationalized – data contribution by various stakeholders were very inconsistent.

FIGURE 5: CURRENT STATE OF NATIONAL FOOD BALANCE SHEET (FBS) IN KENYA



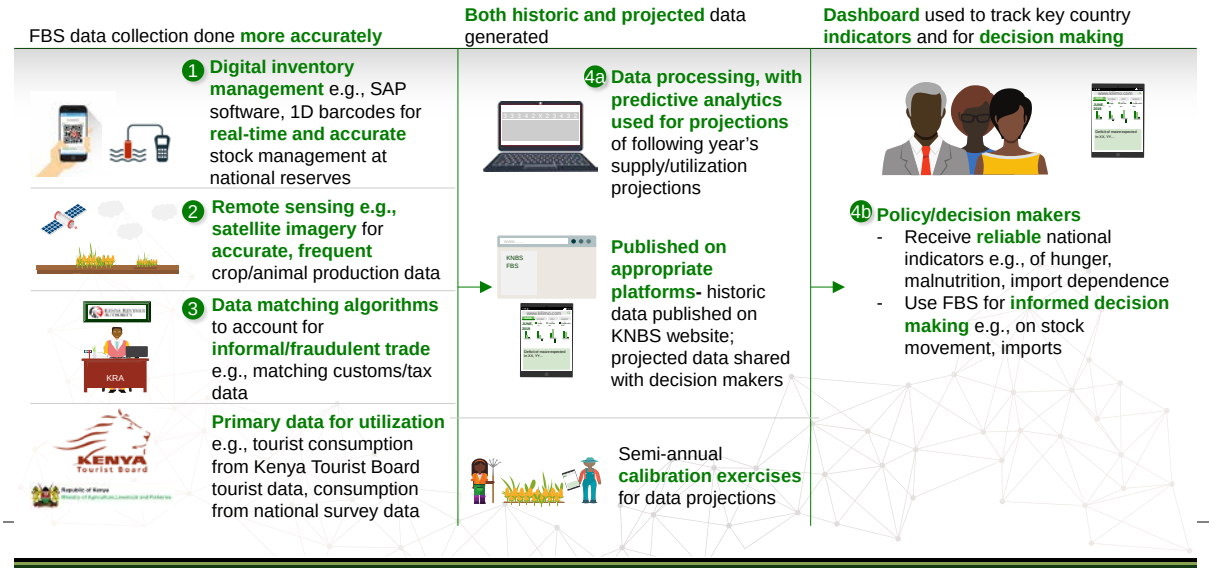
B. Proposed solution

A two-phase solution is proposed to improve monitoring and management of stocks, particularly what stocks to buy and when. In the first phase, digital solutions will track current stocks, for real-time stock monitoring at national reserves. An online dashboard will then be created to relay real-time stock information to the MoALFI and other key decision makers, e.g., the SFRTF. In parallel, reliability of the FBS will be enhanced by improved data collection methods. For the second phase, the output of the FBS will be used to run predictive analytics, to project stock needs. This will allow the MoALFI and the SFRTF to make informed decisions about stock purchases. *See Figure 6.*

The Department of Food Security within the MoALFI currently generates monthly reports on the state of national food security and sharing these with relevant decision-making bodies e.g., MoALFI Directors, the SFRTF, and the Cabinet, by way of the Cabinet Secretary. Given that these reports are generated using food balance sheet data, it is proposed that the primary owner of the solution be the head of the national Food Security Department of the MoALFI. The solution would directly influence decisions made by the SFRTF and so it is proposed that a member of the board also be

given ownership of the solution, for use in quarterly decision-making meetings about stock purchases and sales.

FIGURE 6: PROPOSED SOLUTION - DIGITIZE STOCK MANAGEMENT AND USE THE FBS TO DETERMINE EMERGENCY STOCKS TO BUY



Phase 1: Monitor stocks in real time and improve FBS reliability

1. *Real-time monitoring of national food reserves.* A 1D barcode stock-tracking system will track movement of stocks. A private sector provider will supply the hardware and software tools for tracking, while officers at the food reserves will tag and track the stocks, after training on the systems. Real-time information from national reserves in the counties can then be directly communicated to decision makers within the MoALFI and SFRTF through an online dashboard.
2. *Satellite data collection for crop production.* A private sector provider will be selected to provide satellite data on crop production. This will allow for collection of national, accurate, real-time data on several key metrics such as the total size of land planted with a certain crop, projected yields, crop health etc. The provider will collect the raw data and process it into a format the statisticians at KNBS can incorporate into the FBS.
3. *Data matching algorithms to improve accuracy of trade data.* To decrease vulnerability to tax fraud and informal trade, data matching algorithms can be used to automatically identify potential fraud/informal trade indicators. These indicators will be based on insights from auditors and experts with experience with the trade data. A commonly used method is matching tax declarations to customs data to identify discrepancies. In addition to this, certain proxies can be used to account for informal trade, e.g., off-season consumption spikes.

Phase 2: Determine quantities of new stocks to buy from the FBS

1. *Predictive analytics to generate projections of stock needs.* With improved data collection methods and higher confidence levels in the accuracy of the output of the

FBS, predictive analytics can then analyze the data from the FBS and create projections of national food supply and utilization. The output of the predictive models will be shared with the MoALFI and the SFRTF on the online stock monitoring dashboard. The SFRTF can use these projections to make informed decisions about required amounts of stocks and areas of need. Validation exercises will establish trust in the system, comparing the output of the predictive models to actual data and refining the model based on any discrepancies.

2. *Integrate into regional food balance sheet:* It is not critical that each country establish a credible stand-alone FBS for regional compilation to take place. A regional FBS could be achieved through collaboration of government, private sector and development partners, regardless of the state of individual national FBS upgrades.

   Kenya has an opportunity be a regional leader for FBS. It can encourage regional peers to contribute to a regional FBS team (funded with contributions from EAC member states, private sector and development partners), and benefit from the economies of scale in setting up Remote Sensing Imagery (RSI) analytics and in significantly contributing to national FBS though the work of the rregional team. In a similar model in West Africa CILSS[xvii], since initiating trans-boundary collaboration to monitor informal trade – a key component of the FBS -- there has been a 71% decrease in bribe costs and 27% decrease in delays at border check points.[33]

Impact

Measure	Target	Rationale
Outcome objective	Boost household food resistance for ~4 million households at high risk during food emergencies, using indicators such as the Import Dependency Ratio (IDR)[xviii] and the Dietary Energy Supply (DES)[xix]	This builds on the ASTGS, where boosting household food resistance was identified as one of the three anchors of the strategy
Impact indicator	Identify opportunities to reduce volatility in stock purchases for SFR by 50%	Between 2016 and 2018, volatility in stock purchasing was >70% (measured as the standard deviation of the mean volume purchased), compared to ~30% 2013 and 2016

xvii Comité Inter-Etats de Lutte contre la Sècheresse au Sahel

xviii Recommended: Maintain IDR of <10%. The IDR increased from 10.5% in 2014 to 18.5% in 2017. The high IDR in 2017 was due to the import of more vegetable products, especially maize, to bridge the demand gap caused by the drought. A more stable IDR is a good indicator that the projections from the FBS facilitate better planning, particularly in emergency situations

xix Recommended: maintain DES of greater than 2300 in first 3 years and adjust target thereafter. A stable and higher DES would indicate increasing availability of food per person in the country, which serves as a proxy for the government's ability to manage stocks and trade, given the state of local production, to ensure there is sufficient food

Feasibility

Overall, implementing this use case is highly feasible as it is builds on ongoing efforts by incorporating digital solutions to increase the accuracy and frequency of data reported. As such, data-sharing platforms and key implementing partners exist, and, after some training, they will be able to operate the digital solutions.

- *Data availability:* Stock data and FBS data are already collected, with proxies defined, where needed, for each FBS component. However, there is room for more frequent and accurate data collection.
- *Technology:* The technology proposed is already in use and available e.g., for digitized stock monitoring systems, there are more than 5 private sector providers in the region with the required capabilities for elements of the solution – including Atlas AI, CropIn, GroIntelligence, Kimetrica, Wells Fargo and mSurvey.
- *Execution capacity of government:* KNBS has servers and a data centre for data aggregation, which they currently use to generate the FBS. However, running the predictive models is likely something that will be taken on entirely by the private sector provider, due to the more complex server infrastructure, bandwidth and security requirements for these models.
- *Risks to mitigate:* There is a liability risk associated with the output of the data projections; any inaccuracies could impact the level of food insecurity in the country and so it will be critical to run numerous validation and sampling exercises prior to using the projections for decision making. Also, several legislative changes are in process that would help improve data quality and accuracy – including the Warehouse Receipt Systems Bill (2019) which would increase the sources of data available from certified warehouses. Draft regulations are also pending on drones and other remote piloted aircraft systems that would for cheaper collection of aerial data.

What does this mean for the counties?

- Within the first three years of launching this use case, all national stocks will be monitored digitally and in real time. This will allow government decision makers, including the MoALFI and the SFRTF to view and estimate future stock needs, to support ~4 million food-insecure Kenyans across the country during emergency times (e.g., by moving stock between locations, and or purchasing new stock to high-need locations).
- Improved methods of data collection on granular food supply and consumption will also reliably inform key decision makers e.g., the national and county-level Cabinets on the level of food insecurity in the country by county, allowing for decisions around (e.g., where to allocate funds during food emergencies)

C. Budget proposal (KES M)

		YEAR 1 (2019/ 2020)	YEAR 2 (2020/ 2021)	YEAR 3 (2021/ 2022)	YEAR 4 (2022/ 2023)	TOTAL
A	OBJECTIVE 1: Digitized stock monitoring incl. hermetic bags (~85% of year 1 costs)	465.2	60.9	61.0	11.6	**598.8**
B	OBJECTIVE 2: Dashboard for FBS	7.0	4.2	3.3	2.8	**17.3**
C	OBJECTIVE 3: Satellite data collection for production data	17.5	18.4	19.3	-	**55.2**
D	OBJECTIVE 4: Analytics for trade proxies	2.5	0.1	0.1	-	**2.6**
E	OBJECTIVE 5: Predictive analytics model and personnel	12.0	2.1	1.1	1.1	**16.3**
F	Office Supplies & Administrative costs	25.2	4.3	4.2	0.8	**34.5**
	Sub Total Budget	**529.4**	**90.0**	**89.0**	**16.3**	**724.6**
	Total Project Expenses	**529.4**	**90.0**	**89.0**	**16.3**	**724.6**

D. Key milestones

1. **Set up preliminary version of dashboard and begin using in key decision-making meetings**: Set up dashboard tracking key metrics (raw data e.g., stock levels, domestic production by county, value chain and processed outputs e.g., the DES. *See Appendix 8.2 for others.* Current data sources should be used as input until data from improved sources is ready for use. Implement use in generating monthly MoALF Food Security reports for the PS, as well as other key decision-making meetings e.g., quarterly SFRTF board meetings where decisions are made about quantities of stock to purchase/release, weekly national security meetings held by the Cabinet where decisions are made about food price setting etc.
   - Responsibility: MoALFI, together with SFRTF
   - Start date: Q3 2019
2. **Sign MOU with pilot counties**: Detail new methods of data collection in pilot counties including agreement on data ownership and privacy for the four prioritized value chains (beans, maize, rice, wheat), in the eight counties that grow these value chains at above average yield (Elgeyo Marakwet, Kirinyaga, Mombasa, Nakuru, Tana River, Trans Nzoia, Uasin Gishu, West Pokot).
   - Responsibility: MoALFI, together with JASSCOM
   - Start date: Q4 2019

3. **Procure tools for digital solutions and set up platforms for launch**: Select private sector providers for the required digital solutions i.e., 1D barcode system for stock inventory, satellite data collection for crop production and advanced analytics for improved trade data collection. Begin data transmission from national stocks inventory management system and satellite data producers to KNBS servers and MoALFI dashboard.
   - Responsibility: MoALFI
   - Start date: Q4 2019
4. **Launch of digital solutions in pilot counties:** 1D barcode monitoring system to be set up in all 46 counties with depots/silos, with training for regional officers on use of tools and system. Launch crop production data collection in pilot counties, with provider carrying out ground-truthing exercises. Introduce advanced analytic tools in KRA, and train officers on use.
   - Responsibility: SFRTF, MoALFI
   - Start date: Q2 2020
5. **Scale up:** Scale national food reserve monitoring to remaining counties. Increase number of value chains for crop data collection. Begin livestock monitoring using satellite data collection.
   - Responsibility: SFRTF, MoALFI
   - Start date: Q2 2021

Use case 4: Make more dynamic trade and price stability decisions using an Early Warning System (EWS) for food price inflation

A. Challenges

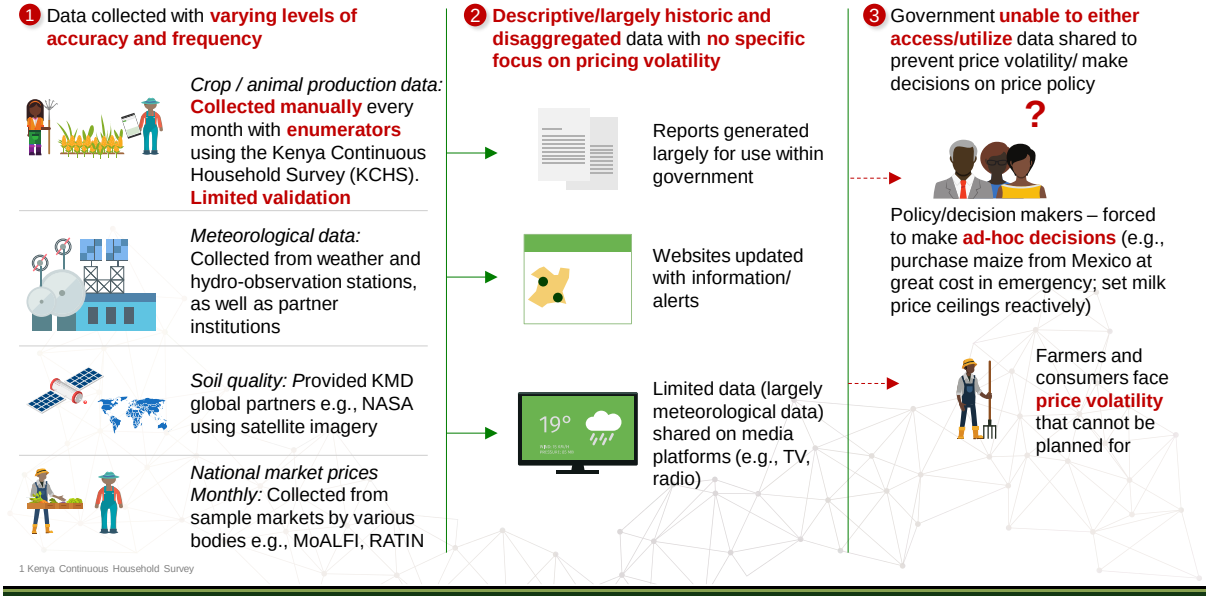
The government is not currently able to anticipate food price inflation, which often leads to reactive responses that leave the country in an unstable situation, e.g., using national food reserve stocks for price stabilization in lieu of help in-need populations during emergency situations. The ASTGS details out potential alternatives for price stability including commodity exchanges, improved crop forecasting, set-aside programmes and trading commodities in futures and options markets.

The Legal Notice 15 of the Public Finance Management Act, 2015, defines stabilizing food prices as part of the Strategic Food Reserve Trust Fund (SFRTF) mandate. However, doing so creates two main challenges: first, the current system of using stocks held by the National Cereals Produce Board (NCPB) as an agent of the SFRTF to buy and release stock into the market creates added uncertainty (e.g., NCPB activity raises prices by up to 15% vs. import tariffs by 2-3%).[34]Second, without a mandate for transparency in the evidence behind decision-making, accountability is more difficult.

Food price volatility is caused by several issues, but mostly by availability of food – including the impact of poor cold chains at the county level that can adversely affect availability. Therefore, some of the key indicators that determine price volatility are factors affecting food availability. An early warning system for food price inflation

would need to incorporate current levels of food availability (i.e., food production, levels of trade and amounts of stock) as well as factors potentially affecting future production, such as climate changes, changes in soil quality, pest infestations and disease outbreaks. In addition, domestic food prices are also influenced by global price fluctuations. Currently, all this data is collected, but by different bodies and shared on various, disaggregated platforms (*see Figure 7*). These datasets are not actively integrated to inform food price inflation and, as a result, the government is unable to utilize the data to define trade and pricing policy.

FIGURE 7: CURRENT APPROACH TO PRICE INFLATION ANALYTICS



The identification of reliable, accurate sources of data and the frequency of data collection will present a challenge in developing an early warning system for price inflation. The required data collection frequency will vary by dataset, e.g., current price levels need to be monitored daily, whereas crop production can be measured monthly. *See Appendix 8.3 for more detail on frequency of data collection for each of the metrics.*

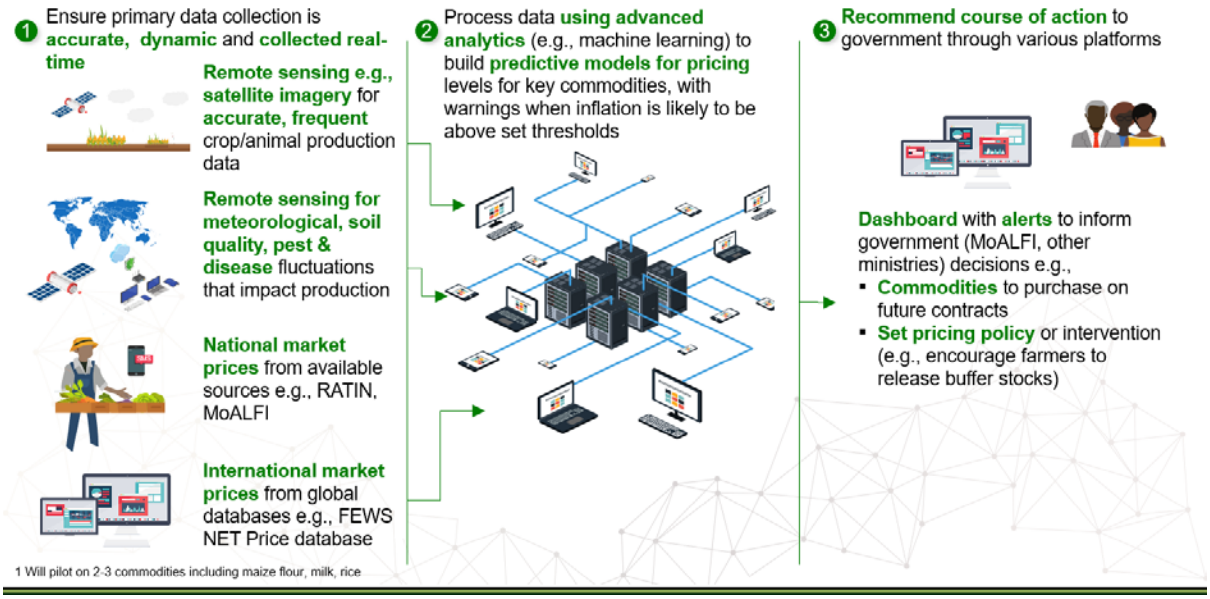
B. Proposed solution

To develop reliable early warning systems for price inflation, usable sources of data (i.e., accurate, with frequent collection) need to be identified for the various factors that influence price inflation (further details on this are given below). Predictive analytic models for projecting price changes can then be developed using data from these sources. The output of these predictive models will inform MoALFI decisions, e.g., future commodity purchases, price policy. *See Figure 8 for more detail.*

The Cabinet ultimately makes price-policy related decisions, such as when to implement price caps in the market/what prices to set. To do so, they are advised by the SFRTF, who make recommendations on what prices to set by pulling from various sources e.g., current market prices, costs of production, findings from research

institutions such as Tegemeo etc. As such, it is recommended that the SFRTF be the primary owner of the solution.

FIGURE 8: PROPOSED SOLUTION – INTEGRATED DATA SOURCES TO SPECIFICALLY INFORM AND FORECAST PRICE VOLATILITY



Identifying accurate sources of data for factors influencing price inflation

There are numerous sources for the data inputs that would be required to develop a food price inflation model for Kenya. It would be important to select the data sources using accurate methods and update this data frequently. Below are examples of potential data sources for each of the data metrics.

- **Domestic food production:** One of the biggest gaps in Kenyan agriculture is in the collection of agricultural production data. Currently, data is collected manually every month, with enumerators using the Kenya Continuous Household Survey (KCHS). However, due to manual data collection methods, there are high levels of inaccuracy. Given the influence of domestic food production on food prices, it is important to ensure accurate data collection – new methods of collecting production will need to be introduced.
- **Levels of trade:** The Kenya Revenue Authority (KRA) oversees trade in Kenya and is the primary custodian of trade data. However, agricultural data reported by the KRA is often unreliable and incomplete due to informal cross-border trade and tax exemptions for smuggled goods. Data analytic tools will improve trade data accuracy. More specifically, data-matching algorithms can identify discrepancies between reported tax and customs data. These discrepancies may indicate fraudulent activities. To proxy informal trade, indicators can be used, e.g., unexplained shocks in consumption patterns/in availability of a specific value chain in a market/area.
- **Availability of stock:** At any time, food stocks sit with various stakeholders in the agriculture supply chain. Stocks are held by the Strategic Food Reserve (SFR) committee, which manages stock through the National Cereals and Produce Board

(NCPB), an agent to the SFR committee. Other stocks sit with farmers, traders, millers and other commodity boards/associations. Of these, national food reserves are the most critical to track as these often have the greatest influence over market prices. However, manual inventory methods and inconsistent reporting frequencies make it challenging to keep track of stocks available at any point. Introducing digital inventory management using 1D barcodes on grain sacks to track quantities will introduce a standardized, accurate inventory management system on a national scale.

- **Meteorological data (weather/climate changes):** Kenya has a network of hydrometeorological observation stations consisting of >40 synoptic stations, >15 agrometeorological stations, >70 Automatic Weather Stations (AWSs), 3 airport weather observation systems, >15 hydrometeorological AWSs, ~1,000 rainfall stations, one upper air station and one global atmospheric watch.[35] Many of these stations are owned either by the Kenya Meteorological Department (KMD) or collaborators, e.g., the Kenya Meteorological Society, the Department of Meteorology at the University of Nairobi, etc., who provide the KMD with the data.

  In addition to nationally collected data, certain organizations collect global hydrometeorological data using remote sensing tools. As an example, the National Oceanic and Atmospheric Administration (NOAA) has publicly available satellite-based rainfall estimates for Kenya (e.g. already utilized by ACRE Africa for insurance, FEWS NET for EWS).

- **Soil quality changes:** Soil quality is largely determined by remote sensing tools in Kenya. NASA, for example, uses satellite imagery to determine qualities such as soil moisture content. This information is publicly available and is already in use, e.g., by FEWS NET for EWS.

- **Pest infestations and disease outbreaks:** Pest and disease outbreaks are tracked in several ways. The National Drought Management System (NDMA) collects survey data from the 23 ASAL counties in Kenya monthly, monitoring a few indicators, including the presence of diseases/pests. This information is published monthly on the NDMA website. In addition to this, the FAO Food Chain Crisis (FCC) management framework has an integrated forecasting approach to assess the likelihood of pest and disease outbreak based on two parameters: (1) the likelihood of threat from another country and further spread within the country; and (2) the likelihood of re-emergence within the country. Finally, a number of new initiatives triangulate methods to predict the risk of outbreaks. The a Pest Risk Information Service (PRISE) programme, for example, is a collaborative initiative in which the Center for Agriculture and Bioscience International (CABI) has partnered with KALRO and the MoALFI to use a combination of earth observation technology + plant health modelling + real-time field observations to predict risk of pest/disease outbreak. Field data is fed into the system iteratively to increase accuracy.

- **Market prices:** Domestically, market prices are collected by several players. The NDMA investigates and reports on price changes in ASAL counties monthly. The Regional Agriculture Trade Intelligence Network (RATIN) uses enumerators to

collect daily market prices from various sources (traders, markets, etc.). Private sector players, e.g., Esoko, also keep track of domestic food prices. For global food market prices, several development partners publish value chain-specific price data on either a monthly or weekly basis (e.g., FEWS NET and FAO's Global Information and Early Warning System– GIEWS, the Predictive Livestock Early Warning System – PLEWS, and the Food Security Network -- FSN).

Increasing accuracy of data sources, and particularly of domestic food production, trade and national stocks, was identified as a critical enabler to having a meaningful and useful Food Balance Sheet. Furthermore, more accurate methods of data collection are needed, e.g., remote sensing tools such as satellite imagery to measure domestic food production. The EWS price inflation tool could build on these data sources once they are in use.

Food prices are highly sensitive to any market shocks. For this use case to be successful, it will be important that the data used is as exhaustive as possible in capturing market influences. Therefore, in addition to public data, there would be great benefit in being able to utilize private sector data, as indicators such as trader stocks could significantly impact markets and prices. Such transparency and openness in sharing data is what has allowed systems such as the Agriculture Market Information System (AMIS) utilized by the G20 countries, to be effective at influencing policy decision-making to support price stability.

Impact

Measure	Target	Rationale
Objective (impact)	Boost household food resilience for ~4 million insecure Kenyans	This builds on the ASTGS, where boosting household food resistance was identified as one of the three anchors of the strategy
Outcome indicator	Identify opportunities to reduce volatility in food prices by 50% to match regional averages	Price volatility is currently 2x regional average (incl. Uganda, Tanzania, Burundi, Rwanda) for key staples

Feasibility

The feasibility of this case is quite high, as the data required to set up the price inflation tool is available and will likely be improved in accuracy due to other initiatives e.g., the Food Balance Sheet. Similar initiatives in the region to develop tools for predicting price changes are evidence of feasibility, e.g., in Ethiopia and South Sudan, given comparable data availability between these countries and Kenya.

- *Data availability:* As described, all the data required to develop the EWS is available in Kenya, often from multiple sources. If specific sources are proven to be more accurate than others, these should be prioritized in the predictive model. Otherwise, triangulation between various inputs can be done.
- *Technology:* The technology proposed is already in use, e.g., in Ethiopia and South Sudan supported by full service providers like Kimetrica, Precision Agriculture, as

well as Gro-Intelligence, and m-Survey for pricing information. The right inputs for Kenya will need to be determined.

- *Execution capacity of government:* The execution of this use case will sit with a private sector provider with the required data analytic capabilities. However, there is a need to more clearly define the policies that will inform decision making using the tool.
- *Risks to mitigate:*
  - This digital solution will help add transparency to decision making, but impact is at risk with the current price stability approach managed by NCPB, particularly if the recommendations in the ASTGS take time to implement.
  - The Warehouse Receipt Systems Bill (2019) which would increase the sources of data available from certified warehouses on stocks of commodities which are important to help understand potential pricing movement.
  - There is a liability risk associated with the output of the data projections; any inaccuracies could significantly impact the level of food insecurity in the country and so it would be critical to run validation and sampling exercises prior to using the projections for decision making.

What does this mean for the counties?

- Food price stability will positively affect consumers, who often have to adjust spending and eating patterns based on price fluctuations.
- Food price stability and predictability will also help stabilize incomes for farmers, who will have more consistency with their earnings from produce.

C. Budget proposal (KES M)

		YEAR 1 (2019/ 2020)	YEAR 2 (2020/ 2021)	YEAR 3 (2021/ 2022)	YEAR 4 (2022/ 2023)	TOTAL
A	OBJECTIVE 1: Develop predictive algorithms	-	14.0	4.2	3.3	**21.5**
B	OBJECTIVE 2: Utilize dashboard for decision making	-	5.0	2.1	1.1	**8.2**
F	Office Supplies & Administrative Costs	-	1.0	0.3	0.2	**1.5**
	Sub Total Budget	**-**	**20.0**	**6.6**	**4.6**	**31.2**
	Total Project Expenses	**-**	**20.0**	**6.6**	**4.6**	**31.2**

Note: Some elements of the use case fall under KCSAP subcomponent 3.3, clause 81 on strengthening existing market information systems. Before begin implementation of the use case in 2020/2021, re-align with KCSAP programme leads on design needs

D. Key milestones

1. **Identify private sector provider to develop Early Warning System tool:** Select private sector provider with data analytics and modelling expertise.
   - Responsibility: MoALFI
   - Start date: Q4 2020
2. **Select sources of data and develop predictive model:** To maintain transparency, the private sector provider should independently assess accuracy of data sources (e.g., by checking published data vs. actual data) and select the most accurate sources for each of the required data inputs. Agreements should be drafted between the EWS tool developer and the data providers, outlining the terms of data sharing between them. The EWS tool should build on other ongoing initiatives, e.g., the data collection improvement methods proposed for the food balance sheet.
   - Responsibility: MoALFI
   - Start date: Q4 2020
3. **Set up dashboard and begin testing output of model against real-time market data:** Set up a dashboard for tracking and visualizing key metrics (current and future food prices for each commodity, at the county level). Dashboard should also push alerts on any significant changes in price levels (either spikes or dips).
   - Responsibility: MoALFI, work closely with institutions like Tegemeo, KNBS
   - Start date: Q2 2021
4. **Begin to use dashboard for decision making relevant Cabinet national security meetings:** Implement use of dashboard in weekly national security meetings, in which food price decisions are made e.g., when to implement price caps, and what price to set these at.
   - Responsibility: MoALFI, work closely with institutions like Tegemeo, KNBS
   - Start date: Q3 2021

Use case 5: Improve value chain selection using an agricultural land optimization model including considerations for water resources, and livestock migratory patterns ***that responds to specific outcomes (e.g., job creation, increase GDP) with a focus on ASAL areas***

A. Challenges

MoALFI can boost household food resilience through food availability by ensuring year-round production in all parts of the country that are agriculturally active. Kenya is facing the worst drought in ~40 years, and slow recovery from the 2016/17 drought means the effects will be felt through 2020.[36] Additionally, there is below-average agricultural production and pasture deterioration leading to food insecurity and decreased SSF incomes.[37] The prolonged droughts pose immediate challenges to food

security plans and mean that value chains prioritized for national food security need to be carefully evaluated.

Kenya currently produces ~100 value chains with widely varying yields. There is an opportunity to improve the current value chain selection process, at national and county level, to increase availability of food nationally (*see Figure 5*). At the national level, ASTGS identified 13 priority value chains to support agricultural transformation based on national priorities (e.g., Vision 2030, Big Four), Kenya's agroecology, and some economic modelling to identify value chains with the potential to boost small-scale farmer incomes (e.g., IFPRI-RIAPA).[xx]

At the county level, most of the County Executive Committee (CECs) engaged wanted better data and analytical tools to conduct a more rigorous value chain selection process. Counties select value chains as part of ASDSP process without access to granular (i.e. sub-county) crop-maps, water basin and table information, and/or livestock migratory patterns, and with limited forward-looking information (e.g., climate, market expectations). Consequently, observe significant yield differences for the same value chain – crops and livestock -- across counties in the same region (e.g., 2-10x).[xxi]

Today, county value chain selection is typically based on historical trends, and perceived future "cash cow" value chains, which are not always aligned with market realities and the agro-ecological realities of the counties. A number of institutions have historically collected land use data that could help counties in this process (e.g., the Regional Centre for Mapping Resource for Development - RCMRD and the Department of Resource Surveys and Remote Sensing - DRSRS), and this use case would deepen the reach of their data to support decision making. *See Figure 9 for more details.*

B. Proposed solution

The proposed solution is an agricultural land optimization model that provides evidence-based insights on land use to policymakers and dynamically responds to specific agreed outcomes. This advanced analytical tool will model the potential impact of switching value chains in certain regions on the specified desired outcome. It will be used for value chain prioritization to help the government better prioritize investments within the counties.

1. **MoALFI will specify the desired outcome of the land optimization model** based on national priorities such as ASTGS, Second Medium-Term Plan (MTPII), etc., ensuring it is aligned to county government plans (e.g., ASDSP). It is critical to ensure input from farmers when selecting these priorities. For example, the model can be used to recommend value chains with the highest potential to maintain farmer incomes during sustained periods of drought or the value chains that increase nutritional diversity.

xx Rural Investment and Policy Analysis model that uses computational General Equilibrium methods
xxi KNBS

FIGURE 9: CURRENT APPROACH TO VALUE CHAIN SELECTION

EXAMPLE: VALUE CHAIN SELECTION

National process

I Ministry of Lands **recommends long term high-potential agriculture areas** (e.g., 2015-2045 National Spatial Plan, Land Use Policy 2017)

⚠ *Shorter-term national agendas take precedence over longer-term plans in reality (e.g., zoned ag land used for commercial buildings)*

II Current government **sets short-term national development agenda** with implications for agricultural value chains (VCs) (e.g., Big Four – manufacturing, which requires cotton)

III MoALFI **consults development partners on economic models** to meet priorities (e.g., IFPRI-RIAPA[1] for VCs that boost farmer income – poultry vs. support employment like coffee)

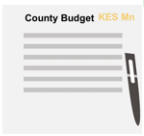
⚠ *Models not tailored to evolving ASTGS context, based on econometrics vs. Big Data methods*

IV MOALFI **implements projects with specific VCs** aligned with national agenda, in consultation with the counties (e.g., Kenya Climate Smart Agriculture - X)

⚠ *>65% of high and medium agriculture potential land is community owned by multi-cropping share holders (<0.5ha). Difficult to scale single VC interventions, and apply technology (e.g., mechanization)*

Selected value drains

County process



III **Agriculture CECs prioritize VCs** and codify into ASDSP plans (every ~2-3 yrs), and seek funding in county budgets (annual)

⚠
- *Counties need evidence to determine which VCs to prioritise; based on focus funders or previous experience with VCs*
- *Priorities sometimes misaligned with agro-ecological base and national priorities*

II County officials meet **with private sector investors and development partners** willing to fund specific VC projects

I Agricultural and extension officers **observe production trends at sub-country level**, and informally **survey farmers** on VCs they can and want to grow

⚠ *Irregular process with varying rigour, sensitive to "fads"; risk misalignment with agro-ecological and market reality*

1 Rural Investment and Policy Analysis model that uses computational General Equilibrium methods

10

2. **Datasets will be selected as inputs to the model to provide a detailed outlook on land use.** This will involve assessment of existing agricultural data and potential data needs, such as regional yield and export market data and satellite imagery data on crop plans and water bodies. Local datasets such as production volume per value chain, farmer demographics, climate data and market information are collected as inputs to the model. Existing data can be collected from institutions such as MoALFI's State Departments, Regional Centre for Mapping Resource for Development (RCMRD), and Kenya Meteorological Department, among others. Agronomic archetypes of specific regions will be developed to model crop yields and expected production by agronomic zone. For example, the seven agro-climatic zones categorized by the National Spatial Plan can be used as the agronomic archetypes.[38] These datasets will be integrated onto a single platform that multiple players can access. This will be supported by data policies on data sharing, security and privacy protocols.

3. **Advanced analytical tool will overlay the datasets captured** to produce a detailed outlook on current land use. Combined with land suitability, this analysis will aid understanding of the potential impact of shifting to different value chains on the desired outcome. The analytical tool will model and determine the economic potential of the value chains at a national level and link value chains to specific counties based on agronomic suitability. The Suitability Mapping Project, as part of ASDSP and with support from University of Nairobi, is developing maps showing the suitability of the previously selected value chains in the counties, based on agronomic, economic and social factors using multiple statistical, analytical and modelling tools such as QGIS, R and MS Excel. This use case will map suitability of all value chains (estimated at ~100 value chains) at a national level to enable prescriptive modelling.

4. MoALFI can use the output from the model **to prioritize national investments and provide counties with data to support farmers with what to grow or rear.** This output can be used to recommend high-potential value chains to decision makers, such as county and national government (CECs, Agriculture County Officers), and the amount of land and other resources to dedicate to each value chain. Additionally, it can be used to advise policy decisions and investments on subsidies for inputs on specific value chains. According to the land use polices outlined in the Draft Agricultural Policy 2019, county governments will provide land use strategies to achieve optimum productivity. This model will assist county governments in making decisions aligned to this.

5. **The output from the model will feed into the extension services used to support farmers and ensure implementation of policy changes.** Potentially shifting to a new value chain will require farmers to change their agricultural practices, such as type of inputs purchased, and this support will be provided by extension services (both physical and digital). *See use case 5 for more details on e-extension services.* Counties will need to provide an enabling environment to set up markets and trade to ensure farmers have access to markets

and can improve their income. *Appendix 8.4* shows the key metrics that can be used to monitor the progress and impact of land optimization use case.

It is important to note that individual solutions exist at a farmer level – using similar data -- to help support value chain selection (e.g., Waterwatch, CropIn). These solutions are complementary to this use case that optimizes outcomes across counties, and across the nation where implications for land use can be quite different from the household level.

Impact

Measure	Target	Rationale
Overall objective	Boost household food resilience for 1.3m farming, pastoralist, and fishing ASAL households during drought	ASTGS outlines that currently, ~1.5mn Kenyans are chronically food-insecure, including 1.3mn in ASALs. By determining high-potential value chains for ASAL regions, the model will improve food availability throughout the year especially in areas that are chronically insecure and vulnerable to drought.[39]
Project indicator	Identify value chains with potential to double small-scale farmer yields	Based on minimum gap between average yield, and maximum yield for selected value chains including sorghum, cowpeas, green grams, cassava, and livestock products incl. milk, mutton, beef 16 ASAL counties. [40]

Feasibility

Land optimization model use case has medium feasibility. Although the technology for this solution exists, MoALFI will need to invest in the infrastructure and execution capability required to implement the solution.

- *Data availability:* Some of the data is available, however fragmented, and data would need to be audited and aggregated. Satellite data is usable but more granular data may not be accurate or recent.
- *Technology:* Several providers exist with knowledge of the technology required for this solution, including CropIn, ACRE Africa, Waterwatch Cooperative and GroIntelligence. Based on their previous experience implementing such solutions, the use case can be piloted in 6-10 weeks.
- *Execution capability:* MoALFI would need to up-skill staff (or recruit) on data analysis to ensure proficiency in structuring and analyzing complex big data sets as well as using the analytical tool. This would also require the ministry to invest in a data warehouse or data lake or use KALRO's bigdata platform.
- *Cost:* Solution elements all exist but require infrastructure investment in analytical software and a data warehouse/lake as well as investment in building capability.
- *Risks:* The value chain selection process is clearly outlined and leads to budgetary allocations with the ASDSP process. In fact, the output from the model will also

assist national and county governments deliver on the land use polices outlined in the Draft National Agricultural Policy 2019. However, there is no guarantee that farmers will switch value chains recommended by the model, particularly because land ownership, last-mile extension and fragmentation post a challenge to farmers scaling. Finally, ground-truthing is essential as satellite data and current remote sensing technologies is not particularly sensitive to issues like nematodes.

What does this mean for the counties?

- Reduced number of households that are food-insecure and in need of emergency aid during drought.
  - Development of counties due to targeted investments and evidence-based decision making.
- Improved livelihood and welfare of small-scale farmers through increase in incomes because of increased yield.

C. Budget proposal (KES M)

		YEAR 1 (2019/ 2020)	YEAR 2 (2020/ 2021)	YEAR 3 (2021/ 2022)	YEAR 4 (2022/ 2023)	TOTAL
B	OBJECTIVE 1: Overlay existing (and eventually new) datasets using analytical solution	-	41.4	36.2	38.0	**115.6**
C	OBJECTIVE 2: Collect new data and use model output to impact policy through extension agents	-	0.0	0.6	0.3	**1.0**
D	Project Monitoring & Evaluation	-	0.0	0.6	0.2	**0.8**
E	Personnel Costs	-	2.5	13.7	14.4	**30.6**
F	Office Supplies	-	2.1	1.8	1.9	**5.8**
G	Vehicle Operation/Transport, Accomodation & DSACosts	-	0.1	0.1	0.1	**0.3**
H	Partner Meetings/Workshops	-	0.5	7.0	2.2	**9.7**
I	Project Equipment	-	0.2	1.5	-	**1.7**
	Sub Total Budget	**-**	**46.9**	**61.6**	**57.1**	**165.6**
	Total Project Expenses	**-**	**46.9**	**61.6**	**57.1**	**165.6**

D. Key milestones

1. **Pilot model in two counties so that the model is delivered for main planting season in Q1 2021.** Propose Trans Nzoia and Uasin Gishu as counties that have invested in data collection and improving agricultural statistics, may change closer to implementation.
   - Responsibility: MoALFI, KALRO, ASDSP County Leaders
   - Start date: Q4 2020
2. **Scale model to 30 counties in ASAL region for main planting season in Q1 2022.** [xxii] Use lessons learnt from pilot counties to scale to 30 counties in ASAL region with initial focus on the 16 most arid counties as categorized by ASTGS flagship 5.[xxiii]
   - Responsibility: MoALFI, KALRO, ASDSP County Leaders
   - Start date: Q4 2021
3. **Scale model to remaining 15 counties nationally for main planting season in Q1 2023.** Ensure this is aligned to the ASDSP value chain selection process and is linked to the Suitability Mapping project.
   - Responsibility: MoALFI, KALRO, ASDSP County Leaders
   - Start date: Q4 2022

NB: The start date is pegged on planting season; however, this can be adjusted for livestock and fish farming as appropriate.

Cross-cutting support

Use case 6: Support M&E using a dashboard that streamlines data collection, verification and visualization of ~10 outcome-focused transformation KPIs linked to ASTGS

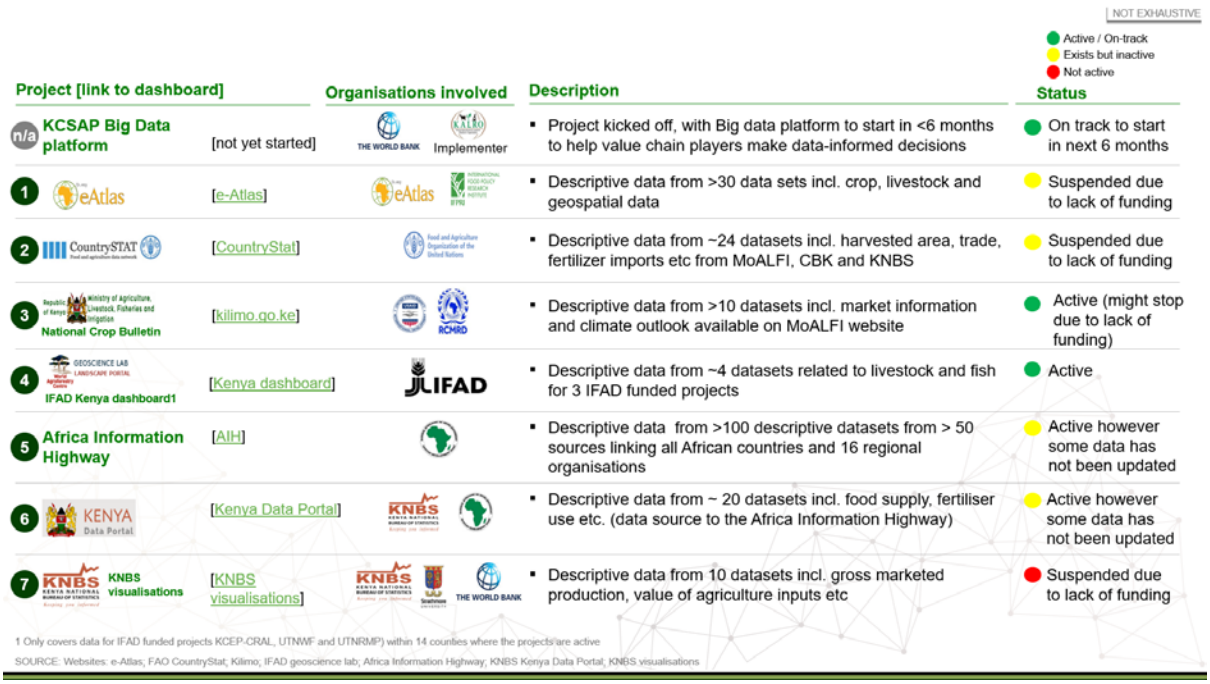
A. Challenges

Key GoK decision makers (e.g., MoALFI Permanent Secretary, Treasury), struggle to make evidence-based decisions due to a number of challenges. First, most agricultural data collected by MoALFI is administrative in nature and used for reporting historical trends (e.g., production by value chain), not for decision making (e.g., predictive analytics on future yields). Second, agricultural data is siloed within Ministry, GoK and counties and not easily searchable.[xxiv] Similarly, private sector and development partners may have more accurate data but are not incentivized to share. Finally, over seven data visualization efforts cataloguing >1,000 variables of MoALFI data have been implemented or are in the pipeline for implementation in partnership with development partners. However, many of these efforts have been suspended due to lack of funding for their large scope, and/or it is not clear how they can best be used to

xxii Vision 2030 Development Strategy for Northern Kenya and other Arid Lands defines 30 counties in ASAL region
xxiii ASTGS Flagship 6 in the first five years will focus on Embu, Kitui, Laikipia, Garissa, Isiolo, Kajiado, Machakos, Makueni, Mandera, Marsabit, Samburu, Tana River, Taita Taveta, Turkana, Wajir, and West Pokot
xxiv Observed data saved on individual employee laptops at Ministry; updated or most recent information is available via a phone call

support the M&E process and inform decisions by Ministry leadership *(See Figure 10 below)*.

FIGURE 10: STATUS OF SELECTED EXISTING VISUALIZATION EFFORTS



B. Proposed solution

The proposed solution is a dashboard leveraging existing visualization efforts mentioned above and used to support M&E. The dashboard will integrate ~10 key metrics, focused on those MoALFI Senior Leadership use most often to make decisions (e.g., yield by value chain) and ASTGS flagship implementation indicators as shown in *Figure 11*. Some of these metrics are aligned to those monitoring impact of the Big 4 agenda of ensuring 100% food and nutrition security such as food availability and fertilizer consumption. [xxv]

xxv Parliamentary Service Commission, "Eye on the Big Four: Budget Watch for 2018/19 and the Medium Term"

FIGURE 11: SAMPLE MOALFI VISUALIZATION DASHBOARD

The dashboard will initially focus on the 13 value chains prioritized in ASTGS: staples (maize, potatoes, rice, beans); horticulture (fruits, vegetables); livestock and fish (beef, poultry, sheep/goats, camels, fish, dairy); and other (imported wheat).[41] The primary data source for these KPIs is MoALFI. Additionally, seven out of the 12 key metrics (excluding ASTGS flagship category), are monitored by the Kenya Data Portal, whose main data sources are FAO and KNBS. The dashboard will be used as a decision-making tool and be the single source of truth from MoALFI to the Office of the President, Cabinet, Treasury, etc. For this reason, the data represented should be of high quality, i.e., accurate, consistent, timely, representative and statistically sound. By focusing on this, MoALFI will start to streamline the data collection methodologies at the county level for the specific metrics.

The dashboard will be owned by the Principle Secretary (PS) and managed by the Agricultural Transformation Office (ATO) at MoALFI. The Agricultural Statistics Units (ASUs) of the State Departments (Crops, Livestock, Fisheries and Irrigation) will coordinate the updating of the dashboard by including it as part of their reporting process. Operational cadence is important to ensure continued use of the data for decision making and has implications on improving data collection. The dashboard should be reviewed at the bi-monthly MoALFI Directors' meeting, chaired by the PS. It will also be reviewed by the Cabinet Secretary (CS) monthly and quarterly at the County Executive Committee (CEC) and County Officials (CO) meetings. Additionally, employees at Kilimo will have access to the dashboard through screens in select offices and channels such as the Ministry website and mobile applications.

In addition to Ministry data, MoALFI can use existing visualization efforts to update the dashboard. It can develop an application programming interface (API) platform that will enable access to a wider number of databases, e.g., Africa Information Highway and Kenya Data Portal, that already have APIs. MoALFI can publish the KPIs to encourage all willing institutions to provide links to their data.

Policies on data management will need to be implemented including:

- Develop agreements with institutions to guide the data exchange from institutions (including KNBS) to MoALFI.
- Define access rules and rights to the data used.
- Develop permission plan and appropriate governance for users to view/edit data.

To develop the dashboard, simple visualization or open-source tools with the right level of security and privacy are recommended to ensure quick implementation of the dashboard including but not limited to Microsoft Power BI, Tableau, Plotyly, and Qlickview.

C. *Budget proposal (KES M)*

Project Code	Account Code	Description	2019	2020	2021	2022	TOTAL
			YEAR 1	YEAR 2	YEAR 3	YEAR 4	
	A	OBJECTIVE 1: Set up data transfer from existing sources to MOALFI	0.3	1.3	1.3	1.4	**4.3**
	B	OBJECTIVE 2: Develop visualization tool	0.1	0.6	0.7	0.7	**2.1**
	C	OBJECTIVE 3: N/A	-	-	-	-	**-**
	D	Project Monitoring & Evaluation (costs accounted for in prior use cases, avoiding double counting)	-	-	-	-	**-**
	E	Personnel Costs	0.9	14.0	14.7	15.5	**45.2**
	F	Office Supplies & Administrative Costs	0.0	0.1	0.1	0.1	**0.3**
	G	Vehicle Operation/Transport, Accomodation & DSACosts	-	-	-	-	**-**
	H	Partner Meetings/Workshops	3.5	3.7	3.9	4.1	**15.1**
	I	Project Equipment	0.3	0.6	-	-	**0.9**
		Sub Total Budget	**5.2**	**20.3**	**20.7**	**21.7**	**67.9**
		Total Project Expenses	**5.2**	**20.3**	**20.7**	**21.7**	**67.9**

D. Key milestones

1. **Design the dashboard minimum viable product (MVP) with the key users and develop visualization tool to be used.** MVP design should be focused on key users (senior management and leadership), but mindful of MoALFI capabilities and infrastructure. Select the most suitable visualization tool that will be easy to use and fast to implement. Purchase screens and other access channels.
   - Responsibility: MoALFI
   - Start date: Q3 2019
2. **Develop processes and policies on data management.** This includes data collection from counties, from other institutions such as KALRO and KNBS and existing visualization efforts. Processes should include operational cadence such as review during bi-monthly Directors' meetings, frequency of data collection and updates to the dashboard.
   - Responsibility: MoALFI, KALRO
   - Start date: Q3 2019
3. **Train and build capabilities of ATO officials on dashboard management.** Together with solution provider train the team responsible for dashboard management.
   - Responsibility: MoALFI
   - Start date: Q3 2019
4. **Launch MVP dashboard using available data and tools** on a stand-alone channel. Gradually transition to Kilimo website and other access channels as the dashboard develops (e.g., TV screens around Kilimo). Use feedback from dashboard users to update and upgrade.
   - Responsibility: MoALFI
   - Start date: Q4 2020

Use case 7: Establish standards and protocols for a shared-access national agriculture data platform with the use case data as the baseline. Platform will enable more evidence-based interventions from stakeholders with access

A. *Challenges*

There is a lot of agricultural data collected and stored by multiple stakeholders such as public sector institutions, private sector players and development partners. More than seven online government databases exist today for agricultural data including the Kenya Agricultural Information Network (KAINet) exist, *see Appendix 10*. Many of these data bases have not been updated in several years. There are profiles of ~2 million farmers registered on three platforms, i.e., Digifarm, MOA-Info and OneAcre. Data on drought and early warning indicators can be found on National Drought Management Authority (NDMA) and Famine Early Warning Systems Network (FEWS NET).

The decentralized nature of data management is an and of itself not an issue. The challenge arises when the data cannot be seamlessly exchanged with authorized users for their access, with a guarantee that the data is of high quality and integrity. This current situation does not provide for a simple exchange of data, there is significant mistrust in data, duplication, wasted efforts, difficulty in scaling the data, and the inability to clearly identify the impact of certain interventions.

B. Proposed solution

Through the Kenya Climate Smart Project (KCSAP), KALRO will set up and host a big data analytics platform that will provide agriculture insights through machine-advanced analytics and data mining of datasets from various sources. For example, it will integrate agriculture datasets from public and research institutions. With KALRO's technical infrastructure and capabilities and funding from KCSAP, the programme will take off. However, to ensure sustainable implementation the challenges must be addressed. Lack of a national data governance framework will slow down platform implementation and the use cases can provide a baseline for data governance.

The recommended solution is to establish standards and protocols, owned and developed by MoALFI, through the use cases to support implementation of the joint access platform. This will provide an enabling environment by resolving the challenges that hinder execution of a successful platform:

1. Through implementation of the use cases, a **data governance framework will be developed, highlighting data access, security, sharing, exchange and ownership** (*see section 3 on data governance*). A data governance framework will guide the operating model and provide policies to exchange data while maintaining ownership and security levels of sharing parties. For example, the Open Algorithms (OPAL), a data platform that uses private data for public good, built privacy features into its data platform complying with General Data Protection Regulation (GDPR). This protects privacy of individuals, groups and companies using the data

platform in Senegal and Colombia. In Colombia, it was used to plan the national population census operations based on mobile phone data.[42] MoALFI should own and champion data governance to encourage sharing and exchange of data within government, research institutions and eventually the private sector.

2. The use cases provide **a manageable scope to develop the data platform** as they will be piloted in a subset of counties and value chains. A large scope and attempt to develop data platforms for every possible dataset from every data source may lead to the platform not being implemented. The use cases cover ~10 data domains from ~20 institutions, and the proposal is to phase incorporating these various data elements onto the shared-access platform. Initially, start with data from the main data producers, i.e., MoALFI and KNBS as well as KALRO's own data. *See Figure 12* below.

   Once the data platform is stable, expand data sources to other research institutions such as Egerton University's Tegemeo Institute and government sectors such as Ministry of Trade and Co-operatives, and even county governments directly – if it is of the right quality. This will ensure that the policies and protocols (governance) are in place and any learning can be used to adjust the data platform. Eventually the platform will be open to private sector players and development partners.

FIGURE 12: DATA REQUIRED FOR THE USE CASES COVERS ~10 DOMAINS FROM ~20 INSTITUTIONS

NOT EXHAUSTIVE

Category	Metric[1] (unit)	Domain[2]	Security level[3]	Primary host institution	National || County	Frequency required	Relevant use cases
Macro-economic	Ag GDP (KES)	Economic	L	KNBS	✓	Quarterly	5
Socio-economic	Food consumption (KES)	Consumption	L	KNBS; Kenya Tourist Board	✓ ✓	Annually	3 5
	Ave. income of SSF (KES)	Economic	L	KNBS	✓ ✓	Annually	5
	Food deficit (kcal/capita/day)	Food availability	L	County Department of Ag World Bank	✓ ✓	Quarterly	5
Ag specific metric	Ave. land size for specific farmers, by location (ha)	Farmer registry	M	MoALFI	✓ ✓	Seasonal	1 2
	Production per value chain* (T)	Production	L	Private sector provider e.g., CropIn, Atlas AI MoALFI SDs Farmer reported	✓ ✓	Real-time Monthly Bi-annually	3 4 5 1
	Harvest volume, post-harvest losses per value chain (T)	Supply	L	Private sector provider County Department of Ag	✓ ✓	Real-time Monthly	3 5
	Manufactured feed[4] (T)	Supply	L	Private sector players	✓ ✓	Monthly	3
	Stock storage (T)	Supply	L	NCPB, KNBS, Commodity Board	✓ ✓	Monthly	3 4
	Trade – domestic and cross-border (T)	Trade	L	County Department Ag KRA	✓ ✓	Monthly	3 4
	Market prices per value chain - domestic and international* (KES)	Trade	L	RATIN		Daily	4 5
Natural resources	Rainfall amount (mm) Temperature (°C)	Climate	L	KMD	✓ ✓	Daily	4 5
	Soil quality (pH level, kg/ha)	Soil data	L	KMD, NASA, KALRO	✓	Monthly	4 5
	Incidences of pest and disease (Number)	Pests and diseases	L	NDMA, KEPHIS Private sector provider	✓	Monthly	4 5

* This data domain exists in the current government platform i.e. production in NaHMIS, LINKS; Trade in NaHMIS, LINKS, NLMIS. Refer to appendix

1 Includes all metric that are not outputs of the digital use case solution, see appendix for more detail | 2 Data domain refers to data coming from one specific entity or data that is related e.g., climate, farmer profiles, demographic | 3 Most agriculture data is public and therefore low security level | 4 Manufactured feed is the most common industrial use of food. e.g. feed for livestock, fish etc.)

3. Delivery of use cases depends on the **private sector as implementation partners either for technology solutions or operations to scale use cases.** Several potential solution providers have the requisite technology to support use case 7, including MS Azure, Oracle Cloud, and Amazon Web Services. This will facilitate buy-in from all implementers of use cases to provide data (e.g., through APIs). This will also provide incentives to encourage private sector participation through implementation of enabling use cases.

Implementation of a full-scale national platform will require extensive coordination and engagement across public sector players. In countries where this has been successful (e.g., Zambia, Sierra Leone) the Ministry of ICT (or Authority) has a leadership role and power to implement sustainable platforms quickly and efficiently. MoALFI, with the support of Ministry of ICT, can provide a case example to the rest of the sectors on how this can succeed. This is in line with GODAN recommendation by Office of Deputy President and Ministry of ICT to use MoALFI as a showcase to other Ministries on Open Data management.[xxvi] *See Box 4 for details on Zambia.*

Box 4 – Zambia Agriculture Management Information System (ZIAMIS)

ZIAMIS was developed to support the management of different agriculture processes such as farmer registration and Farmer Input Support Programme (FISP), including e-Voucher System.

It was designed with multiple interfaces and functionalities for the different users: >90 agro-input suppliers, 1,500 agrodealers, and >1.5m farmers, ~6 banks and 2 mobile payment providers for real-time management of payments and monitoring of transactions.

It was implemented together with SMART Zambia institute (SZI), a division under the Office of the President.

A key success factor is SZI's mandate, which cuts across all public sector players to integrate, coordinate and standardize ICT infrastructure platforms, enabling a conducive environment that supports development of the national agriculture platform.

C. Budget proposal (KES M)

The Big Data platform being developed at KALRO, through KCSAP, has dedicated funding to set up the infrastructure (~KES 180M) including servers, cloud-hosted components that should be operational by September 2019 – hardware systems are being procured. There is also dedicated funding to integrate the agro-weather advisory system *(a key component for use cases 2-5)*, market information systems *(a key component for use cases 2 and 5)*. Detailed conversations with KALRO and KCSAP aligned that implementing use case 7 is a good way to kick-start the big data platform with the guidelines laid out herewithin.

D. Key milestones

1. **Develop and implement data governance including policies on data sharing, exchange and access.** Develop governance framework using KALRO policies as baseline to adjust, considering national laws and regulations related to data e.g. Draft Data Protection Bill 2018.
   - Responsibility: MoALFI together with KALRO and Ministry of ICT
   - Start date: Q3 2019

xxvi Kenya GODAN brief May 2018, Ministry of Agriculture and Irrigation State Department of Crops Development

2. **Update TOR (as need be) for vendor to support Big Data platform at KALRO that will house this use case.** This document – including the identified data domains for the above six use cases, governance recommendations including privacy, sharing, exchange and access should provide guidance.
   - Responsibility: MoALFI together with KALRO
   - Start date: Q3 2019
3. **Set up data lake that can start to consolidate GoK data** with priority on MoALFI, KALRO and KNBS data, with the appropriate privacy considerations *(start with low-level security data)*
   - Responsibility: KALRO
   - Start date: Q4 2020
4. **Continue to lobby for policy changes** (e.g., Data Privacy Bill, Open Data Bill) that will support implementation of use cases 1-7. Work closely with the Legislative and Intergovernmental Liaison Office (LiLO) at the Office of the Deputy President.
   - Responsibility: MoALFI
   - Start date: Ongoing

Bringing it all together

The use cases are designed to be stand-alone, but interoperable. Together, the total cost of the digital solutions is ~KES 2.0B total by 2023 (~10% of the ASTGS budget estimate for enablers), with development partners interested to fund at least KES 300M as detailed below in *Box 5*. An additional ~KES total 3.2B is required for the actual e-voucher disbursement *(use case 1)*, once the full KES 5B p.a. amount in NAAIAP and other input support programmes is repurposed to the new proposed system.

Box 5: PROPOSED BUDGET FOR THE DIGITAL USE CASES (2019-2023)

*Unit: KES M; *indicates development partner willingness to fund; + indicates significant non-digital cost*

Line Item	KES, M	YEAR 1 (19/20)	YEAR 2 (20/21)	YEAR 3 (21/22)	YEAR 4 (22/23)	TOTAL	Interest to fund
1	**Use Case 1:** *Accelerating farmer registration, and targeting eligible farmers with e-incentives*	**498**	**89**	**457**	**2,873**	**3,917**	*Various players, see below*
*	OBJECTIVE 1: Set up cloud-based farmer database and e-incentive software	73	11	11	12	106	FAO (KES 75M)
*	OBJECTIVE 2: Register farmers, agrodealers and extension agents	2	6	7	3	18	World Bank (KES TBD)
+	OBJECTIVE 3: Send out e-vouchers, annually (incremental to the KES 5B p.a already in MoALFI budget for subsidies)	335	-	310	2,610	3,255	
	Other	89	72	128	248	537	
2	**Use Case 2:** *Improving farmer practices through* customized e-extension and advisory services	**-**	**207**	**33**	**57**	**297**	*Pending commitments as of 7/8/2019; however certain elements do fall under KCSAP subcomponent 3.3, clause 85 on market advisory*
	OBJECTIVE 1: Build e-extension portal	-	186	3	3	192	
	OBJECTIVE 2: Enable workforce, pilot and scale	-	2	9	18	29	
	Other	-	19	21	37	77	
3	**Use Case 3:** *Monitor emergency food reserve stocks using a more robust national Food Balance Sheet (FBS)*	**529**	**90**	**89**	**16**	**725**	*Various players, see below*
+, *	OBJECTIVE 1: Digitized stock monitoring incl. hermetic bags (~85% of year 1 costs)	465	61	61	12	599	World Bank, FAO (KES TBD)
*	OBJECTIVE 2: Dashboard for FBS	7	4	3	3	17	World Bank, FAO (KES TBD)
*	OBJECTIVE 3: Satellite data collection for production data	18	18	19	-	55	Office of Deputy President, DEA (KES TBD)
	OBJECTIVE 4: Analytics for trade proxies	2	0	0	-	3	
	OBJECTIVE 5: Predictive analytics model and personnel	12	2	1	1	16	
	Other	25	4	4	1	35	
4	**Use Case 4:** *Make more dynamic trade and policy stability decisions using an Early Warning System (EWS) for food price inflation*	**-**	**20**	**7**	**5**	**31**	*Pending commitments as of 7/8/2019; certain elements do fall under KCSAP subcomponent 3.3, clause 81 on strengthening existing Market Information System*
	OBJECTIVE 1: Develop predictive algorithms	-	14	4	3	22	
	OBJECTIVE 2: Utilize dashboard for decision making	-	5	2	1	8	
	Other	-	1	0	0	1	
5	**Use Case 5:** *Improve value chain selection using an agricultural land optimization model*	-	**47**	**62**	**57**	**166**	*Various players, see below*
*	OBJECTIVE 1: Overlay existing (and eventually new) datasets using analytical solution	-	41	36	38	116	Office of Deputy President, DEA (KES TBD)
	OBJECTIVE 2: Collect new data and use model output to impact policy through extension agents	-	0	1	0	1	USAID (TBD)
	Other	-	5	25	19	49	
6	**Use Case 6:** *Suppport M&E using a dashboard that streamlines data collection, verification and visualization of ~10 outcome focused KPIs)*	5	20	21	22	68	*Various players, see below*
	OBJECTIVE 1: Set up data transfer from existing sources to MOALFI	0	1	1	1	4	
	OBJECTIVE 2: Develop visualisation tool	0	1	1	1	2	
*	Data visualization analyst (can also support other use cases)	5	18	19	20	61	USAID, IFAD (KES TBD)
7	**Use Case 7:** *Establish standards and protocols for shared access national agriuclture data platform, using the above data (use cases 1-6) as a baseline. Start with GoK data, then expand to development partner and private sector data*	-	-	-		-	*World Bank under KCSAP (from $10M envelope, incl. $1.8M for hardware)*
*	Costs already budgeted and funded as part of KCSAP Big Data Platform (*particularly* setting up infrastrucure for big data -- subcomponent 3.2, clause 80)						
	Total Project Expenses	**1,033**	**473**	**667**	**3,030**	**5,203**	
	Less non-digital components (i.e. e-vouchers incentive amount)	**698**	**473**	**357**	**420**	**1,948**	
	Less potential commitments from development partners (*)	**599**	**393**	**280**	**364**	**1,636**	

3. DATA ECOSYSTEM REQUIREMENTS AND IMPLICATIONS FOR GODAN

Interoperability framework

Interoperability is the ability of information systems, applications or devices to connect and exchange data in an organized way, within and across different institutions. Fully interoperable systems ensure that data is readily available and shareable with the end user, regardless of the data's origin or destination. MoALFI should facilitate a fully interoperable agricultural data ecosystem that includes national farmer registration to build an accurate agriculture sector baseline – starting with government data and unlocking data to support innovation for the future.

The best practice example of a government interoperability is X-Road. It is a decentralized secure exchange layer that enables different public and private information systems to interoperate. It connects more than 1000 institutions and companies and 650 public agencies, offering nearly 1,500 services and processing more than 3 billion requests. It has been implemented in Estonia, Faroe Islands, Finland, Iceland, Kyrgyzstan, Namibia, Ukraine and other countries.[43]

Kenya has access today to >1000 data sets with agriculture data are hosted on various platforms across >40 global institutions that are part of the GODAN network. However, these data sources are not yet fully interoperable. The use cases 1-6 can provide a tightly defined starting point for interoperability in Kenya's agriculture data ecosystem as broader national standards are legislated and adopted. *Appendix 11* demonstrates what the journey to interoperability could look like, anchored in specific use cases.

To transition to full interoperability, MoALFI needs to address three key elements: data, integration and governance.

Data: The means of acquiring different datasets from multiple sources and using them on a common platform must be defined. The key data required for the use cases covers ~10 data domains, from ~20 institutions (*See Figure 12 above*). This proposal is for real-time acquisition for unstructured data (e.g., satellite images) or batch acquisition for structured data (e.g., production per value chain), by use case. It also defines data domains to structure how to use the data, e.g., for the e-incentives, data analysts can easily refer to the farmer registry data domain.

Integration: This refers to bringing all the data from different sources together to provide a single view to run the analytics needed for the use cases. The objective is to create a common schema where records are linked, using supporting infrastructure to store data such as a data lake or warehouse. For example, to get data on volume of commodity stocks stored in national silos, datasets from KNBS, NCPB and commodity boards will be integrated on a single platform. Integration is seamless if the data quality of different sources is high, the infrastructure hosting the data is robust and connects easily to the source of the data. *Figure 13* shows an assessment of the primary GoK institutions providing data for the use cases, specifically their legacy infrastructure and the level of integration with other data infrastructure. The majority

of these government institutions have Oracle or other SQL-accessible database management systems as their legacy infrastructure. These can be easily integrated. However, MoALFI does not have an integrated data infrastructure (i.e. different hardware and software layers that form its network) and only a handful of on-site servers. A lot of data is stored on individual employee computers in MS Word – making it very difficult to integrate.

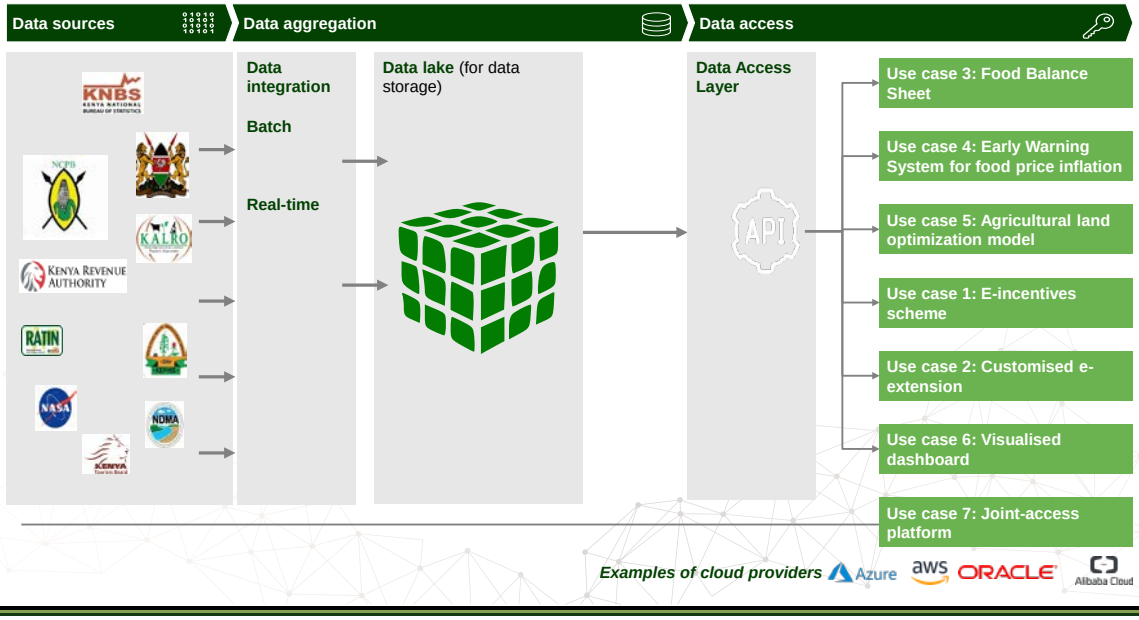
FIGURE 13: GOK INSTITUTIONS AND THEIR LEGACY INFRASTRUCTURE

Institution	Legacy infrastructure	Level of interoperability (L,M.H)
KNBS	Oracle	H
Counties	MS Windows	L
MoALFI State Departments	MS Windows	L
NCPB	SQL server (database)	H
AFFA	Oracle and MySQL	H
KRA	Oracle	H
KMD	Oracle (with SQL servers)	H
KALRO	MS Enterprise and SQL database servers	H
KEPHIS	MySQL and SQL server database	H
RMCRD	Postgres SQL databases Online geoserver and arcgisserver	H

- The nature of infrastructure and quality of connection to source database has implications on integration
- Majority of the government institutions have Oracle as the legacy infrastructure which can be easily integrated and may not need more time and effort to translate the data
- MoALFI uses MS Windows and has very few servers to support data storage; data is stored on individual computers

MoALFI can integrate the use case data in a common repository (i.e., a data lake hosted by KALRO) and build the supporting data architecture around it. Data architecture fully hosted in the cloud is easier to access, scale and manage through central administration tools from cloud providers *(see Figure 14)*. However, cloud hosting poses challenges with data security and impact on network delay, which MoALFI can address by: (1) Implementing security protocols such as ensuring confidential data is anonymized, encrypted, or masked to avoid accidental/malicious privacy breach (*see security section below*); and (2) Improving the network infrastructure at Kilimo House by investing in wireless local area network (WLAN). MoALFI may require a secondary server on the premises to store some of the data for ready access until these network issues are resolved. A proposal has already been put forward by the MoALFI ICT department of KES 160m for investment of upgrade of network, replacement of ICT equipment, digital notice board, set up of a data centre, implement databases and establishment of an ICT resource centre.

FIGURE 14: A CLOUD-BASED DATA ARCHITECTURE WILL ALLOW MOALFI TO EASILY SCALE THE 7 USE CASES



Governance

Governance defines the common standards for interoperability, including data security, regulations and policies that ensure data is consistent and trustworthy.

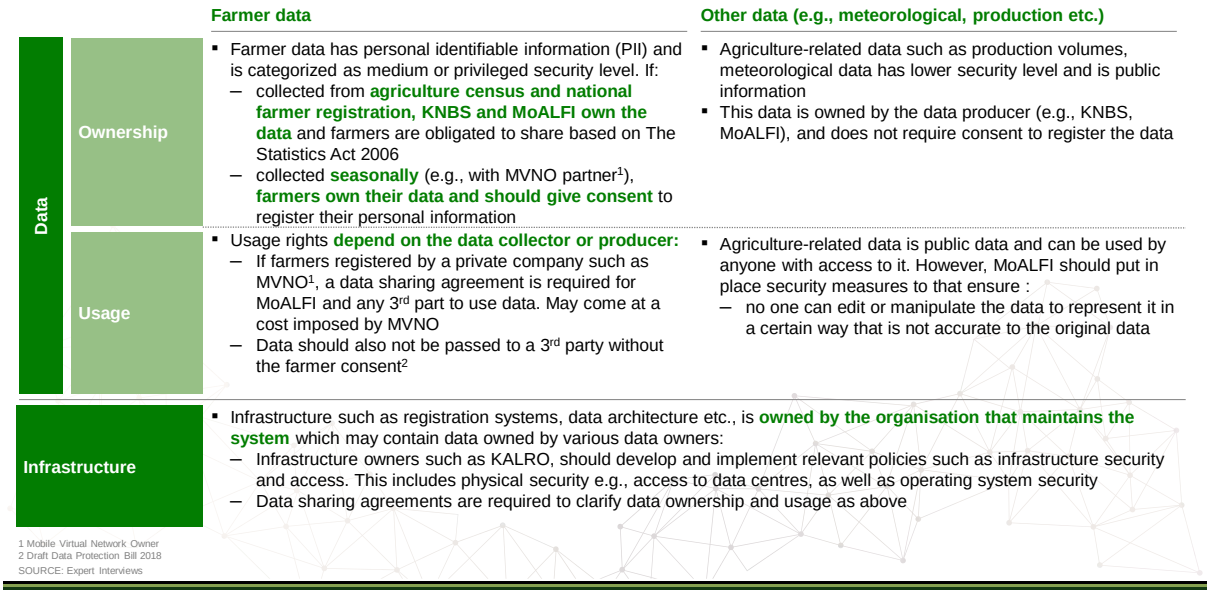
- **Security:** This defines who should have access to the data lake, specific components of the system or specific portions of the data. Security features should include:
  - Protection of data (at rest and in motion), such as encryption, data masking, permissions and authorization, and levels of access
  - Protection of networks from unintended or unauthorized access, change or destruction

Security level (and access) depends on the criticality and risk profile of the data (e.g., different risk for farmer national ID details vs. livestock count). *Figure 12* above identifies the proposed security levels of the data in the use cases, and *Figure 15* below provides an overview of the proposed approach to handle primary security challenges. Most data required for the use cases is classified as low security level – viewable by both internal and external stakeholders without causing damage to the data owner.

However, farmer-related data from the farmer registry, such as farm location, has medium security level because public release could have serious negative consequences. For example, farmers' data may be exploited or sold to 3rd party organization without farmers' consent. It is important that data security is integrated into the cloud environment to deal with potential threats such as cyber-attacks and this can be done using platform access and privileges, network security measures, Personal Identifiable Information (PIII) data security, and secure search. A more

detailed view of these security measures proposed here are in *Appendix 12* derived from best practice security requirements. Note that this list is not exhaustive and acts as a baseline for developing more specific security requirements.

FIGURE 15: GUIDELINES FOR DATA OWNERSHIP, USAGE AND INFRASTRUCTURE



- **Policies:** A data policy needs to be implemented describing ownership, accountability and responsibilities, and for end-to-end data management. This is different than the legislative policies described above for each use case. This data policy will answer questions such as: Who has access to the data center? Who has access to different levels of data? As KALRO is the likely data host for several the use cases and the shared-access platform, the data policy (pending approval from the Board) can provide a baseline for the use cases. The can be further adopted as more institutions and more data are added to the architecture.
- **Standards:** Mechanism and processes to monitor data quality need to be established. Key standards to put in place include:
  - Maintain the data source as master, e.g., RATIN will be the original source of market price data and not the data platform
  - Establish standard intervals for data to be refreshed or updated. This should be done monthly
  - Complete all data fields, e.g., no missing fields on dates or regions
  - Develop a data dictionary to standardize data description. Provide a standardized nomenclature for domains and data elements for accurate interpretation and use, e.g., trade domain refers to all data related to market prices, volume, etc.

A key barrier to interoperability that has not been addressed in this section is the incentive for data producers in public and private institutions to share data. Individual use cases address this topic as it relates to data in each use case, but MoALFI has a role to play by:

- Linking private sector organizations with academic and research institutions. Private sector organizations are involved in research and development (R&D) that supports market and commercial goals but not necessarily for development purposes that they have an interest in. This results in some organizations such as Syngenta and MasterCard, setting up foundations to conduct R&D in subjects that matter to them.
- Providing an opportunity and visible platform for private sector to advance their reputation for making the world better e.g., contributing to the SDGs. This may be especially meaningful for private sector players that do not monetize their data as a core function, such as MNVOs.
- Facilitating the access of data to private sector for future applications. For example, a private sector player can share data set A with MoALFI, who in turn gives them free access to data set B. The private sector player can then combine data set A and B that could potentially provide a different revenue stream. A revenue sharing model can be developed with MoALFI based on this.

The following are proposed next steps for MoALFI to develop an interoperable platform to deliver the use cases:

1. **Set up initial core team**: Recruit a data architect to design and develop the data infrastructure and identify technology and data needs.
2. **Set up data lake infrastructure on cloud**: Based on the data infrastructure design, select a cloud solution provider.
3. **Develop MVP** use case: The first use case to be implemented is the dashboard. Build an MVP based on this as it can be implemented in a relative short amount of time and used aa a basis to develop the data environment and integrate to multiple data sources.

Implications for GODAN

Global Open Data on Agricultural Nutrition (GODAN) initiative was launched in 2013 to promote the use of open data for innovation in agriculture and nutrition to combat world hunger and food security. As a GODAN champion, Kenya can further pursue its aims of achieving transparency and fostering an innovative ecosystem of accessible open data as a national asset that can improve social and economic welfare.

In 2017, the Nairobi Declaration was passed, creating the GODAN Secretariat. The secretariat was established at MoALFI and tracks commitments of ~17 partners to its activities. It has the mandate to promote the 15 commitments made in the Nairobi Declaration, for example: increase human capacity for statistical departments; improve uptake of data-driven youth innovation; support national interoperable agriculture data platform.[44]

However, its activities have been constrained by lack of funding and clear next steps to drive the mandate. In 2019, at the request of the secretariat, the Programme for Capacity Development (P4CDA) was created to actively promote open data

collaborations between government agencies, academia (Universities and TVET Colleges), research organizations (FARA/CGIAR) and development programmes/partners through experiential learning and agriculture technology hubs targeting data-driven youth innovation and entrepreneurship.

GODAN Action, a three-year initiative by GODAN, has led several training sessions with universities and research institutions. Examples include open data training by Technical Centre for Agricultural and Rural Cooperation (CTA), with micro-grants provided to integrate open data thinking into programmes, e.g., KALRO and University of Nairobi (UoN), and data journalism training by Local Development Research Institute (LDRI) and Association of Freelance Journalists, for more accurate data reporting.

Since 2017, Kenya's GODAN Secretariat has focused on the training, but other elements of the Nairobi Declaration require more attention (e.g., interoperable national platforms for decision making). Based on the seven priority MoALFI digital use cases, the GODAN Secretariat should consider the following priorities through 2023:

1. **Facilitate access to ~40+ GODAN partner data portals:** Facilitate access to ~20 public databases hosted by GODAN and partner network (e.g., USDA Soil Maps) that capture the datasets required for the use cases. Include data on field, geospatial or climatic dimensions. *(See Appendix 13 for list of publicly available data portals through GODAN partner networks*)
2. **Advise on data management approaches:** Give technical advice to the use case delivery teams on data management approaches – including best practices on data access, security – public vs. private, content level – as stricter standards and regulations are set for interoperability. Secretariat should tap into knowledge from trainings and partner interactions.
3. **Play an active role in KCSAP implementation:** Play an active role in KCSAP implementation, particularly standards and protocols to set up the KALRO big data platform. In addition, GODAN can advocate for and train relevant implementation staff on open data approaches. GODAN also plans to support the KALRO/World Bank linkage with the hiring of young technical experts to support development for the implementation of KCSAP.
4. **Advocate and support development of national data laws and regulations:** Identify relevant best practices from other countries and achieve proof of concept for open data policies in the country through these tightly scoped use cases. GODAN should also support ongoing efforts to improve and implement the Data Protection and Open Data Bills to ensure fairness and protection of individuals (e.g., advocate for data controller liability for third-party information sharing). Finally, as the use cases begin to test the frontiers of topics like interoperability of agricultural sector data, GODAN may take up the mandate to support a D4Ag "regulatory sandbox", like the one currently proposed for FinTech innovations to test methods by which the needs of both the public and private sectors can be balanced.[45]

5. **Continue focus on capacity building**: Include specialized training for key roles required for the use cases (e.g., data scientists). Identify and recruit high-potential individuals and upskill them through exchange programmes with GODAN partner institutions (e.g., Wageningen Research Institute, CTA etc.)

4. DELIVERING THE USE CASES

Immediate next steps across the use cases

The seven use cases are phased, and designed to scale fully by 2023, in line with first NAIP. *Please refer to Chapter 2 for use case specific milestones.*

However, there is still some outstanding groundwork needed across the use cases to prepare them for implementation:

1. *[Q3-Q4 2019]:* **Continue to engage counties and private sector providers who have the technology to implement elements of the use cases, signing MoUs as necessary** (e.g., for farmer registration) **to pilot** and begin scale-up of use cases. Communicate the use cases as part of domestication of the ASTGS.
2. *[Q3-Q4 2019]:* **Secure additional investment, financing and in-kind support from private sector and development partners.** As of 7 July 2019, all the use cases either have a development partner with a promise to fund (e.g., World Bank for e-incentives registration and programme roll-out, shared-access platform, FAO for e-incentives software solution), an indicated interest to fund (e.g., World Bank and FAO on FBS, USAID on KPI dashboard), or there is potential to share resources with the on-going KCSAP project (i.e. shared-access dashboard, early warning systems and e-extension). MoALFI should:
   - Clarify the terms of committed funding, and when it can be disbursed across these partners
   - Meet with key members of the private sector and development community – regionally and internationally, including one-on-one meetings at the Africa Green Revolution Forum (AGRF) and the World Economic Forum (WEF) for Africa. Use this platform to share the use case proposals and secure additional support.
3. *[Q3 2019]*: **Secure technical expertise to finalize use case pilots and project manage upcoming milestones**. The agricultural statistics department at MoALFI is not adequately resourced to manage business-as-usual requirements, in addition to launching the use cases that cut across MoALFI and other government agencies, private sector and development partners. Specifically, the following are required:
   - *A digital and analytics expert* who understands a broad range of AA techniques, and can navigate technical issues of interoperability and data architecture as

they arise across use cases. They should be able to help vet providers of digital solutions for the use cases (and draft RfPs as required)

- *A project manager* to support the use case delivery teams with ATO (e.g., track all use case milestones, own visualization use case, prepare for ASTGS SteerCo meetings, prepare agendas and schedule high-level stakeholder meetings for MoALFI leadership at key fora like AGRF and WEF). Where required, work with digital and analytics experts to further define use cases. A project manager with policy experience is a plus.

4. *[Q3 2019]:* **Kick off the use case delivery teams with the ATO**. These teams comprise government, private sector and development partners who offer direct support to use cases (e.g., funding, hosting data, or are otherwise nominated by the ARDDG). The teams will facilitate delivery of the use case milestones and remove bottlenecks to implementation, including but not limited to funding and improving performance of the use cases. They should be operational, even as the ATO scales up their capabilities. *More detail in the next section.*
5. *[Q3-Q4 2019]: Once funding is secured,* **identify digital solution providers** to operate the digital tools for the use cases (e.g., visualization dashboard, cloud storage solution). This may require issuing RFPs. Will need to repeat this process as new use cases are launched.

Use case delivery teams

Once it is fully operational, the Agricultural Transformation Office (ATO) is the natural home to facilitate implementation of the digital use cases, as part of its mandate to M&E support delivery of all the flagships, including Flagship 8, under which the use cases fall. The ATO will require a ramp-up period to move from inception to full roll-out of its functions at both the national and county levels. Therefore, as part of this digital use case work, the team explored several cross-sector collaboration models that could potentially be implemented faster and with fewer resources – from embedding within JASSCOM, to a fully private sector-led approach observed globally *(see Appendix 14 for more detail).*

Ultimately, MoALFI decided to maintain the ATO as the primary delivery mechanism for the use cases – deploying the seven use cases as proof of concept for how to implement a flagship with the ATO. Eventually, the ATO will be ramped up to support all nine ASTGS flagships. Accordingly, the use cases will use a similar core governance model and cadence established in the ASTGS. *See Figure 16 below for additional detail.*

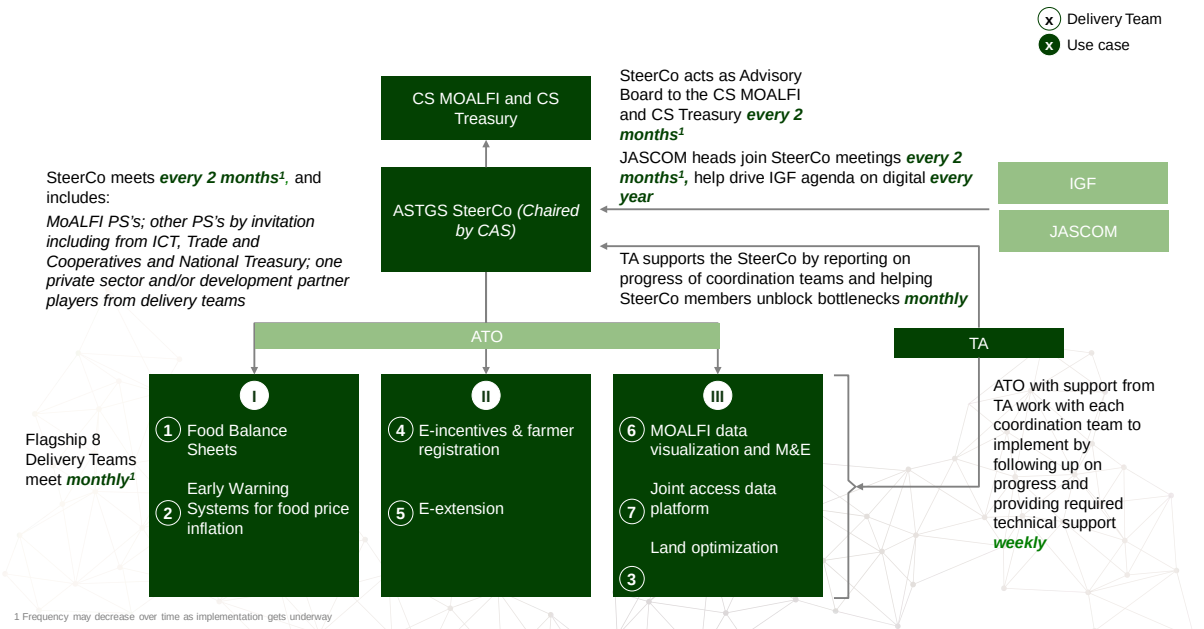
- Every ~8 weeks, **a Steering Committee chaired by the CAS** will meet to act as the advisory board to the CS. Membership should include: (1) MoALFI PSs; (2) representation from the Council of Governors (CoG), JASSCOM; (3) other PSs or their equivalents at the invitation of the CAS, depending on the agenda for the meeting – including but not limited to Ministry of ICT (MoICT), Ministry of Industry, Trade and Cooperatives (MoITC) and National Treasury; and (4) one

representative each from the Delivery Teams, comprising private sector and development partner players.

- Every month, the **Delivery Teams** for Flagship 8 will meet to coordinate delivery, guide MoALFI on how to adapt implementation based on emerging evidence from the field, and remove barriers, including funding. The Delivery Teams are clustered around the use cases, and comprise a Director from MoALFI, a representative from CoG and/or the CECs of Agriculture, and private sector and development partner representation based on specific technical knowledge of a use case, ability to move to action, and authority to allocate funds towards implementation.
- A fully dedicated TA will support the Delivery Teams on project management (e.g., tracking milestones) and the ATO to monitor progress with the visualization dashboard, and prepare for SteerCo meetings (e.g., set agendas).

A proposed TOR that lists the full description of the mandate, scope, critical success factors, monitoring and tracking for the Delivery Teams is in *Appendix 15.*

FIGURE 16: PROPOSED GOVERNANCE MODEL – SEE TOR FOR MORE DETAIL



Capability building

MoALFI will need to partner with several public institutions to collect, integrate, analyze and distribute the data required to track progress against ASTGS goals, and support various D4Ag interventions. >40 public institutions across the globe house >1bn records of data relevant to Kenya's agricultural transformation.

The prioritized use cases, described in section 2, all involve descriptive, predictive and prescriptive analytics. This means that MoALFI and its partner institutions will need to have relevant data capabilities to fully realize the impact of the use cases. To deliver (i.e., implement a pilot and scale) the prioritized use cases, institutional capabilities

are evaluated across the key elements of the data lifecycle. Domestically, there are ~20 public sector institutions that collect, store and provide access to data relevant to their scope of work and these are assessed on the following criteria (*see Appendix 16 for a list of institutions and their capabilities*):

- **Ability to collect data:** Does the institution use manual or digital data collection methods? What is the quality of the data with regards to accuracy and completeness?
- **Ability to integrate data:** Does the institution have the infrastructure to integrate data? Does the institution have the right capabilities or talent to enable data integration?
- **Ability to analyze data:** Does the institution have the infrastructure to analyze data and what type (Excel, STATA, SPSS, Modelling...)? Does the institution have the right capabilities or talent to perform data analysis (data analysts, statisticians)?
- **Ability to distribute and provide access to data:** Does the institution have the infrastructure to distribute/provide access to data (static, e.g., PDF reports or dynamic, e.g., visual dashboards)? Does the institution have the capabilities or talent to manage data access and distribution?

These capabilities were assessed across the four criteria for all institutions. KALRO and KNBS stand out for their capabilities across the board, from data collection to dissemination, given their investments in infrastructure and people as follows:

- *Data collection:* Data collection methods impact the accuracy of data due to human error, particularly where data collection is manual. The majority of institutions analyzed use manual data collection methods, with some exceptions. KNBS uses a combination of manual and digital methods, while KALRO largely uses digital collection for its research programmes and RCMRD uses remote sensing. Overall, research institutions and regulators (e.g., KEPHIS) have more accurate data collection methods, given the mandate and staff capacity.
- *Data integration and aggregation:* MoALFI needs access to a wide range of data infrastructure to integrate and store large and sometimes confidential data. Several instances were observed of data aggregated on individual computers, which poses a significant risk. Most hardware across institutions consists of stand-alone servers except KNBS that has cloud servers and KALRO has cloud-ready infrastructure in addition to physical servers. Recent investments in include data centres and recovery sites for data aggregation. Aggregation of data from different sources requires governance and policies in place, without which platforms struggle to aggregate data in a way that can be quickly analyzed and disseminated for decision making, e.g., KAINet, platform hosted by KALRO, aggregates data from different sources.
- *Data analysis*: Most institutions use general analytical tools such as MS Excel, Statistical Package for the Social Sciences (SPSS), Stata and Enterprise Resource Planning (ERP), which do not have the capacity to conduct predictive analytics.

Institutions like Kenya Meteorological Department (KMD) and RCMRD use predictive modelling tools and analysis based on their specific areas of operation.

- *Data access and distribution:* Most institutions provide access to data through static reports, e.g., downloadable PDF files, charts and graphs on websites, etc. KALRO disseminates some data directly to farmers via 32+ mobile applications for download and RCMRD disseminates through its open data site. Some institutions such as MoALFI however do not have information that is easily accessible and requires stakeholders to request for data.

In summary, KNBS and KALRO have higher levels of data maturity. They have invested in high-tech physical infrastructure, e. g., data centres and recovery sites for storage (aggregation and integration) and analysis of large datasets as well as personnel with required skill sets (statisticians, developers, data scientists).

The Ministry must build capabilities to deliver the use cases in the planned timeline as well as internal capabilities in the long term to deliver future use cases. Both short- and long-term plans need to be implemented to build capabilities within the priority institutions.

- **Short-term:** Recruit initial core team focused on the initial design and development of the data architecture infrastructure and use cases.
- **Medium- to long-term:** Build internal capability using "field and forum" approach, detailed in ASTGS, at national level for the three priority institutions. This should start at the same time with the initial core team to ensure knowledge transfer.
- **Long-term:** MoALFI should consider setting up a Centre of Expertise (CoE) for digital and advanced analytics. The CoE would be the centre of best practice focused on promoting the use of advanced analytics in the Ministry and wider government to drive value and capture opportunities. CoE would consist of a team of experts in advanced analytics (internal and external to government) that would manage and deliver future use cases. The CoE could serve the government rather than the Ministry alone and would be the source of capabilities to deliver on digital and advanced analytics projects. This should be done together with the Ministry of ICT and ICT Authority as part of the Digital Economy Blueprint to deliver digital skills and values and cross-cutting issues.[46] Note the CoE requires cross-sectoral consultation and implementation, therefore has not been costed as part of the capability building. *This cost is not included in the use case budgets in Chapter 2.*

For the priority institutions (MoALFI, KNBS, and KALRO) to deliver on the digital use cases, they need to have an initial core team focused on the initial design and development of the data architecture and use cases. The initial team, consisting of four key roles, will use technology delivery tools such as Agile to ensure user-driven, flexible and faster-to-market delivery of the use cases. The roles highlighted below are based on an assessment of roles required to deliver data use cases and not on a deep-dive capability gap analysis.

1. **Data architect:** Understands the different paradigms of data architecture and will design the data architecture required. The individual should have experience in system data mapping and project management leadership.
2. **Data engineer:** Use the data architect's design to build the architecture minimum viable product (MVP). Design, build, integrate data from various resources, and manage big data.
3. **Data scientist:** Identify and conduct advanced analytics analysis based on the use cases. Respond to data requests by sourcing, aggregating and validating data.
4. **Subject matter experts:** Use knowledge in agronomy, economics, climate to assist in building analytical models, understanding data and developing insights. As the first use case to be implemented is the visualization dashboard for MoALFI, five representatives from the Agriculture Statistics Units for each State Department) will be the experts.

The capabilities highlighted above are not currently in the priority public institutions and would need to be recruited to quickly start implementation of the use cases. It is proposed that the core team be recruited by MoALFI and seconded to KALRO. However, in the long term, these capabilities need to be built within the institutions, at national and county level. The capability building is based on the "field and forum" approach detailed in ASTGS capability building for transformation leaders and implementation frontline.[47]

National level (for MoALFI, KNBS and KALRO):

To build capability in these institutions, design and develop learning journeys based on the roles. As the use cases are implemented, the initial core team will expand to include more advanced analytical roles such as business translators, data analysts, data quality experts. As the recruited team will be seconded to KALRO, the KALRO team would qualify to be reskilled. Currently there are 77 team members in the KALRO ICT structure including roles in data centre operations and network infrastructure, as well as 20 statisticians. ICT team including statisticians, developers and data managers.

- **Capability gap assessment:** Conduct role-specific capability assessments on individuals from the institutions. Selection of individuals will be based on role and development goals, e.g., statisticians from KNBS and KALRO who want to transition to data-specific roles. The assessment will guide the design of the learning journey (see *Appendix 17* for example of learning journey to develop a certified data scientist).
- **Formal training**: Conduct formal training through a combination of bootcamps, classroom and online sessions based on the learning journey, starting from gaining foundational applicability to use cases. This should clearly link to certification.
- **Fieldwork and secondment:** Apply the learnings from formal training towards delivery of use cases. This will be ramped up as the individual progresses through the training and gains more skills. For example, a newly trained data scientist can

start in delivery of the dashboard use case to gain skills and gradually progress to a technically more complex use case such as Food Balance Sheet.

- **Coaching:** Support on-the-job training with ongoing coaching and joint problem solving with instructors from private sector technology players (e.g., solution providers) and Ministry of ICT representatives. Second trained individuals to organizations with high data management maturity to transfer knowledge and best practice.
- **Performance management:** Design clear path for competency building and link performance management of the trained individuals to the learning journey.

County level (Agriculture County Officers):

At the county level, agricultural data is collected as an input for national and county planning. In the data lifecycle, county governments are focused on data collection and are regarded as a key source of data. Currently, data collection is done manually by extension agents. There are opportunities to improve data collection at county level by implementation of statistically sound methodologies to provide accurate data, improve coordination between county and national government.[48]

As the use cases will be implemented at county level, it is important to build data collection capabilities as they relate to the needs of the use cases. This will in turn support the counties in building the same capabilities for the general data collection. Counties should be able to collect good-quality data, which is defined by dimensions such as accuracy, timeliness, consistency, completeness, coherence, interpretability, availability, security and confidentiality. Flagship 7 of ASTGS outlines the county transformation leaders, who will be the focus of capability building, as the Agriculture County Executives, County Chief Officers for Agriculture and the Chairs of the County Assemblies' Agriculture Committee.

- **Technical training and certification:** Through the State Department's Agriculture Statistics Units, build and deliver training curriculum on data collection specific to the use cases highlighting dimensions mentioned above. This is initial technical training and can only be completed through train-the-trainer model (see below). GODAN, as part of its mandate, can also support in building capacity at county level.
- **Train-the-trainer model:** Identify model counties that have advanced in data collection methods. Representatives from these counties will be deployed to other selected counties to conduct on-the-job training. This will be the second step in building capability and should be linked to the technical training. The trained representatives are then selected to go to other counties to train representatives.
- **Peer network across counties:** Based on train-the-trainer model, create a network of trainers across counties through WhatsApp groups. These networks should provide a platform to ask questions, get information and assistance on data collection methods and serve as an informal means of training.

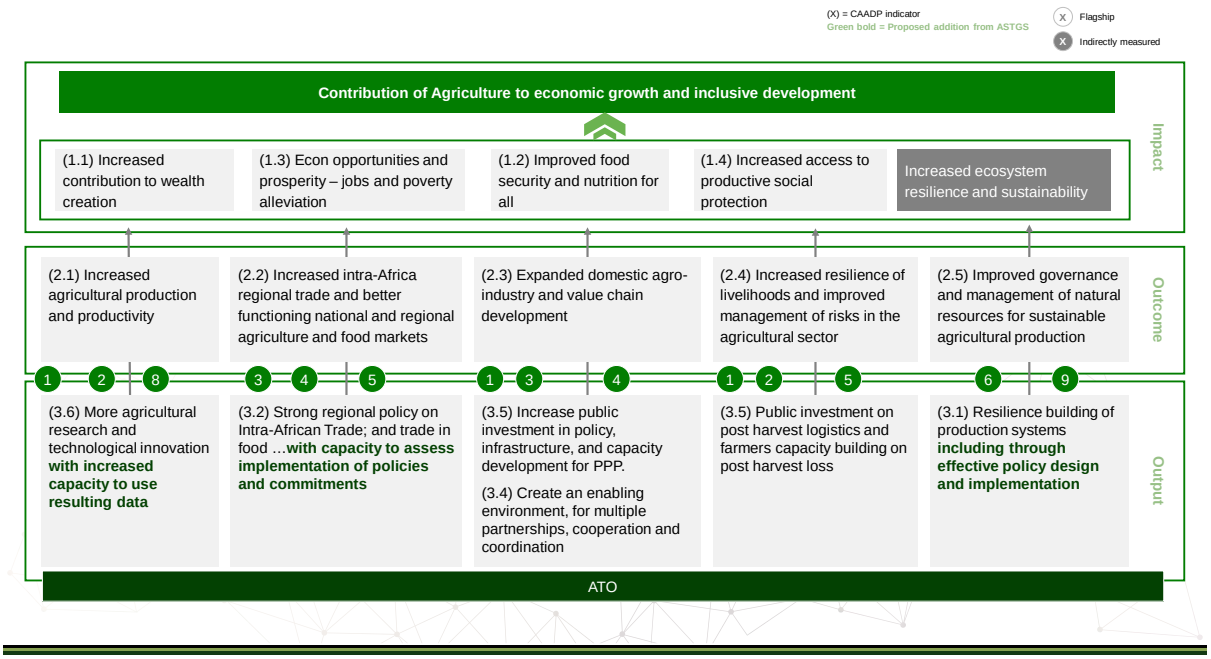
- **Participation in negotiations with solution providers:** County representatives should be present at negotiations for agriculture projects related to data collection with private sector and development partners. This will provide an opportunity to understand what is needed from these players and what (if any) new data collection methods will be required.

5. MONITORING AND EVALUATION

The Kenya Agricultural Sector Results Framework identifies the key outputs, outcomes and impact to which the sector is committed. It is aligned to United Nations Sustainable Development Goals (SDGs) and the outcomes of the Comprehensive Africa Agriculture Development Programme (CAADP) Malabo Declaration Commitments.[49] The framework is aligned to ASTGS, with the flagships corresponding to the desired outputs and outcomes. This flagship (Flagship 8), will drive the impact on increased contribution to wealth creation (CAADP impact indicator 1.1), *see Figure 17*. MoALFI M&E taskforce is in the process of finalizing ~80 indicators and developing a standardized measurement system.

To ensure that the overall objective or impact of the use cases has been achieved, a robust monitoring and evaluation (M&E) plan should be implemented, to cover process and results M&E.

FIGURE 17: KENYA'S AGRICULTURAL SECTOR RESULTS FRAMEWORK



Process M&E

This will track and confirm the progress of the each of the use cases to achieve the intended outcome and will be done by the technology solution provider (private sector player) for each specific use case. Every use case has an outcome indicator and target

which will be tracked within the use case. (*Refer to section 2.*) Measurement will focus on data collection of the outputs to determine whether they contribute toward achievement of outcomes. In addition to measuring the outcomes, assessment will cover the following qualitative and quantitative criteria:

- **Data:** Number of metadata available in machine-readable format; number of (allowable) users able to access the data repository; number of data assets that are interoperable; presence of data access and authentication policy, etc.
- **Demand:** Number of data requests; number of data domains served by the repository; number of users and user groups.
- **Technology:** Presence of data governance; level of security built into technology; presence of open access standards; technology performance versus number of additional users and data, etc.

Results M&E

This will be based on tracking outcomes for the wider agriculture sector. According to ASTGS, ATO will be responsible for tracking and monitoring while third parties such as research and academic institutions will be responsible for validation of the performance results. This will be done in two phases:

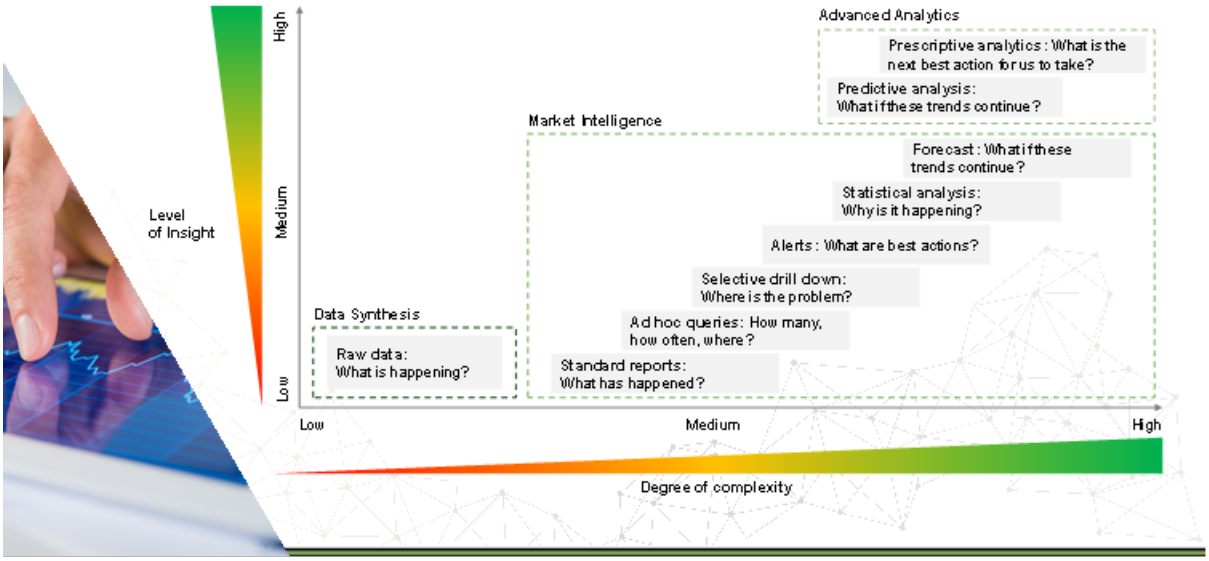
Phase 1: MoALFI will use the dashboard to track ~10 indicators linked to transformation of the agriculture sector and the flagship progress indicators. These KPIs were selected due to their importance to key stakeholders within the Ministry. *Refer to section 2 for the use case 6 on MoALFI dashboard.* The purpose of the dashboard is to communicate agriculture data and aid evidence-based decision making. This means that the data fed into the dashboard will be of high quality, i.e., accurate, complete and consistent. The data will be collected at county level, allowing the Ministry to streamline the data collection process for counties, which will benefit the wider Ministry as the improved methodology will be cascaded

Phase 2: Gradually, as the data collection process becomes more efficient, the number of indicators tracked will be expanded to include wider agriculture sector indicators as well as agriculture programmes and projects. There are currently 14 programmes running in the agriculture sector at national and county level. The indicators will be tracked to determine the impact of specific programmes. For example, KCSAP contributed 5% increase in animal productivity in Marsabit county.[50]

In conclusion, MoALFI is ready to accelerate the launch of these use cases to support implementation of the ASTGS, and support the overall goal to be create a vibrant, commercial, and modern agricultural sector that supports 100% food security in the context of devolution. The use cases provided a focused and manageable scope of activities that are integrated with existing initiatives where possible. These use cases will guide MoALFI through the implementation challenges of interoperability, data governance including privacy, sharing and exchange protocols. In doing so, MoALFI can continue to be a champion and pioneer the use of D4Ag solutions to improve the livelihoods of millions of Kenyans.

6. APPENDIX

APPENDIX 1: ADVANCED ANALYTICS CAN DRIVE BETTER DECISION MAKING



APPENDIX 2: SUCCESSFUL DIGITAL SOLUTIONS CHAMPIONED BY GOVERNMENTS AROUND THE WORLD

Global success stories from at-scale solutions

Digital

Digital literacy and access to basic technologies

Ethiopia 80-28 hotline; **4m users**
- Used **low-tech workarounds** (e.g., IVR, voice) to access farmers

Data accuracy and usability

Growth Enhancement Scheme; **14.5m users** *(>80% active across main inputs)*
- Demonstrated **end-to-end feasibility of digitized e-wallet** in partnership with Cellulant. 90% of farm inputs reached farmers, supporting a more than 2x increase in income

Data management systems

Zambia Agriculture Management Information system (ZIAMIS), **1.2m users**
- Led **implementation from Office of the President** with mandate cutting across all government institutions

Monetization and private sector involvement

Bank of Kigali - Ikofi, 2019 launch – but **potential for >1.5m** users[1]
- Government **invested early in middleware** and links to regional markets easing start-up and expansion costs for private sector firms

Digital skills and expertise

Maharashtra Gov and New Vision for Agriculture, **110k in pilot alone**
- Initiated 6-year PPP for agriculture value chains with **emphasis on building local data capacity**, expanding to cover drones and IoT

Global success stories

Non-Digital

Food system complexity

USDA and NASA Partnership, ***ROI of $20 for every $1 invested in agriculture research***
- **Partnership for cutting edge data and research** in agriculture (e.g., NASA soil moisture data to USDA Crop Explorer forecasts, help prevent wildfires etc)

Policy and regulation

South African Government; ***>1200 Unmanned Aerial Vehicles registered***
- Agriculture innovation objectives **integrated into policy frameworks and funded** (e.g., public ag R&D ~3% of Ag GDP[1], on par with UK, Switzerland, Korea)
- At forefront of **digital regulation (e.g., drone law** with updates for privacy, crop protection drones can reach remote and/or small fields more cost effectively than standard aerial application[2]

Regional/ county readiness

Maroc Vert; GDP growth of 43% in 4 years, ***targeting >1.2m farmers***
- **Targeted geographic areas with tailored strategies**; with common goal of growing high value crops on irrigated land to address poverty

Last-mile service delivery

Brazil DATER reform helped raise ***~20% of rural population*** *out of poverty in 5yrs*
- Created **research and funding links** between government, universities and FBOs to train extension service providers on ag-tech innovations

1 Intensity of public R&D spend on agricultural sciences | 2 South Africa case study: drones get 1.5-3m above plants preventing overspray, and reaching almost 100% of field areas with challenging terrain, use 60% less fuel than manned aircrafts, China case study: can cover >40x area an human can spray in a single day

SOURCE: KALRO, McKinsey.com "How digital innovation is transforming agriculture"; Lessons from India; OECD; WEF; MOALFI; CTA/Dalberg Landscape Analysis, FSD, WEF; McKinsey.com – Successful Agricultural Transformations, NAPREJ 2017

APPENDIX 3: FIVE CRITERIA TO EVALUATE FEASIBILITY

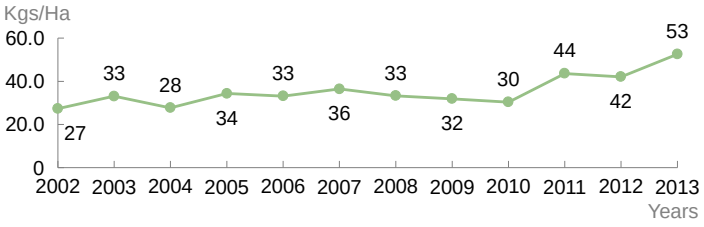
Critical and not ready
Medium critical and not ready
Ready

Evaluating feasibility

	Question
Data availability	Is sufficient data available for target variable? *If not,* is proxy data available? Is data quality useable?
Technology	Does the existing tech system, or planned upgrades support use case? Can the use case be piloted in 8-12 weeks?
Execution capability	Does MoALFI have the people (number, skills) to support the solution? Does government have the capacity to store, analyze, process and manage disparate sources of data *(where relevant)*?
Cost	How expensive is the full solution? Does the Ministry already have funds allocated or committed to the solution?
Risks	Are there legal constraints? Are there other external dependencies? Is there political will to implement the solution?

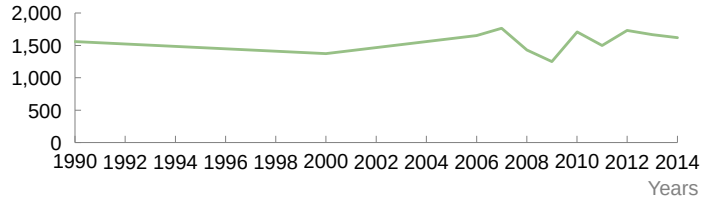
APPENDIX 4: THE CURRENT INPUT ACCESS PROGRAMME HAS NOT INCREASED YIELDS IN OVER A DECADE

Kenya Fertilizer consumption kgs per hectare of Arable Land



Kenya – Cereal Production Yields per Ha

Cereal production, Kg/Ha



SOURCE : World Development Indicators. World Bank

Fertiliser use has increased 12% p.a. amongst small-scale farmers but has not impacted yield.

Key constraints to increasing yield are:

- **Poor soil quality** (e.g. high acidity), due to blanket use of fertiliser and low use of lime
- **Unsuitable crops choice** according to agroecology
- **Limited awareness of best practices** to increase productivity

Design a system to:

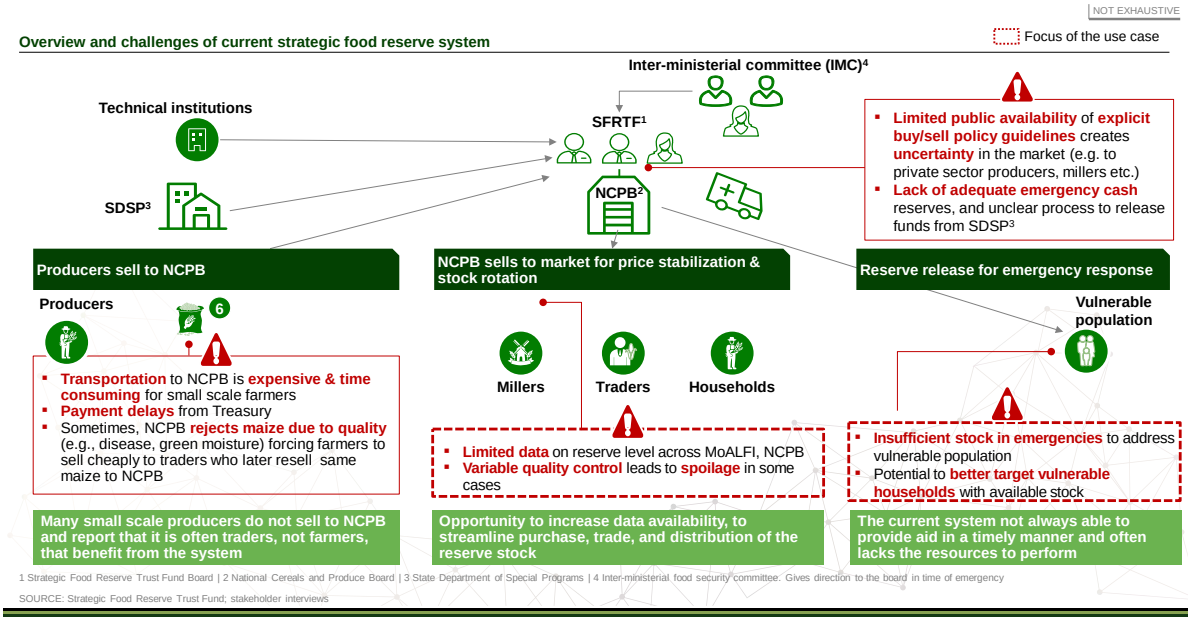
- **boost use of a range of inputs** that **match soil needs** (i.e. not just focus on increasing use of fertiliser)
- **Increase access to information** on best practices to **boost productivity**

APPENDIX 5: CURRENT/RECENT PROGRAMMES VARY IN DESIGN, WITH REPORTED INCENTIVE DUPLICATION

	Program			
Program component	**NAAIAP[1]**	**KCEP-CRAL[2]**	**E-Fertilizer Subsidy Management System**	**County programs**
Year	▪ 2009-present	▪ 2015-2022	▪ 2016	▪ 2015-Present
Cost, *KES Bn*	▪ 29.6 (over 9 years)	▪ 15.3 (over 7 years)	▪ 0.058 (for pilot)	Bungoma, Kakamega and Trans Nzoia all ran subsidy programs in 2015. Uasin-Gishu and Kirinyaga are in the process of piloting one now. The design, purpose, and targeting approaches differ, but the impact across all these projects is yet to be clearly quantified.[3]
Cost per farmer, *KES*	▪ 8,000	▪ 82,000	▪ 2,320	
Funder	▪ MOALFI / Treasury	▪ EU, IFAD	▪ MOALFI	
Key partner	▪ NCPB	▪ Equity Bank	▪ Safaricom	
Farmers reached	▪ 3.7 mn (over 9 years)	▪ 34,000 (of target 185,000)	▪ 25,000+ (TBC)	
Location	▪ At all 110 NCBP depots	▪ 13 counties	▪ Machakos, Embu, Muranga	
Farmer contribution	▪ 50%	▪ 10%	▪ Partial (% TBC)	
Products subsidized	▪ Fertilizer	▪ Variety of inputs	▪ Fertilizer	
Inputs support format	▪ Paper-based voucher	▪ Debit card e-voucher	▪ SMS code	

1 National Accelerated Agricultural Inputs Access Programme
2 Kenya Cereal Enhancement Programme – Climate Resilient Agricultural Livelihoods Window
3 FAO 2019, Proposed Kenya National E-Incentive Inputs Program (KeNEIIP) Management - Final Report

APPENDIX 6: CURRENT STATE OF THE STRATEGIC FOOD RESERVE SYSTEM IN KENYA



1 Strategic Food Reserve Trust Fund Board | 2 National Cereals and Produce Board | 3 State Department of Special Programs | 4 Inter-ministerial food security committee. Gives direction to the board in time of emergency

SOURCE: Strategic Food Reserve Trust Fund; stakeholder interviews

APPENDIX 7: KEY METRICS FOR MOALFI KPI DASHBOARD

PROPOSED METRICS

X Existing visualisation efforts in figure 2.6.1

Category	Key metrics for proosed MoALFI dashboard, unit	Primary data source	Existing data visualisation efforts
Macro-economic factors	▪ Agriculture contribution to GDP relative to target, KES, %	▪ KNBS	2 5 6
	▪ Expenditure versus budget, KES, %	▪ MoALFI	5 7
Socio-economic factors	▪ Food deficit by location (by value chain), tonnes	▪ KNBS (through FBS), World Bank	6 Daily calorie supply and food consumption only
	▪ Stock in government silos versus target (by location, value chain), tonnes, %	▪ NCPB	n/a
	▪ Price volatility, standard deviation from average, %	▪ MoALFI (National Crop Bulletin – maize beans, wheat) ▪ NDMA (cattle, goat, milk, maize) ▪ RATIN (maize, beans, sorghum, rice)	5
Ag. and food specific – Production	▪ Production volume (by location, value chain), tonnes	▪ MoALFI (Economic Review of Agriculture)	2 6 7
	▪ Yield (by location, value chain), tonnes	▪ MoALFI	3 6
	▪ Post-harvest losses (by location, value chain), tonnes	▪ MoALFI	4 6
Ag. and food specific – Inputs	▪ Fertilizer consumption (by location, value chain), tonnes	▪ MoALFI	5 6
	▪ Manufactured feeds (by location and type), tonnes	▪ MoALFI	7
Ag. and food specific – Trade	▪ Agricultural exports and imports (by overall, value chain), KES, tonnes	▪ KNBS	2 3 6
	▪ Agricultural traded volume (by commodity, location), KES, tonnes	▪ NCPB, RATIN, Ministry of Trade	4 5 7
ASTGS Flagship	▪ Percentage milestone completed for each of the flagships, %	▪ MoALFI - ATO	n/a

SOURCE: ASTGS

APPENDIX 8.1: AN ADDITIONAL SET OF KPIS ARE REQUIRED TO MAINTAIN THE E-INCENTIVES AND E-EXTENSION, AND CAN FORM BASELINE FOR THE SHARED-ACCESS PLATFORM (USE CASE 7)

NOT EXHAUSTIVE -- TO BE REFINED BY IMPLEMENTATION TEAMS

	Metric	Source	Frequency
Reach	▪ Number of farmers receiving incentives	▪ Incentive software	▪ Real-time
	▪ Number of agrodealers registered and active	▪ Incentive software	▪ Real-time
	▪ Number of extension service providers registered and active	▪ Incentive software	▪ Real-time
Yield	▪ Production per hectare per crop	▪ Remote sensing ▪ Ground truthing ▪ Farmer reported	▪ Real-time ▪ Bi-annually ▪ Bi-annually
	▪ Live weight per head, per breed	▪ Farmer reported	▪ Bi-annually
	▪ Tonne of fish landed, per species	▪ Farmer reported	▪ Bi-annually
Input utilization	▪ Type of inputs procured by farmers with incentives	▪ Incentive software	▪ Real-time
	▪ Quantities of inputs procured by farmers with incentives	▪ Incentive software	▪ Real-time
	▪ Geographic distribution of inputs procured	▪ Incentive software	▪ Real-time
	▪ Price of inputs procured by farmers with incentives	▪ Incentive software	▪ Real-time

APPENDIX 8.2: AN ADDITIONAL SET OF KPIS ARE REQUIRED TO MAINTAIN THE FBS, AND CAN FORM BASELINE FOR THE SHARED-ACCESS PLATFORM (USE CASE 7)

NOT EXHAUSTIVE -- TO BE REFINED BY IMPLEMENTATION TEAMS

	Metric	Source	Frequency
Local production	Production per hectare per crop	Private sector provider	Real-time
	Harvests and post-harvest losses	Private sector provider	Real-time
	Livestock reared per hectare, per breed	Private sector provider	Real-time
	Tonne of fish landed, per species	KNBS	Monthly
National reserves	Stock held by the strategic food reserves	Private sector provider	Real-time
	Stocks held by farmers	KNBS	Monthly
	Stocks held by commodity boards e.g., Kenya Dairy Board	Commodity boards, private sector	Monthly
Utilization	Industrial use of food/seed	Private sector players	Monthly
	Tourist food consumption	Kenya Tourist Board	Monthly
	National food consumption trends and feeding habits	KNBS	Annually
Trade	Magnitude of cross-border trade	KRA	Monthly

APPENDIX 8.3: AN ADDITIONAL SET OF KPIS ARE REQUIRED TO MAINTAIN THE EWS, AND CAN FORM BASELINE FOR THE SHARED-ACCESS PLATFORM (USE CASE 7)

NOT EXHAUSTIVE -- TO BE REFINED BY IMPLEMENTATION TEAMS

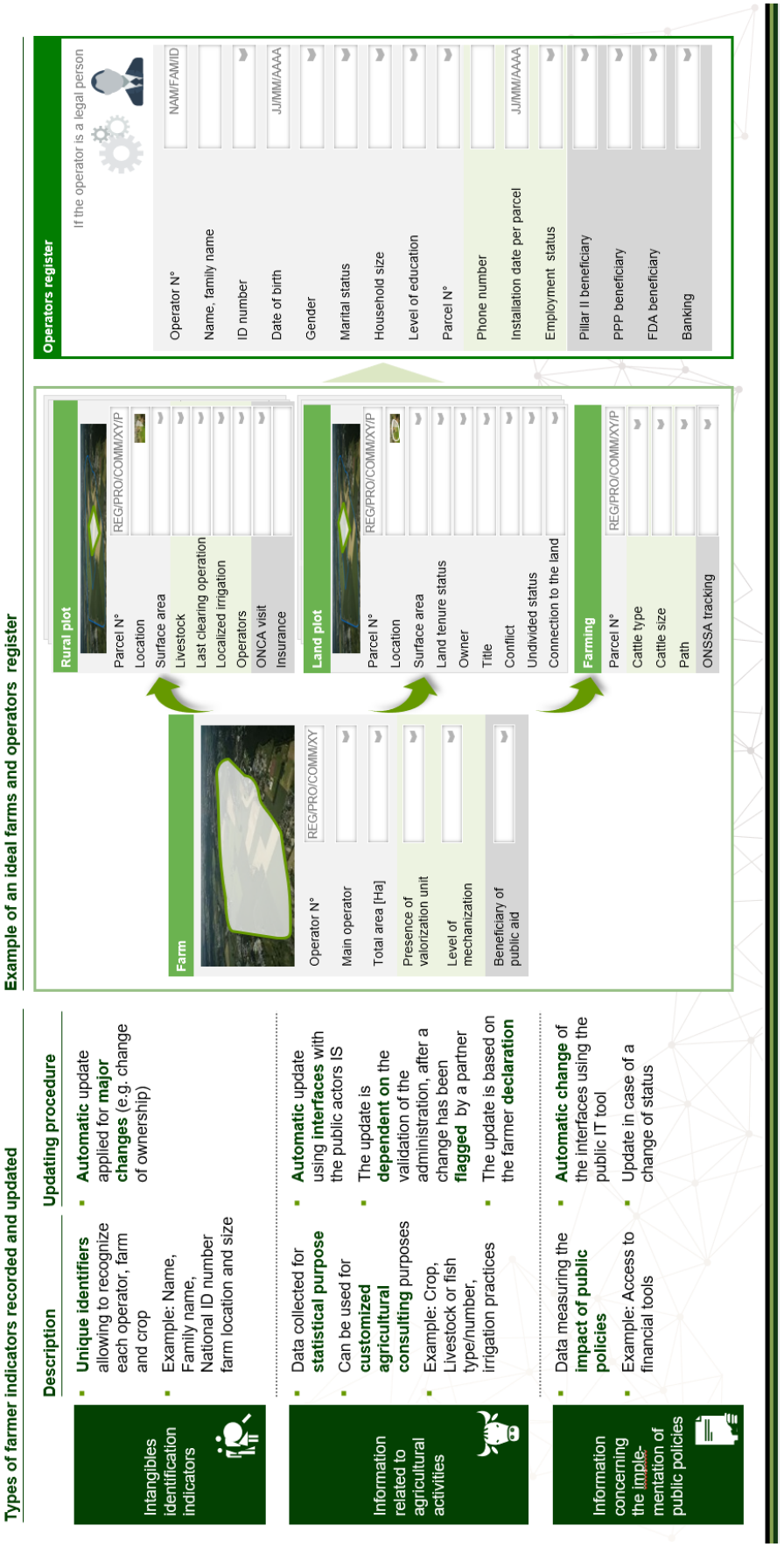
	Metric	Source	Frequency
Domestic food availability	Production per hectare per crop	Private sector provider	Real-time
	Harvests and post-harvest losses	Private sector provider	Real-time
	Livestock reared per hectare, per breed	Private sector provider	Real-time
	Fish bred per water body, per species	KNBS	Monthly
	Stock held by the strategic food reserves	NCPB	Monthly
	Stocks held by farmers	KNBS	Monthly
	Stocks held by commodity boards e.g., Kenya Dairy Board	Commodity boards	Monthly
Environmental factors	Meteorological data (temperature, rainfall etc.)	KMD	Daily
	Soil quality data	KMD, NASA	Monthly
	Pest and disease data	NDMA	Monthly
		Private sector provider	Daily
Market dynamics	Magnitude of cross-border trade	KRA	Monthly
	Domestic market prices	RATIN	Daily
	International market prices	Development partners	Daily

APPENDIX 8.4: AN ADDITIONAL SET OF KPIS ARE REQUIRED TO MAINTAIN THE LAND OPTIMIZATION MODEL, AND CAN FORM BASELINE FOR THE SHARED-ACCESS PLATFORM (USE CASE 7)

NOT EXHAUSTIVE -- TO BE REFINED BY IMPLEMENTATION TEAMS

	Metric	Source	Frequency
Macro-economic	▪ Agriculture contribution to GDP	▪ KNBS	▪ Annually
Reach	▪ Number of counties implementing/changing value-chain policy	▪ Agriculture CEC	▪ Biennially
	▪ Number of households implementing recommendations	▪ ESPs	▪ Seasonally (VC dependent)
Socio-economic	▪ Average income of SSF in specific counties	▪ KNBS	▪ Annually
	▪ Food deficit per value chain per county	▪ Agriculture CEC	▪ Quarterly
	▪ National food consumption trends and feeding habits	▪ KNBS	▪ Annually
Ag production	▪ Production per value chain	▪ MoALFI ▪ Ground truthing	▪ Monthly
	▪ Harvests and post-harvest losses	▪ MoALFI ▪ Ground truthing ▪ Private sector provider	▪ Monthly
	▪ Market prices per value chain	▪ RATIN ▪ Ground truthing	▪ Monthly
Environmental factors	▪ Meteorological data (temperature, rainfall etc.)	▪ KMD	▪ Daily
	▪ Soil quality data	▪ KMD, NASA	▪ Monthly
	▪ Pest and disease data	▪ NDMA ▪ Private sector provider	▪ Monthly ▪ Daily

APPENDIX 9.1: THE IDEAL FARMER REGISTER IS DYNAMIC AND HELPS UNDERSTAND THE FARMER AND THEIR PRACTICES



APPENDIX 9.2: PLANNED GOK PROCESS FOR FARMER REGISTRATION

Ongoing activity

National Integrated Identity Management System (NIIMS)

- **Ministry of Interior** currently conducting individual biometric registration for a Huduma Namba using the NIIMS
- MoALFI can **access the agriculture module within NIIMS**
- MoALFI will use this data to **understand the number of individuals in involved agriculture and the type of agriculture (crop, fish, livestock, trees)**

National Population Census

- KNBS will conduct a full population census in August 2019
- MoALFI will have access to and can use the agricultural module in this data to understand:
  - **number of households involved in agriculture and gender of farmer(s)**
  - **type of agriculture (crop, fish, livestock, trees)**
  - **location of farm (incl. village)**
  - **size of farm**
- This will generate a sampling frame to be used for farmer registration

Farmer registration

- MoALFI plans to conduct farmer registration *(2020)* using the sampling frame in Huduma and Pop census
- Will capture more data on farmers such as:
  - **Farmer demographics (education level,**
  - **type of enterprise (crops/livestock/fish) and variety**
  - **acreage under each**
  - **inputs used and services taken (access to financial services)**
  - **Market linkages and access**
  - **Farm mechanization and irrigation**
- Will be updated seasonally and in accordance to the WCA 2020

Existing programs will have all this data for up to 2Mn farmers by the time the Ministry gets to farmer registration module

APPENDIX 9.3: SAMPLE OF PROGRAMMES WITH DEVELOPMENT PARTNERS THAT ALREADY COLLECT FARMER PROFILE DATA (1/2)

Examples of agriculture sector programmes[1]

		KCSAP	KCEP-CRAL	NARIGP
Project name		▪ Kenya Climate Smart Agriculture Project (in 24 counties) (2022)	▪ Kenya Cereal Enhancement Programme Climate Resillient Agricultural Livelihoods (Window) (2022)	▪ National Agricultural and Rural Inclusive Growth Project (2022)
Funders		THE WORLD BANK	IFAD	THE WORLD BANK
Registration objective		▪ Two-way communication for collecting data and disseminating info.	▪ Disseminating info. and verification of project impact	▪ Registration of farmers and farmer groups to link them to markets
Targeted reach[2]		▪ 0.5 Mn HHD (~0.75 Mn farmers)	▪ 0.2 Mn farmers	▪ 0.4 Mn HHD (~0.6 Mn farmers)
Farmer data	Name	✓	✓	✓
	ID no.	✓	✓	✓
	Mobile	✓	✓	✓
	Location	✓	✓	✓
	Crop/livestock	✓	✓	✓
	Farm size	✓	✓	✓
	Other	✓ Age, gender, inputs, ag. practices	✓ Age, gender, inputs, ag. practices	✓ Age, gender, inputs, ag. practices

1 MoALFI currently has 14 programmes running, this list is not exhaustive 2 Estimated 1.5 farming individuals per HHD (household)

SOURCE: Stakeholder interviews; KCSAP; KCEP-CRAL website; NARIGP website

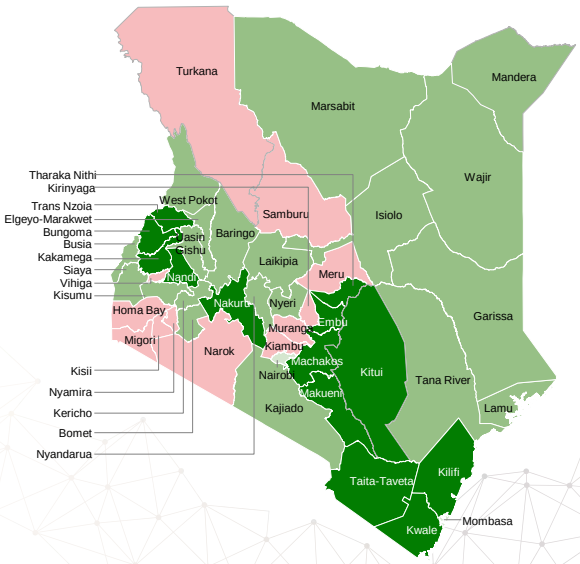
APPENDIX 9.3: SAMPLE OF SCALABLE PRIVATE SECTOR INITIATIVES THAT COLLECT FARMER PROFILE DATA (2/2)

NOT EXHAUSTIVE

		DigiFarm	acre AFRICA	we farm	MOA-Info with PAD
How to access?		▪ USSD - dial *283#	▪ Send unique SMS code to short code	▪ SMS 22301	▪ SMS 'farmer' 'shamba' to 40130
Service offered		▪ Advisory services, Access to inputs and Agricultural finance (loan); *2017 launch*	▪ Index insurance for farmers; *2016 launch*	▪ Advisory services (peer-to-peer); *2017 launch*	▪ Advisory services (focused on Fall Army Worm); *2018 launch*
Farmer data	**Name**	✓	✓	✓	✓
	ID no.	✓			
	Mobile	✓	✓	✓	✓
	Location	✓	✓	✓	✓
	Crop/Livestock	✓	✓	✓	✓
	Farm size	✓			
	Other		✓ Inputs purchased	✓ Age	
Reach (No. of farmers)		▪ ~ 0.9 Mn	▪ ~ 1.7 Mn[1]	▪ ~ 1.6 Mn[2]	▪ ~ 0.4 Mn

1 This number includes Kenya and Tanzania, with Kenya accounting for majority. | 2 This number is across Kenya, Tanzania and Rwanda, assuming that Kenya numbers account for majority. | 3 Currently, have location data for 50% of the farmers registered on MOA-Info platform. | 4. Response rate for farmers is 30-45%

APPENDIX 9.4: THROUGH THESE PROGRAMMES, THERE IS ALMOST FULL INTENDED NATION-WIDE COVERAGE



1 MOA-Info is not covered in the map as it is present nationwide (every county), however with a larger presence specifically in Western Kenya where they started the pilot

APPENDIX 10: EXISTING WEB-BASED GOVERNMENT INFORMATION SYSTEMS

1. **Kenya Agricultural Information Network (KAINet),** which was focused on the development of an electronic repository as part of a Kenyan national agricultural science and technology information system to the Strategy for Revitalizing Agriculture
2. **National Farmers Information Service Kenya (NAFIS)** provides agricultural information on major crop and livestock production, inputs and output markets
3. **Agricultural Information Resource Centre (AIRC)**, which works by collecting and disseminating research results from research institutions, universities and other organizations
4. **Kenya Plant Health Inspectorate Service (KEPHIS),** which is a government parastatal whose responsibility is to assure the quality of agricultural inputs and produce to prevent adverse impact on the economy, the environment and human health
5. **National Horticulture Market Information System (NaHMIS)** provides market information system in the horticulture sub-sector.
6. **Livestock Information Network Knowledge System (LINKS),** which provides regular livestock prices and volume information on most of the major livestock markets in Ethiopia, Kenya and Tanzania along with information on forage conditions, disease outbreak, conflict and water supply to support decision making at multiple scales
7. **National Livestock Marketing Information System (NLMIS),** which is based on the short message service (SMS) to report on weekly livestock volumes and prices from a network of markets in Kenya, in form of near-real-time information

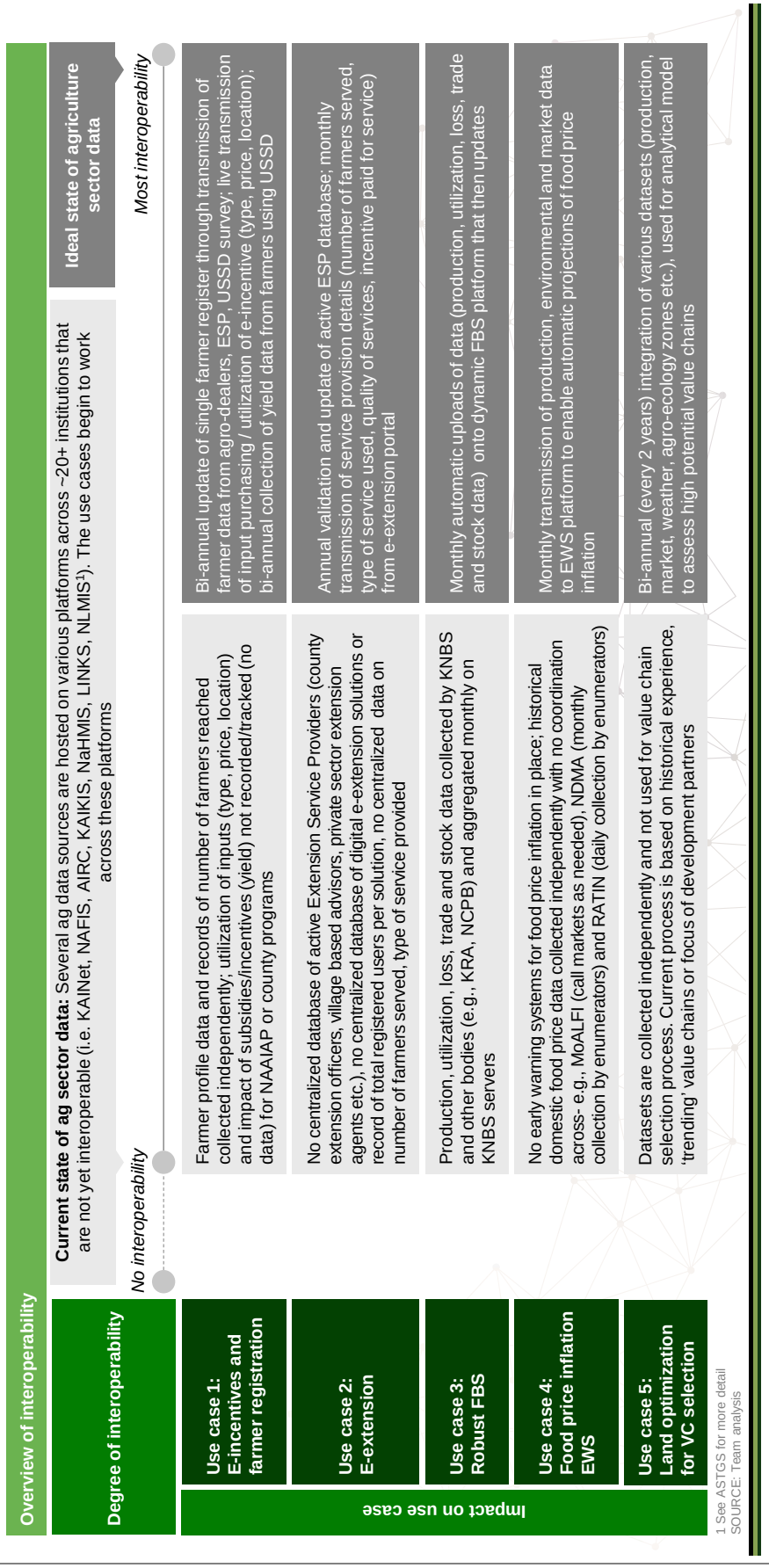
- *Production data domain specifically for horticulture value chains however would not be used as it was last updated in 2015 and only captures data for 3 counties*
- *Trade data domain specifically on prices (farmgate, retail, wholesale international) also has not been updated since 2015*

- *Production and trade (prices) data domains specifically for livestock however would not be used as it has not been recently updated*

- *Trade (prices) data domain specifically for livestock is regularly updated*

SOURCE: ASTGS

APPENDIX 11: INTEROPERABILITY ACROSS THE 5 CORE USE CASES IS A STARTING POINT FOR THE SECTOR AS ANTIONAL STANDARDS ARE GRADUALLY ADOPTED



- Platform access and privileges:
  - Implement Least Privilege Model i.e. users (e.g., Food Security Department that needs to access FBS) and cloud solution provider (CSP) administrators should only possess those rights required to perform their task
  - Implement role-based access control, regular reviews of roles and rights and provide different types of user accounts e.g., superusers (MoALFI ICT department), standard users (Agriculture Statistics Unit for the 5 State Departments) and guest users (consultants, development partners) to perform their task)

- Network security:
  - Set up security measures against malware (anti-virus, Trojan detection, anti-spam, etc.) and network-based attacks (IPS/IDS systems, firewall, Application Layer Gateway, etc.)
  - Segment the network by isolating the management network from the data network
  - Encrypt communication between cloud computing locations

- Data security:
  - Classify and anonymize all Personal Identifiable Information (PII) such as farmer location, national ID before integrating into the platform
  - Develop data encryption and masking mechanisms to improve the security and privacy
  - Implement regular data backups, with data providers being able to audit their basic parameters
  - Ensure data security is aligned to the Data Protection Bill (2018)

- Secure search:
  - Implement document level access restrictions for each of the use cases. Only users with the appropriate privileges should be able to see specific data/documents

APPENDIX 13: PUBLICLY AVAILABLE DATABASES THROUGH GODAN PARTNERS:

APPENDIX 14: THE ATO IS THE RECOMMENDED COORDINATION STRUCTURE TO DELIVER THE USE CASES, BUT IT WILL REQUIRE STRONG TECHNICAL ASSISTANCE

Recommended model, drawing best practices from ****

Government Led → Private Sector Led

Body	ATO *(Kenya)*	JASCCOM *(Kenya)*	Agriculture and Rural Development Donor Group *(Kenya)*	Power Africa SteerCo *(Kenya)****	ITASCA *(Minneapolis, USA)*
Who are the participants?	▪ Government employees	▪ Government (National & County level), development partners	▪ Development partners, plus government, private sector	▪ Government, private sector and industry experts	▪ Largest private sector organisations in Minneapolis
How frequently do they meet?	▪ Weekly	▪ Monthly	▪ Monthly	▪ Quarterly	▪ Every 6 weeks
What is their mandate?	▪ Inter-Ministerial coordination ▪ County domestication of the ASTGS ▪ Technical support ▪ Performance management ▪ Mutual accountability	▪ Consultation between national and county government ▪ Oversight of policy development and implementation ▪ Dispute resolution	▪ Coordination ▪ Decision-making	▪ Setting the national power sector agenda ▪ Coordination ▪ Decision-making	▪ Set the agenda for private sector contribution to economic development, ▪ Setting the economic development agenda, ▪ Coordination ▪ Decision-making
Who facilitates?	▪ CAS	▪ CS ▪ Chair CoG Agriculture Committee	▪ Facilitated internally by a rotating Chair	▪ Facilitated by independent player; Chairmanship maintained with USAID/funder	▪ Facilitated and project managed by non-voting independent player Chair rotated amongst members
Pros/cons for coordinating digital strategy	⊕ ATO is responsible for delivering ASTGS ⊖ Interim structure in place but very under resourced – particularly Project management & delivery expertise	⊕ Credibility to bring together county and national decision-makers ⊖ To date have had passive role in implementation	⊕ Members are high-level ⊕ Agendas are driven ⊖ based on resources ⊖ Must represent own national government interests	⊕ Multi-sectoral ⊕ Members are decision-makers ⊕ Ownership by groups of specific agenda items ⊖ Supported by independent TA / facilitator ▪ Catalytic but not self-sustaining	⊕ Full ownership by each member of particular actions, with funding commitments from within the group ⊖ No requirement for government involvement as it is a fully private sector agenda

AGRICULTURE SECTOR TRANSFORMATION AND GROWTH STRATEGY (ASTGS)

FLAGSHIP 8: DATA AND DIGITALIZATION GOVERNANCE MECHANISM

TERMS OF REFERENCE (ToR)

I. Context

Background

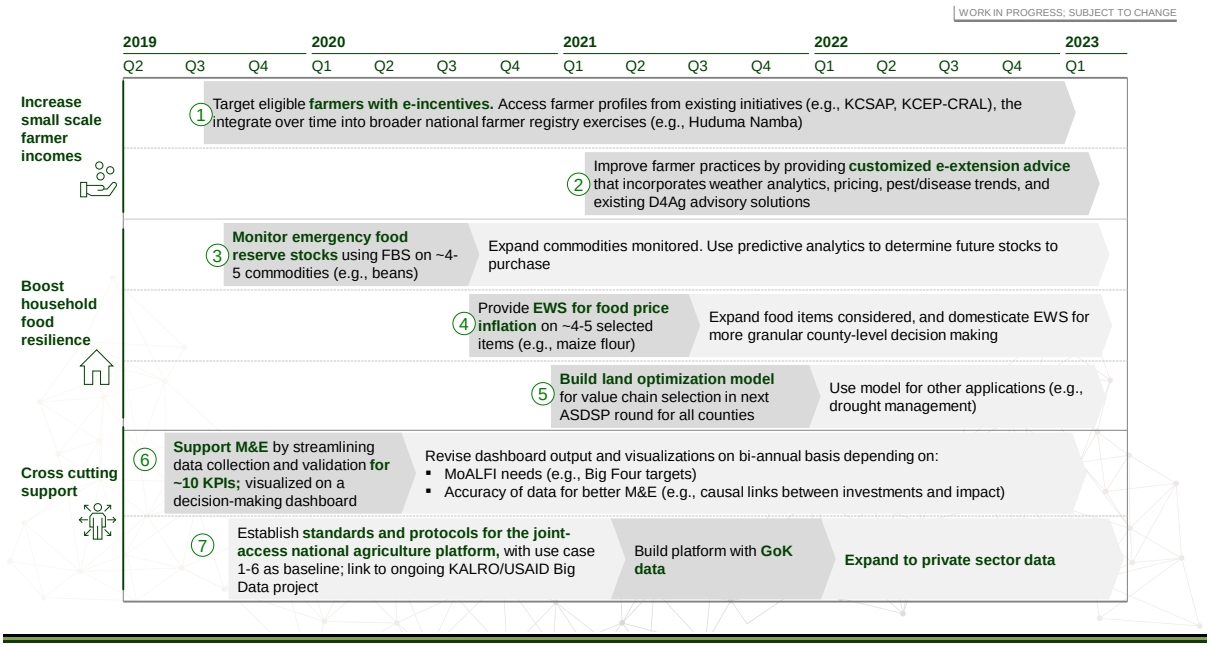
The Ministry of Agriculture, Livestock, Fisheries and Irrigation's (MoALFI) Agriculture Sector Transformation and Growth Strategy (ASTGS) aims to grow the economy, reduce the cost of food, alleviate poverty and deliver 100% food and nutrition security through the implementation of 9 flagships, *see the addendum for more details*. Flagships are strategic projects with a lifetime of >3 years, with both high feasibility and impact within Kenya's agricultural context. Of these, Flagship 8 is designed to "Strengthen research and innovation as launch priority digital and data use cases to drive better decision-making and performance management".

As MoALFI implements Flagship 8, it has identified and prioritized 7 digital use cases to support Kenya's food security and agricultural transformation agenda, as well as a framework to bring them all together (including data architecture, M&E), *See Appendix 15.2*. This ToR addresses MoALFI's desire to coordinate the agricultural sector to implement these use cases through the Agricultural Transformation Office (ATO), with dedicated Delivery Team(s) for the flagship

As outlined in the ASTGS, the ATO is intended to serve as the national secretariat facilitating transformation efforts across the agricultural sector. Working under the ATO, the Flagship 8 delivery teams will bring together members of national and county government, development partners, private sector and other non-state actors, to align their time and resources more effectively for the coordination and implementation of the 7 digital use cases.

APPENDIX 15.2: THE SEVEN DIGITAL USE CASES

FIGURE 15.3: PROPOSED PHASED APPROACH TO IMPLEMENTATION OF USE CASES



A. Objectives

i. Coordinate delivery of ASTGS Flagship 8 milestones across government, private sector, development partners and non-state actors, with a strong focus on the 7 digital use cases

ii. Guide MoALFI on how to adapt implementation of the use cases and other Flagship 8 milestones based on emerging evidence from the field

iii. Identify and remove barriers to implementation including but not limited to determining the most effective allocation of joint resources in the sector

iv. Catalyse support from key institutions/personnel outside of the Flagship 8 Delivery Teams who are critical to delivering the use cases and other Flagship 8 milestones

II. Mandate, Governance and Membership

A. Mandate

To support MoALFI to deliver the national digital agriculture agenda, based on, but not limited to, the ASTGS and the prioritized use cases

B. Governance structure and membership

The Flagship 8 Governance Mechanism is composed of:

i. ASTGS Steering Committee: Acts as the Advisory Board to the Cabinet Secretary of the Ministry of Agriculture, Livestock, Fisheries and Irrigation; Leads inter-Ministerial coordination and collaboration with the Intergovernmental Forum for Agriculture (IGF-A); Implements accountability mechanisms to drive performance of the ATO and Flagship 8 Delivery Teams

ii. Agricultural Transformation Office: Facilitates implementation needs of Flagship 8 Delivery Team(s) and reports to the Chief Administrative Secretary (CAS) MoALFI; Collaborates closely with the Joint Agricultural Sector Steering Committee (JASSCOM) to facilitate domestication of the ASTGS in the counties

iii. Technical Assistant (TA): Provides project management support and technical expertise to the ATO and Flagship 8 Delivery Teams in implementing the use cases, reporting on progress and monitoring impact

iv. Flagship 8 Delivery Teams: Collectively comprise of ~15 people clustered into 2 teams, each responsible for driving delivery of 3-4 use cases

The Flagship 8 Governance Mechanism will be composed of national and county agriculture, digital and development actors working focused on transforming the sector and achieving 100% food security. The ATO and Flagship 8 Delivery Teams will engage with the relevant Ministries, county governments, national institutions, development partners, private sector actors and non-state actors on delivery.

i. The Steering Committee operates at national level and shall be comprised of ~15 people, as per below, Chaired by the CAS MoALFI:

   a. All Principal Secretaries of Agriculture, Livestock, Fisheries and Irrigation

   b. Chair of the Council of Governors Agriculture Committee

   c. Representative from JASSCOM

   d. One representative from each of the 3 Flagship 8 Delivery Teams (re-elected every 12 months)

   e. Other PS's or their equivalents at the invitation of the CAS, depending on the agenda for the meeting - including but not limited to Ministry of ICT (MoICT), Ministry of Industry, Trade and Cooperatives (MoITC) and National Treasury

ii. The Technical Assistant recruitment criteria will be as defined by AGRA, together with MOALFI

iii. Flagship 8 Delivery Teams will be comprised of ~5 people, vetted by the ATO, as per below, with chairmanship rotating every 12 months:

a. Relevant MOALFI Director and/or programme representative from on-going initiatives that use cases rely on including KCSAP, KCEP-CRAL, NARIGP, ASDSP

b. Council of Governors / relevant county representative

c. Private sector representation based on direct support offered to the use case

d. Development partner representation based on nomination from the ARRDG

e. Other members may be included in the group as required on a temporary basis to progress specific agenda items

Competencies/contributing factors must include

a. Technical knowledge of use case

b. Authority to allocate funds towards implementation

c. Ability to catalyse non-Delivery Team players to action

The ultimate responsibility and accountability for the functioning of each group lies with the respective Chairperson.

The effectiveness and membership of the Flagship 8 Governance Mechanism will be reviewed every 12 months at the Steering Committee level.

C. Roles and responsibilities

i. Steering Committee

a. Support the ATO and Flagship 8 Delivery Teams to prioritize actions

b. Remove financial and policy bottlenecks to implementation

c. Hold Flagship 8 Delivery Teams to account on workplans and critical success factors

d. Review effectiveness of the Flagship 8 Governance Mechanism

ii. Technical Assistant

a. Support each Flagship 8 Delivery Team to implement by following up on progress and required technical support, on a weekly basis

b. Report to the Steering Committee monthly on implementation progress against workplans

c. Support the Steering Committee members to convene meetings and coordinate with other Ministries, parastatals and counties to unblock bottlenecks

iii. Flagship 8 Delivery Teams

a. Drive delivery of each use case; including approving the quarterly workplans designed by MoALFI, and track progress towards impact and the milestones

b. Adapt quarterly workplans according to emerging information/evidence

c. Communicate progress towards impact defined for each use case to the and Steering Committee accurately and regularly, escalating any issues that require decisions from Cabinet Secretary

iv. Role of all individual members:

a. Commit to carrying out assigned tasks in the time frame required and actively pursue the Flagship's outcomes

b. Attend regular meetings as required, without delegating

c. Represent the interests of the nation and be a public advocate for the Flagship's outcomes

d. Convene meetings, with support from the TA (for the chair only)

D. Critical success factors

i. 75% milestones reached within 4 weeks of deadline

ii. 75% use cases implemented at +/- 15% budget

iii. 100% sustainability achieved for 6+ use cases within 2 years of implementation

III. Coordination and operations

A. Mindset

Solve problems early; make decisions quickly; test, learn and iterate

FIGURE 15.4: APPROACHES DESIGNED TO FACILITATE SUCCESSFUL DELIVERY

B. Monitoring and tracking

i. Simple digital tools (e.g., online / cloud records of meeting agendas and minutes) to track progress towards impact and milestones in implementation plans

ii. Progress against plans is to be reviewed at every meeting and publicised (with the exception of specific items protected by confidentiality) to hold the Flagship 8 Delivery Mechanism to account

iii. Outcome metrics are to be reviewed and published annually

C. Meetings

i. Frequency of meetings

Leading party	Frequency
CS MoALFI	Every 2 months
IGF-A	Annually
ASTGS Steering Committee	Every 2 months
Delivery Team	Monthly

ii. Agenda items

a. All agenda items will be forwarded to the Chair of the group in question and TA by close of business 10 working days prior to the next scheduled meeting

b. The agenda, with attached meeting papers, will be distributed at least five working days prior to the next scheduled meeting

iii. Minutes and meeting papers

a. The minutes of each meeting will be prepared by the ATO

b. Full copies of the minutes, including attachments, will be provided to all Flagship 8 Delivery Team members, the ATO and Steering Committee no later than five working days following each meeting

c. By agreement of the group, out-of-session decisions will be deemed acceptable. Where agreed, all out-of-session decisions will be recorded in the minutes of the next scheduled meeting

iv. Quorum requirements

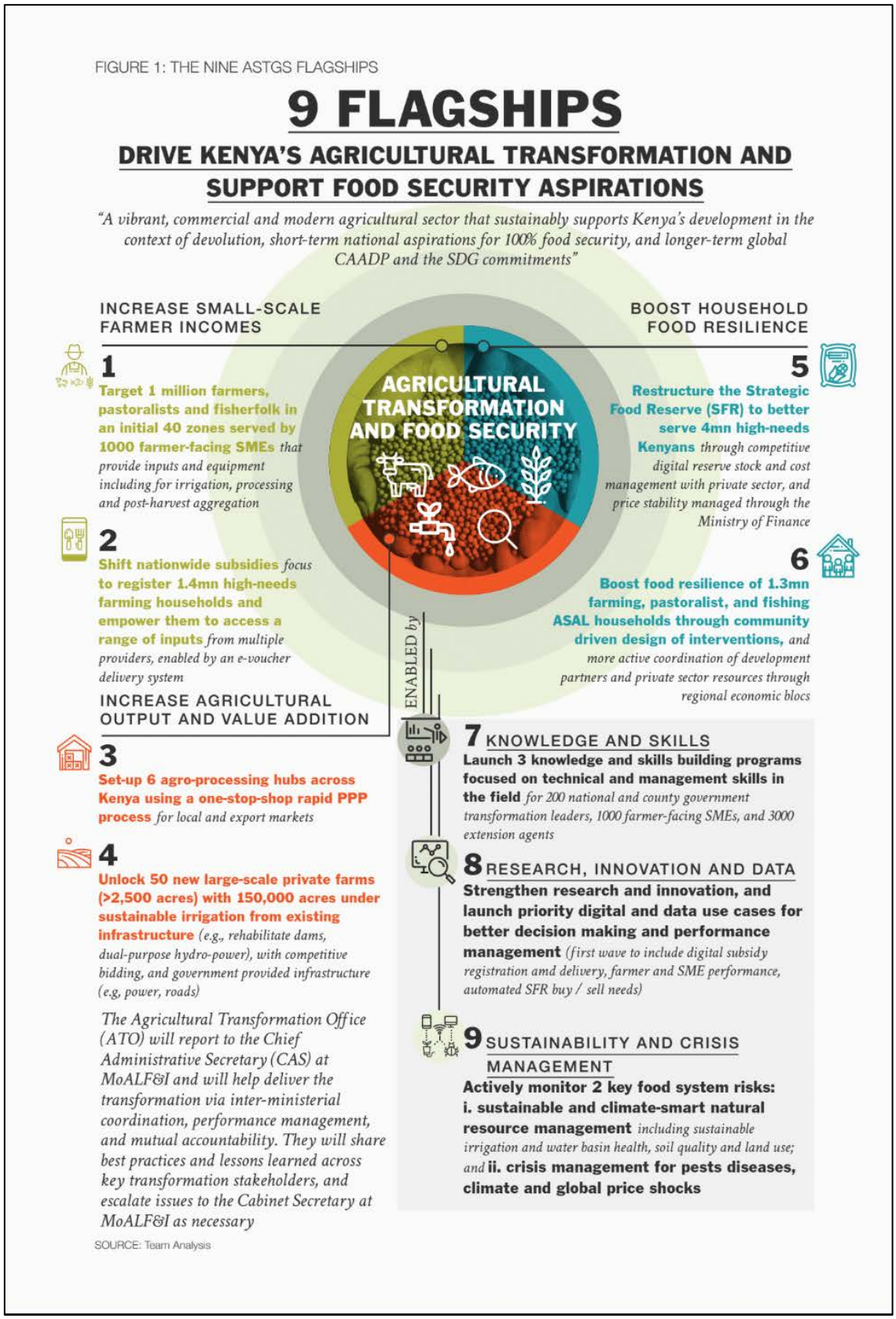
a. A quorum will be a minimum four out of five Flagship 8 Delivery Team members, six out of eight of the Steering Committee, and two out of five for the ATO

IV. Confidentiality

The parties attending these meetings will seek to preserve confidentiality regarding any individual farmer data, early government decisions/intentions/plans that are yet to be made public, IP of private sector whenever sharing related information, and reporting on such information.

IV. Addendum

A. The Nine ASTGS Flagships



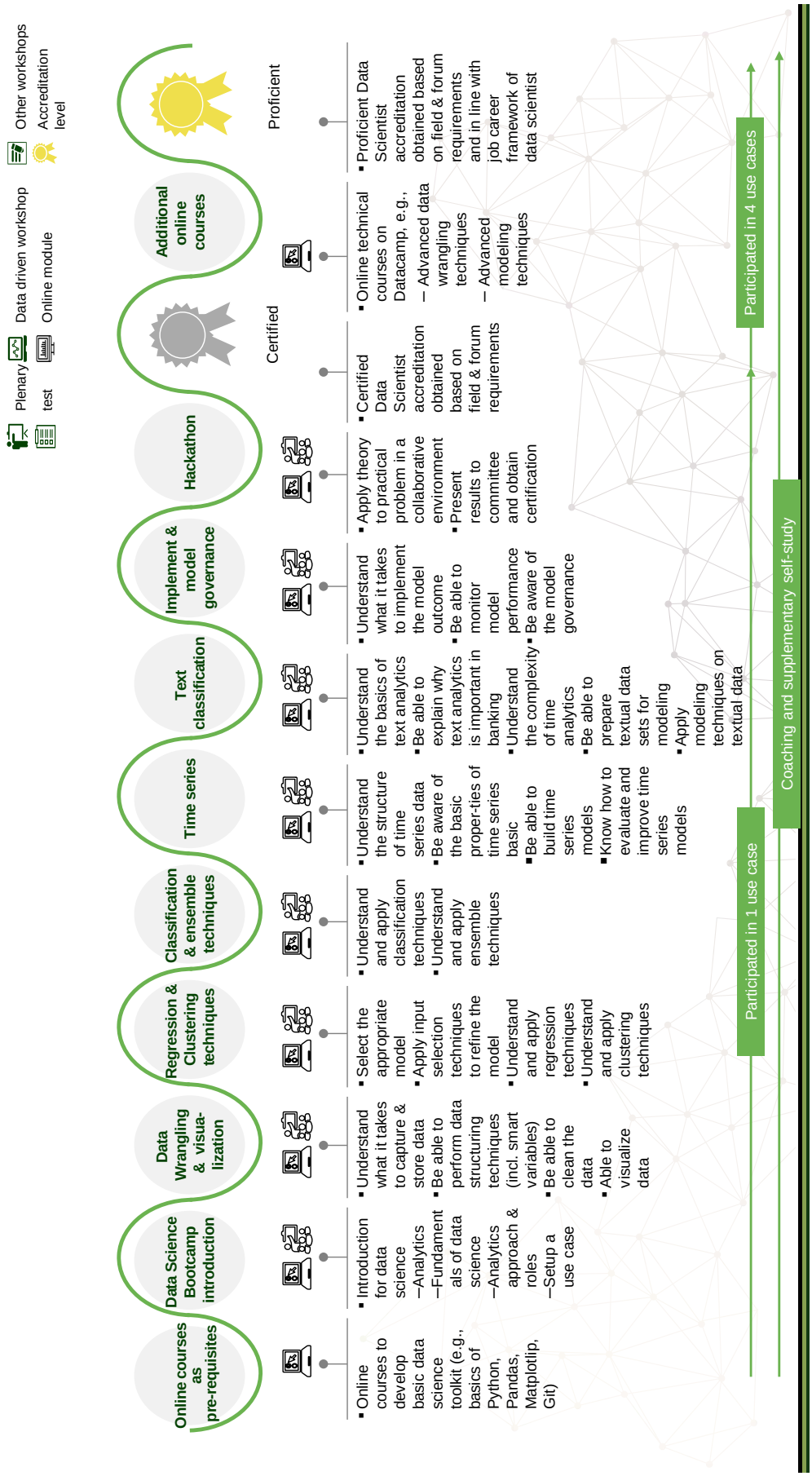
APPENDIX 16: OVERVIEW OF CAPABILITIES OF SELECTED PUBLIC SECTOR INSTITUTIONS:

	Collect	Integrate/aggregate[1]	Analyze[2]	Access/distribute
Agriculture, Fisheries and Food Authosrity (AFFA) (through its directorates e.g, Horticultural Crops, Tea etc)	✓	✓	✗	✓
Agricultural Information Resource Centre (AIRC)	✗	✓	✗	✓
Department of Resource Surveys and Remote Sensing (DRSRS)	✓	✗	✓	✓
Kenya Agriculture and Livestock Research Organisation (KALRO)	✓	✓	✓	✓
Kenya Dairy Board	✓	✓	✓	✓
Kenya Marine and Fisheries Research Institute (KEMFRI)	✓	✓	✗	✓
Kenya Meat Commission	✓	✓	✗	✓
Kenya Meteorological Department (KMD)	✓	✓	✓	✓
Kenya National Bureau of Statistics (KNBS)	✓	✓	✓	✓
Kenya Plant Health Inspectorate Service (KEPHIS)	✓	✓	✓	✓
Kenya Revenue Authority (KRA)	✓	✓	✓	✓
Ministry of Industry, Trade and Co-operatives	✓	✗	✗	✓
Ministry of Water and Sanitation	✓	✓	✗	✓
MoALFI (State Departments: Crop Development, Livestock, Irrigation, Fisheries and Aquaculture, Agricultural Research)	✓	✓	✓	✓
National Cereals and Produce Board (NCPB)	✓	✓	✓	✓
National Drought Management Authority (NDMA)	✓	✓	✓	✓
National Farmers Information Service (NAFIS)	✗	✓	✗	✓
Regional Centre For Mapping Resource For Development (RCMRD)	✓	✗	✓	✓
Information and Communication Technology (ICT) Authority (Kenya Open Data)	✗	✓	✓	✓

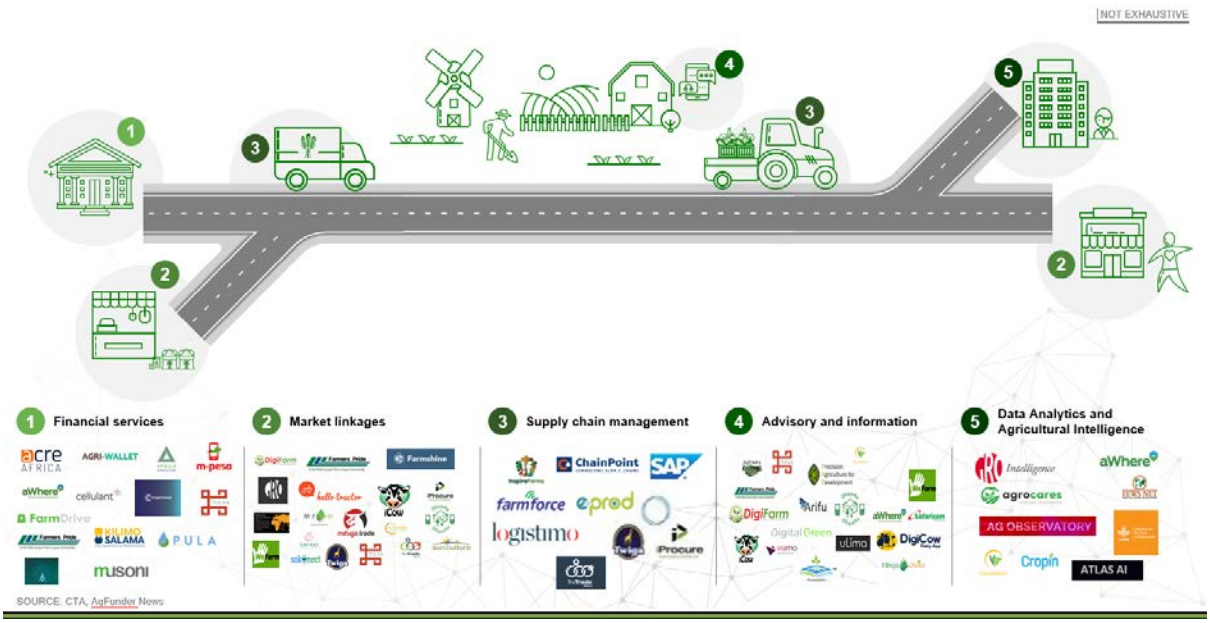
Majority of the institutions collect and store data relevant to their scope of work and conduct basic analysis to develop useful information. They facilitate consumption through developing reports that are shared with other stakeholders upon request

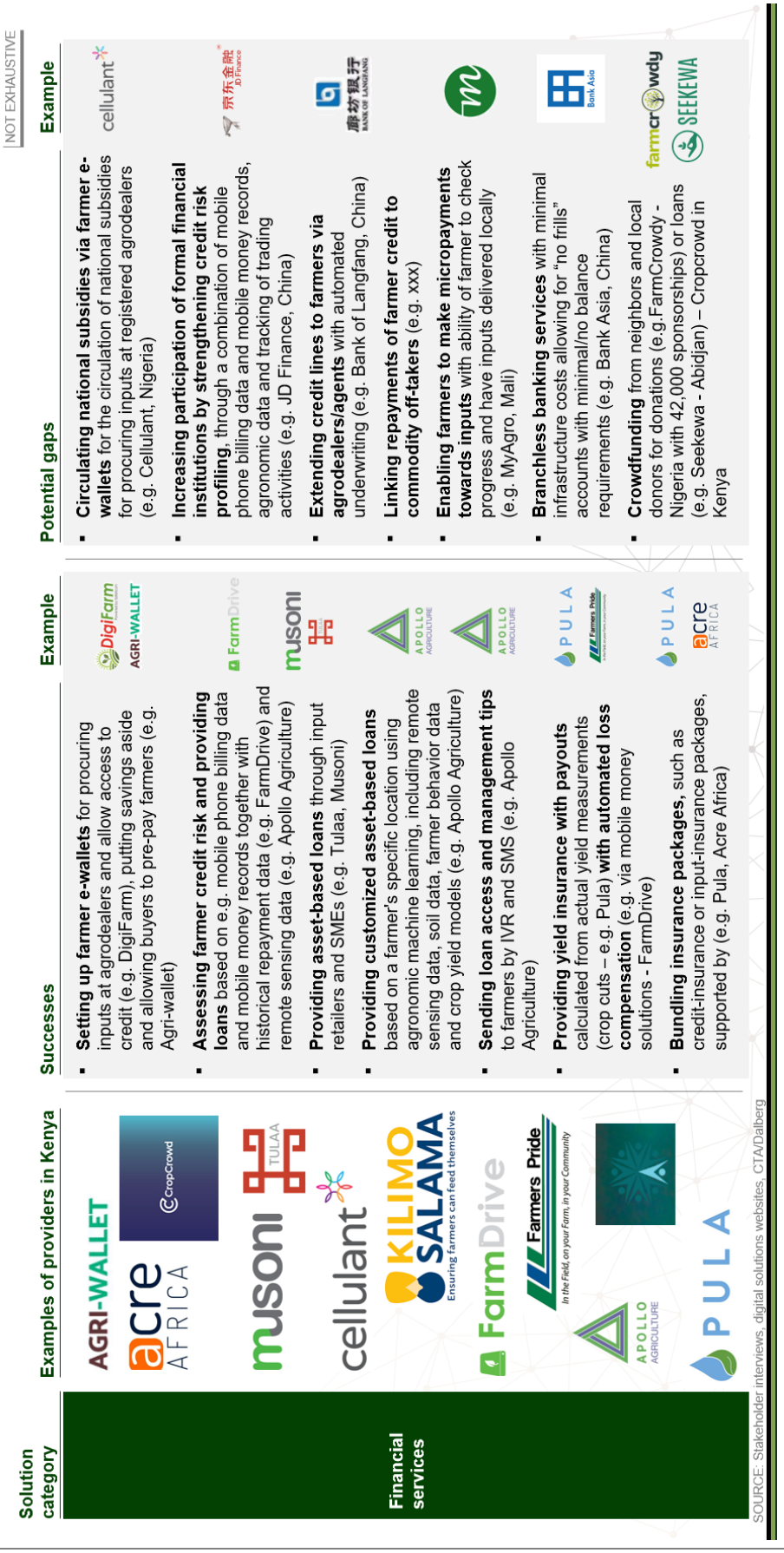
1 Data integration describes movement of data between data sources and data repositories. | 2 Data analysis is a process of inspecting, cleansing, transforming, and modeling data to develop useful information and support decision-making

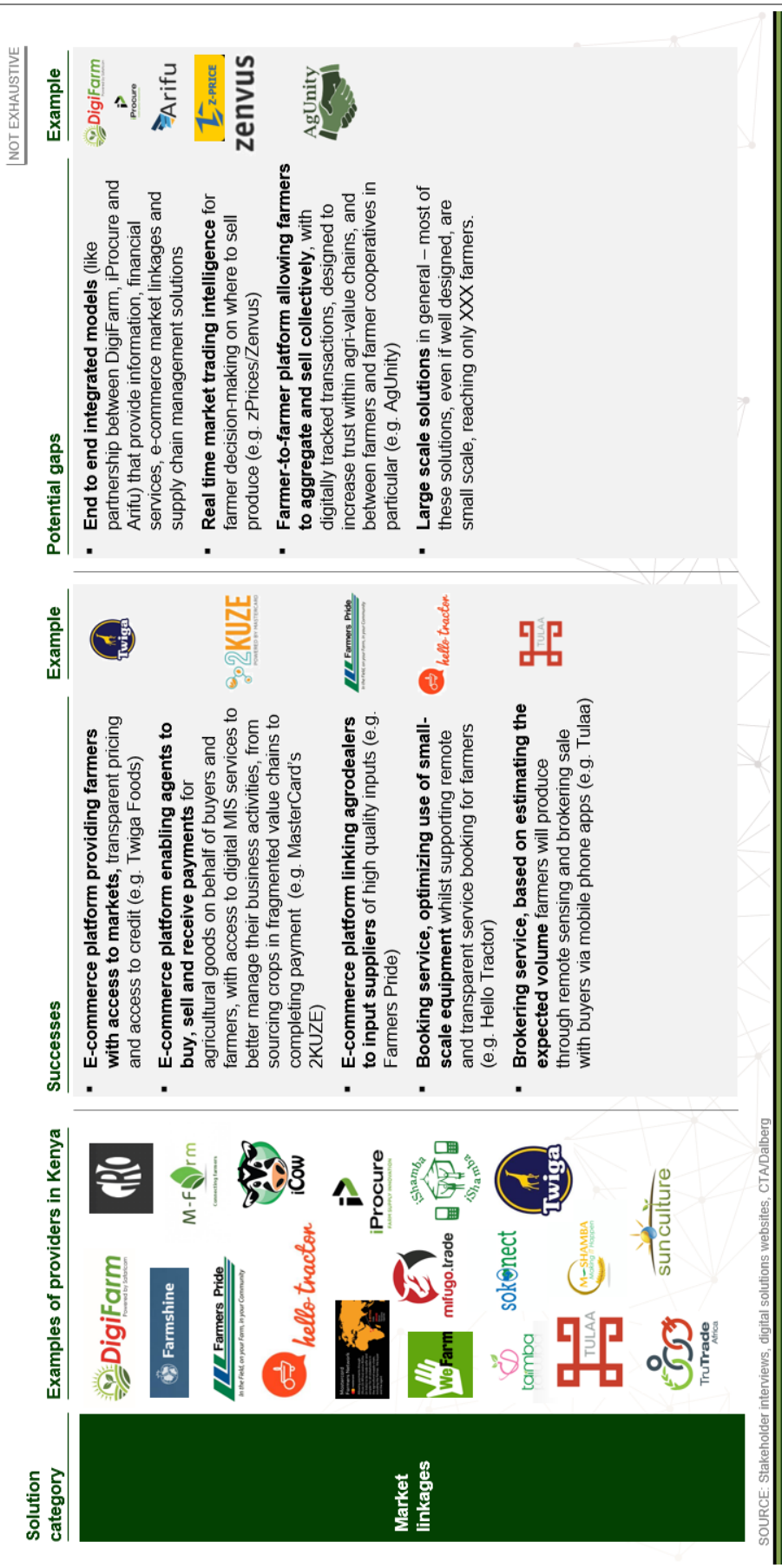
APPENDIX 17: LEARNING JOURNEY TO DEVELOP CERTIFIED DATA SCIENTISTS



APPENDIX 18: KENYA'S 100+ D4AG SOLUTIONS CAN BE GROUPED INTO 5 AREAS




NOT EXHAUSTIVE
Solution category
Examples of providers in Kenya
Successes
Example
Potential gaps
Example
Financial services
AGRI-WALLET
acre AFRICA
CropCrowd
musoni
TULAA
cellulant
KILIMO SALAMA
Ensuring farmers can feed themselves
FarmDrive
Farmers Pride
In the Field, on your Farm, in your Community
APOLLO AGRICULTURE
PULA
Setting up farmer e-wallets for procuring inputs at agrodealers and allow access to credit (e.g. DigiFarm), putting savings aside and allowing buyers to pre-pay farmers (e.g. Agri-wallet)
Assessing farmer credit risk and providing loans based on e.g. mobile phone billing data and mobile money records together with historical repayment data (e.g. FarmDrive) and remote sensing data (e.g. Apollo Agriculture)
Providing asset-based loans through input retailers and SMEs (e.g. Tulaa, Musoni)
Providing customized asset-based loans based on a farmer's specific location using agronomic machine learning, including remote sensing data, soil data, farmer behavior data and crop yield models (e.g. Apollo Agriculture)
Sending loan access and management tips to farmers by IVR and SMS (e.g. Apollo Agriculture)
Providing yield insurance with payouts calculated from actual yield measurements (crop cuts – e.g. Pula) with automated loss compensation (e.g. via mobile money solutions - FarmDrive)
Bundling insurance packages, such as credit-insurance or input-insurance packages, supported by (e.g. Pula, Acre Africa)
DigiFarm
AGRI-WALLET
FarmDrive
musoni
APOLLO AGRICULTURE
PULA
acre AFRICA
Circulating national subsidies via farmer e-wallets for the circulation of national subsidies for procuring inputs at registered agrodealers (e.g. Cellulant, Nigeria)
Increasing participation of formal financial institutions by strengthening credit risk profiling, through a combination of mobile phone billing data and mobile money records, agronomic data and tracking of trading activities (e.g. JD Finance, China)
Extending credit lines to farmers via agrodealers/agents with automated underwriting (e.g. Bank of Langfang, China)
Linking repayments of farmer credit to commodity off-takers (e.g. xxx)
Enabling farmers to make micropayments towards inputs with ability of farmer to check progress and have inputs delivered locally (e.g. MyAgro, Mali)
Branchless banking services with minimal infrastructure costs allowing for "no frills" accounts with minimal/no balance requirements (e.g. Bank Asia, China)
Crowdfunding from neighbors and local donors for donations (e.g.FarmCrowdy - Nigeria with 42,000 sponsorships) or loans (e.g. Seekewa - Abidjan) – Cropcrowd in Kenya
cellulant
京东金融 JD Finance
BANK OF LANGFANG
Bank Asia
farmcrowdy
SEEKEWA
SOURCE: Stakeholder interviews, digital solutions websites, CTA/Dalberg



SOURCE: Stakeholder interviews, digital solutions websites, CTA/Dalberg

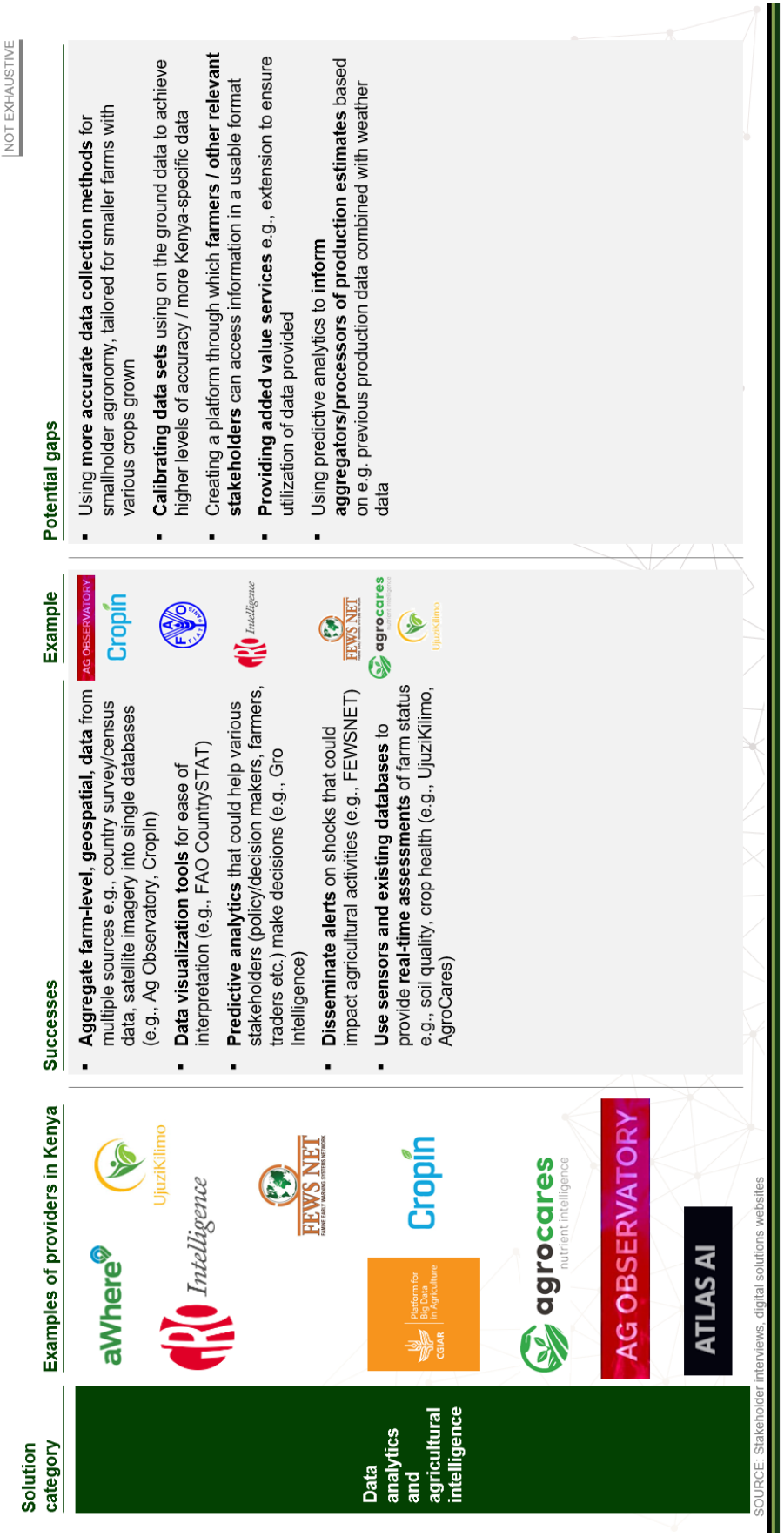
NOT EXHAUSTIVE

Solution category	Examples of providers in Kenya	Successes	Example	Potential gaps	Example
Supply chain manage-ment	ChainPoint; InspiraFarms; SAP; eProd; iProcure; Twiga; logistimo; farmforce; TruTrade Africa	▪ **Create sustainable supply chains and coordinate aggregation, storage and movement of farmer produce** e.g., by handling transaction logistics and delivery to buyers (e.g., TruTrade, Twiga Foods) ▪ **Increase traceability within the supply chain** e.g., by monitoring field activities, managing input distribution and product aggregation (e.g., eProd) ▪ **Provide mobile-enabled product aggregation and payment platforms** for produce tracking and quality-based payments (e.g., eProd) ▪ **Increase smallholder famer access to formal markets** using mobile technology to ensure traceability and compliance of smallholder produce (e.g., Farmforce) ▪ Link farmers to **silo and warehouse facilities** (e.g., iProcure)	TruTrade; Twiga; eProd; eProd; farmforce; iProcure	▪ **Digitization of agvets/agro-dealers** with regards to input supply chain management, e-extension and e-subsidies ▪ Providing farmers with **demand forecasts** to allow for demand-driven production ▪ Improved **storage and transportation technologies for shelf life extension** where needed ▪ **Visual mappings** of existing supply chains to identify opportunities, risks and hotspots (e.g., ChainPoint in some countries) ▪ Consolidation and dissemination of **best practice information** to farmers to increase uptake (e.g., Jagriti Agro Tech in India) ▪ **Registration and coding of certified products** to reduce counterfeits with digital capability for agrovets/agrodealers and farmers to counter check (e.g. KEPHIS, ETG pilot in Mweya) ▪ **Traceability solution targeting cooperatives,** designed to streamline operations (e.g. AgUnity, Farmforce)	ChainPoint; JAGRITI AGRO TECH; ETG; farmforce; AgUnity

SOURCE: Stakeholder interviews, digital solutions websites, CTA/Dalberg


NOT EXHAUSTIVE
Solution category
Examples of providers in Kenya
Successes
Example
Potential gaps
Advisory and information
Mass SMS to increase productivity (e.g., appropriate seed choice, fertilizer requirements) or reduce market asymmetries (e.g. by sending weekly crop market prices from major markets countrywide, as with e.g. M-Farm)
Targeted SMS on specific crops/livestock to help farmers improve farming practices (e.g. Tulaa) or protect against pests / diseases (e.g., signs of infestation, ways of managing outbreaks) (e.g. Arifu, PAD / MOA-Info)
Targeted agronomic and weather intelligence dissemination based on location so farmers can optimize timing of planting (e.g. uLima)
Connect farmers with affordable ag equipment (Hello Tractor)
Mobile applications to provide information that will help with decision-making on farm management (e.g. Shamba Digital, KALRO apps)
Interactive information service for farmers to solve issues in real time (e.g. iShamba call center)
Farm management software to track farm budget and operations (e.g. ProbityFarms)
Centralized farmer database to facilitate targeting of tailored information to farmers
Searchable web portal cataloguing of all available digital advisory solutions to strengthen extension services
Extension service provider catalogue for farmers to locate nearest agent
Training modules (video or otherwise) for extension officers to keep knowledge current
Custom recommendations on subsidy expenditure directed to the farmer based on farmer profile
Single government information source on legislation, regulations, fees, processes and services (e.g. transparency of export processes and fees, approved seed varieties, national crop reports, license application)
Linkages from farmers to credible and affordable agrodealers/vet service providers within the local community
Survey capabilities to monitor pest/disease outbreaks, input usage and farmer awareness/understanding of recommendations
Digital platform that gives processors real-time / aggregated data about markets (what's available, what quantities, price information)
Greater use of real time surveys to study farming practices and behaviours to inform customization of extension services
Directed alerts regarding events or extension officer visits to maximise farmer attendance
SOURCE: Stakeholder interviews, digital solutions websites, CTA/Dalberg

APPENDIX 17.6: ~10+ DATA ANALYTICS AND AGRICULTURAL INTELLIGENCE DIGITAL SOLUTIONS



Solution category	Sub-category	Organization	Description	Weblink
Advisory and information (contd.)	▪ Crowdfarming	Farmerline	▪ Farmerline aims to transform smallholder farmers into successful entrepreneurs by increasing their access to information, inputs, and resources to increase productivity.	▪ https://farmerline.co/
	▪ Farm management software	Arifu	▪ Arifu is a personal learning tool you can chat with on any mobile device to learn new skills and access opportunities from our partners.	▪ https://www.arifu.com/
	▪ Farm management software	KALRO	▪ The national blue print Vision 2030 recognizes the role of research in technology generation and creation of new knowledge; all of which are vital in national development. Vision 2030 also places great importance on value addition in agriculture and livestock as a means of raising rural household incomes as captured by the sector's driving strategy, the Agricultural Sector Development Strategy 2010-2020. In implementing the second medium term plan the Kenya Government reformed the National Agricultural Research Systems through creation of the Kenya Agricultural and Livestock Research Organization (KALRO). Its formation was aimed at restructuring agricultural and livestock research into a dynamic, innovative, responsive and well-coordinated system driven by a common vision and goal. KALRO is a corporate body created under the Kenya Agricultural and Livestock Research Act of 2013 to establish suitable legal and institutional framework for coordination of agricultural research in Kenya with the following goals:- Promote, streamline, co-ordinate and regulate research in crops, livestock, genetic resources and biotechnology in Kenya.- Expedite equitable access to research information, resources and technology and promote the application of research findings and technology in the field of agriculture.	▪ http://www.kalro.org/about_us
	▪ Farmer information services	iCow	▪ iCow will make millions of Africa's farmers more productive and prosperous by offering easy access to relevant knowledge and connecting them with other agricultural players.	▪ https://www.icow.co.ke/about

Note: this appendix catalogues private sector and government D4Ag solutions (many of which are supported by development partners). For a current list of on-going D4Ag initiatives from development partners in Kenya, please see the CTA/Dalberg report "The Digitisation of African Agriculture" (2018)

Solution category	Sub-category	Organization	Description	Weblink
Advisory and information (contd.)	▪ Farmer information services	Digital Green	▪ Digital Green is a global development organization that empowers smallholder farmers to lift themselves out of poverty by harnessing the collective power of technology and grassroots-level partnerships.	▪ https://www.digitalgreen.org/contact/
	▪ Farmer information services	MbeguChoice	▪ MbeguChoice is the result of collaboration between the Kenya Agriculture and Livestock Research Organization (KALRO), the Kenya Plant Health Inspectorate Service (KEPHIS), Kenya's crop seed companies, Agri Experience, Ltd., and Kenya Markets Trust.	▪ http://www.mbeguchoice.com/
	▪ Financial analytics	AgroSpaces	▪ AgroSpaces is a web and mobile platform that connects the smallholder farmer in the agricultural value chain to a wider online market to trade (sell and buy agricultural produce), access real-time commodity prices across various trading markets in the country, weather forecast for specific locations, farming advice and tips delivered to their mobile phones via SMS and also open source agricultural data aggregation for third parties. AgroSpaces aims to empower the smallholder farmer financially by eliminating the middlemen who buy their commodities at a low price to resell in urban areas for great profits and also connecting farmers with investors to help them easily access finance. AgroSpaces also organize workshops for farmers for them to get directly in touch with experts and also help them easily access finance.	▪ http://www.africaieg.com/agrospaces-empowering-farmers-and-sustaining-livelihoods-kenya-techmoran-com/
	▪ Logistics platforms	uLima	▪ Ulima is a mobile logistics platform designed specifically for farmers, agro-dealers, and the broader agricultural community.	▪ http://ulima.co/

Solution category	Sub-category	Organization	Description	Weblink
Advisory and information (contd.)	▪ Marketplaces	zowasel	▪ Zowasel is the 2018 Winner, Visa's Everywhere Initiative (VEI) on Financial Inclusion Challenge for Sub-Saharan Africa. The 2018 Visa's Everywhere Initiative is the first edition in Sub-Saharan Africa, and the "Financial Inclusion" challenge award since the (VEI) was launched in 2015.	▪ http://www.zowasel.com/
	▪ MNO mAgri services	viamo	▪ Viamo is a global social enterprise that specializes in mobile engagement and Information and Communication Technology for Development. Viamo works in partnership with organizations to connect them and individuals through digital technology, in order for everyone to make better decisions.	▪ https://viamo.io/
	▪ Participatory and peer-to-peer	we farm	▪ WeFarm is the world's largest farmer-to-farmer digital network, with more than 1 million farmers using our ecosystem in Kenya and Uganda alone. Farmers connect with one another to solve problems, share ideas, and spread innovation, for free, and without needing an internet connection (Wefarm works even through SMS).	▪ https://wefarm.co/
	▪ Precision advisory services	AgUnity	▪ Agunity streamlines co-operative operations via a simple mobile app using blockchain technology designed for the smallholder farmer. Agunity has a presence in a number of countries and is staffed by people dedicated and committed to helping developing world farmers to lift themselves out of poverty by restoring trust.	▪ https://agunity.com/
	▪ Precision advisory services		▪ Precision Agriculture for Development is transforming agricultural extension in developing countries using the latest available technologies and research methods.	▪ https://precisionag.org/
	▪ Precision advisory services	UjuziKilimo	▪ Ujuzi Kilimo uses mobile phones as tools to transform farmers from a traditional to a mordern knowledge based agricultural community	▪ https://www.ujuzikilimo.com/

APPENDIX 18: CATALOGUE OF DIGITAL SOLUTIONS IN KENYA (4/10)

Solution category	Sub-category	Organization	Description	Weblink
Advisory and information	▪ Supply chain management ERP		▪ We digitize and professionalize village-level informal agriculture supply chains systems in order to bridge information, inputs and services gap among smallholder farmers. We give rural smallholder farmers and agro dealers tools and opportunities they did not have before to succeed in their farming enterprises through creating one stop solution DigiShops from existing village level agrodealer stores.	▪ http://farmerspridеafrica.com/
	▪ iShamba		▪ iShamba is a call centre of agricultural experts where you can SMS in your questions or call in to speak to an expert for instant help. Once you sign up, you will also receive agri tips on crop and livestock, market prices and weather updates.	▪ https://ishamba.com/

Solution category	Sub-category	Organization	Description	Weblink
Financial services (contd.)	▪ Crowdfarming	aWhere	▪ aWhere operates a global-scale agronomic modeling environment with immense processing capacity that collects over seven billions points of data every day to create unprecedented visibility and insight across the agricultural earth. aWhere partnered with KALRO in setting up the Kenya Agricultural Observatory Platform, providing real time, historic and 7-day predictive weather data using met sensors in every 9km^2 across the country	▪ https://www.awhere.com/about/
	▪ Crowdfarming	Probity Farms	▪ Probity Farms offers services designed to help farmers and coops manage farm operations and improve productivity, while providing a platform for farm investors to track investment remotely to derisk lending.	▪ https://probityfarms.com/
	▪ E-wallets	cellulant	▪ Cellulant is a one-stop payments platform in Africa, operating in 34 countries all from a single, connected payments platform which processes 12% of Africa's digital payments today. Cellulant partnered with the Nigerian government in setting up the subsidies e-wallet in 2012	▪ https://www.cellulant.com/
	▪ E-wallets	AGRI-WALLET	▪ Agri-wallet is an innovative mobile business account to save, borrow and pay for income generating activities to increase food security and fight poverty.	▪ https://agri-wallet.com/
	▪ Farm management software	m	▪ myAgro set up a unique mobile scratch card platform which allows farmers to save money for seed and fertilizer in small increments using scratch cards	▪ https://www.myagro.org/
	▪ Financial analytics	APOLLO AGRICULTURE	▪ Apollo helps farmers in emerging markets maximize their profits. Apollo uses agronomic machine learning, remote sensing, and mobile phones to deliver financing, farm products, and customized advice to smallholder farmers with radical efficiency and scalability. Apollo assesses farmer credit risk and customizes each product to a farmer's specific location using satellite data, soil data, farmer behavior data and crop yield models. Apollo's primary product is a customized package of credit, high-quality farm inputs, and advice that can double farm yields, starting in Kenya.	▪ https://apolloagriculture.com/about

APPENDIX 18: CATALOGUE OF DIGITAL SOLUTIONS IN KENYA (6/10)

Solution category	Sub-category	Organization	Description	Weblink
Financial services (contd.)	▪ Financial analytics	FarmDrive	▪ FarmDrive's alternative credit risk assessment model is providing financial institutions with an agriculturally relevant and data-driven model to assess risk and develop loans that fit the needs of smallholder farmers. Not only will this solution unlock millions of dollars of previously risk-averse capital for smallholder farmers, it will improve the livelihoods of entire communities, thereby alleviating poverty, hunger, and inequalities.	▪ https://farmdrive.co.ke/
	▪ Financial analytics	m-pesa	▪ M-Pesa is a mobile phone-based money transfer, financing and microfinancing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania. It has since expanded to Afghanistan, South Africa, India and in 2014 to Romania and in 2015 to Alb. M-Pesa now provides loans to farmers and bases farmer credit risk profile on assessments by FarmDrive.	▪ https://www.safaricom.co.ke/personal/m-pesa
	▪ Financial analytics	mastercard	▪ The MasterCard Farmer Network or 2KUZE is a digital platform that connects smallholder farmers, agents, buyers and banks in East Africa. 2KUZE, which in Swahili means "Let's grow together," enables farmers to buy, sell and receive payments for agricultural goods via their feature phones. The platform brings the benefits and security of mobile commerce and payments to farmers in Kenya, Uganda and Tanzania.	
	▪ Insurance	PULA	▪ Pula aims to radically restructure agricultural insurance, using technology to insure the previously unbanked, uninsured, untapped market of 1.5 billion smallholders worldwide	▪ https://www.pula-advisors.com/

Solution category	Sub-category	Organization	Description	Weblink
Financial services (contd.)	▪ Financial analytics	FarmDrive	▪ FarmDrive's alternative credit risk assessment model is providing financial institutions with an agriculturally relevant and data-driven model to assess risk and develop loans that fit the needs of smallholder farmers. Not only will this solution unlock millions of dollars of previously risk-averse capital for smallholder farmers, it will improve the livelihoods of entire communities, thereby alleviating poverty, hunger, and inequalities.	▪ https://farmdrive.co.ke/
	▪ Financial analytics	m-pesa	▪ M-Pesa is a mobile phone-based money transfer, financing and microfinancing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania. It has since expanded to Afghanistan, South Africa, India and in 2014 to Romania and in 2015 to Alb. M-Pesa now provides loans to farmers and bases farmer credit risk profile on assessments by FarmDrive.	▪ https://www.safaricom.co.ke/personal/m-pesa
	▪ Financial analytics	mastercard	▪ The MasterCard Farmer Network or 2KUZE is a digital platform that connects smallholder farmers, agents, buyers and banks in East Africa. 2KUZE, which in Swahili means "Let's grow together," enables farmers to buy, sell and receive payments for agricultural goods via their feature phones. The platform brings the benefits and security of mobile commerce and payments to farmers in Kenya, Uganda and Tanzania.	
	▪ Insurance	PULA	▪ Pula aims to radically restructure agricultural insurance, using technology to insure the previously unbanked, uninsured, untapped market of 1.5 billion smallholders worldwide	▪ https://www.pula-advisors.com/

Solution category	Sub-category	Organization	Description	Weblink
Market linkages (contd.)	▪ End-to-end integrated	TULAA	▪ Launched in 2017, Tulaa uses mobile technology and artificial intelligence to smartly connect smallholder farmers with input suppliers, and buyers in a digital marketplace. Tulaa provides smallholder farmers with quality agricultural inputs on credit and brokers the sale of their crop at harvest time.	▪ https://www.tulaa.io/#who
	▪ Farm management software	DigiFarm	▪ DigiFarm is farm management software designed to provide farmers withthe highest accuracy, reliability, and security for precision farming systems. Tech includes an ever-expanding RTK Virtual Base Network to Apple MFi certified Beacon v3.0 wireless data streaming device, allowing farmers to take their practices to the next level of accuracy	▪ https://www.godigifarm.com/
	▪ Farmer information services	M-SHAMBA Making It Happen	▪ M-shamba is one of the pioneering Agritech social enterprises in Africa. The concept began in 2010 and has evolved through various stages of technology development. Overtime, M-Shamba has developed and deployed extremely innovative solutions for the smallholder farmer leveraging on the power of the mobile phone	▪ https://m-shamba.net/
	▪ Farmer information services	Taimba	▪ Kenyan startup Taimba is a mobile based, cashless platform which connects farmers to retailers. Taimba sources produce from the farmer at affordable prices that are farmer friendly, then offers the retailers the fresh produce at lower than market prices enabling them to sell to the final consumer at more affordable prices including delivering to their premises.	▪ https://taimba.co.ke

Solution category	Sub-category	Organization	Description	Weblink
Market linkages (contd.)	▪ Marketplaces	Twiga	▪ Since 2014, Twiga has been bridging gaps in food and market security through an organised platform for an efficient, fair, transparent and formal marketplace.	▪ https://twiga.ke
	▪ Marketplaces	Farmshine	▪ Farmshine is a global agriculture platform where farmers, buyers and service providers can trade on mutually beneficial terms.	▪ http://farmshine.io/
	▪ Marketplaces	Kitovu	▪ Kitovu helps farmers triple their crop yields while guaranteeing offtake of their produce through our data driven mobile platform.	▪ http://kitovu.com.ng/
	▪ Precision advisory services	sunculture	▪ SunCulture offers affordable, smart solar powered irrigation technology with an IoT connected proprietary control system	▪ http://sunculture.com/
	▪ Shared economy and PAYGO	hello tractor	▪ Hello Tractor is an Internet-of-Things (IoT) solution that supports the improved efficiencies, profitability, and transparency in the tractor contracting market. It connects farmers, tractor owners, bankers and dealers. The Hello Tractor platform enables farmers to request affordable equipment inputs, while providing enhanced security to tractor owners through remote asset tracking and virtual monitoring. This value extends to all stakeholders in the mechanization ecosystem.	▪ https://www.hellotractor.com/about-us/
	▪ Supply chain management ERP	iProcure	▪ iProcure is the largest agricultural supply chain platform in rural Africa. In addition to complete procurement and last mile distribution services, iProcure provides business intelligence and data-driven stock management across the supply chains, delivering value to farmers and suppliers	▪ https://iprocu.re/

Solution category	Sub-category	Organization	Description	Weblink
Supply chain management	▪ Farm management software	SourceTrace	▪ SourceTrace Systems specializes in agriculture software mobile applications for developing economies with a primary focus on sustainable agriculture and empowerment of smallholder farmers. SourceTrace farmer centric mobile applications help manage the agriculture value chain all the way to the last mile to enable smallholder farmers participate in global markets. SourceTrace mobile applications are scalable from small co-operatives, farmer producer companies to large agribusiness corporations and government agencies working in the sustainable development sector.	▪ http://www.sourcetrace.com/apps/
	▪ Traceability End to end solution	TruTrade Africa	▪ Online and mobile enabled trading and payment platform for collaborative supply chain management. This allows for the capture of all costs, analysis of transaction viability and price setting; registration of farmers and triggering payments; and tracking of produce from collection to delivery.	▪ http://www.trutradeafrica.net/
Data analytics and agricultural intelligence	▪ N/A	GRO	▪ Gro Intelligence bridges the data gaps across the global agriculture sector, empowers decision makers, and creates a more connected, efficient, and productive global food industry.	▪ https://www.crunchbase.com/organization/gro-intelligence#section-overview

7. REFERENCES

1 Bernard Marr, "How Much Data Do We Create Every Day? The Mind-Blowing Stats Everyone Should Read", 21 May 2018, https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/#55ea5a3a60ba

2 Vernon Turner, "The Digital Universe of Opportunities", IDC and EMC², 2014

3 Gartner IT, 2019. https://www.gartner.com/it-glossary/digitization/

4 Bjarne Cordyon, Vidhya Ganesan, and Martin Lundqvist, "Transforming Government Through Digitization", McKinsey.com, 2016

5 World Economic Forum, McKinsey, "Innovation with a Purpose: The role of technology innovation in accelerating food systems transformation", 2018

6 MOALFI, "The Agricultural Sector Transformation and Growth Strategy, 2019-2029", 2019

7 Ibid

8 Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

9 KALRO website (2019). http://www.kalro.org/mobile-apps

10 Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

11 Ibid

12 The Syngenta Foundation, "How can digital solutions help to feed a growing world?", July 2019

13 KALRO, "The Status of ICT Infrastructure, Innovate Environment and ICT4Ag Services in Agriculture, Food and Nutrition in Kenya, April 2019

14 Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

15 KALRO, "The Status of ICT Infrastructure, Innovate Environment and ICT4Ag Services in Agriculture, Food and Nutrition in Kenya, April 2019

16 Frankline Sunday, "Giant tech firms join race to digitise Kenya's agriculture", 4 June 2019, https://www.standardmedia.co.ke/business/article/2001328374/giant-tech-firms-join-race-to-digitise-kenya-s-agriculture

17 Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

18 Agricultural R&D Indicators Factsheet (2016). https://www.asti.cgiar.org/sites/default/files/pdf/Kenya-Factsheet-2017.pdf

19 Disrupt Africa, "African Tech Startups Funding Report 2018", http://disrupt-africa.com/funding-report/

20 Ministry of Agriculture, Livestock, Fisheries and Irrigation, "National Agriculture Investment Plan: 2019-2023"

21 Ministry of Agriculture, Livestock, Fisheries and Irrigation, "Agricultural Sector Growth and Transformation Strategy: 2019-2029"

22 Principles for Digital Development, 2019. https://digitalprinciples.org/about/

23 World Bank, FAO. E. M. Muindi, E. Semu, J. P. Mrema, P. W. Mtakwa and C. K. Gachene, "Soil Acidity Management by Farmers in the Kenya Highlands", Journal of Agriculture and Ecology Research International, 5(3): 1-11; Article no.JAERI.22519, 2016

24 External End of Project Evaluation of Kenya Agro-dealer Strengthening programme (KASP). Final report. Okello, B., AGMARK-Kenya, 2010

25 Kenya National Bureau of Statistics, "Strategic plan for agricultural and rural statistics 2015-2022", 2016

26 Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

27 ibid

28 KCSAP PROJECT APPRAISAL DOCUMENT, KCEP-CRAL website, NARIGP website

29 Cellulant Nigeria (2016). http://cellulant.com.ng/government-case-study.html

30 MOALFI, "The Agricultural Sector Transformation and Growth Strategy, 2019-2029", 2019

31 Benjamin K. Addom, Michael Hailu, Swetha Totapally and Michael Tsan, "Digtalisation of Africa Agriculture Report 2018-2019", CTA, 2019

32 MOALFI, "The Agricultural Sector Transformation and Growth Strategy, 2019-2029", 2019

33 Antoine Bouet, Kathryn Pace, Joseph W. Glauber, "Informal Cross-Border Trade in Africa How Much? Why? And What Impact?", IFPRI (2018)

[34] Jayne Thomas, Robert Meyers, James Nyoro. "Effects of Government Maize Marketing Trade Policies on Market Prices in Kemya", Tegemeo Institute (2015)

[35] Bernard Chanzu, "Status of Climate Monitoring in Kenya", KMD. http://www.wmo.int/pages/prog/wcp/wcdmp/documents/KENYA.pdf

[36] Relief Web, 2014. https://reliefweb.int/disaster/dr-2014-000131-ken

[37] ibid

[38] Ministry of Lands and Physical Planning Department of Physical Planning, "National Spatial Plan, 2015 - 2045", 2019

[39] MOALFI, "The Agricultural Sector Transformation and Growth Strategy, 2019-2029", 2019

[40] KNBS County Statistical Abstracts, 2017. https://www.knbs.or.ke/county-statistical-abstracts/

[41] Ministry of Agriculture, Livestock, Fisheries and Irrigation, "Agricultural Sector Growth and Transformation Strategy: 2018-2028", 2019

[42] Open Algorithms (OPAL) Project, 2016. https://dig.watch/resources/open-algorithms-opal-project-what-has-been-achieved-senegal-and-colombia-and-how-can-it

[43] e-Estonia website, 2017. https://e-estonia.com/solutions/interoperability-services/x-road/

[44] "Statement by Ministers Responsible for Agriculture attending the GODAN Ministerial Conference, Nairobi, Kenya, 15 June 2017," GODAN Nairobi Declaration

[45] The Distributed Ledgers Technology and Artificial Intelligence TaskForce and MoICT, "Emerging Digital Technologies for Kenya: Exploration and Analysis". 2019

[46] Ministry of Information Technology and Communications, "Digital Economy Blueprint: Powering Kenya's Transformation, 2019"

[47] MoALFI, "Agricultural Sector Growth and Transformation Strategy: 2019-2029", 2019

[48] USDA, "Assessing Capacity for Agricultural Data Collection and Analysis in Support of the Global Food Security Act, June 19-30," 2017

[49] MoALFI, "National Agriculture Investment Plan (NAIP), 2019 2024," 2019

[50] Expert Interview, June 2019