Food traceability in the domestic horticulture sector in Kenya: An overview

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Acronyms and Abbreviations

AFA	Agriculture and Food Authority (of Kenya)
AH	Albert Heijn
BRC	British Retail Consortium
FAO	Food and Agriculture Organization (of the United Nations)
FFV	Fresh Fruits and Vegetables
FSA	Food Standards Agency (of the UK)
FTS	Farm Traceability Software
GAP	Good Agricultural Practices
GPS	Global Positioning System
HCD	Horticultural Crops Directorate
HTD	Horticulture Tracking Database
HTS	Horticulture Traceability System
IBM	International Business Machines (Corporation)
ICS	Internal Control Systems
ISO	International Standardization Organization
KAVES	Kenya Agricultural Value Chain Enterprises
LIN	Location/Premises Identification Number
M&E	Monitoring and Evaluation
QMS	Quality Management Systems
QR Code	Quick Response Code
RFID	Radio Frequency Identification
SMS	Short Messaging Service
USAID	United States Agency for International Development

1 Introduction

Traceability is defined as the ability to discern, identify and follow the movement of a food or substance intended to be or expected to be incorporated into a food, through all stages of production, processing and distribution (FAO, 2017 – Food Traceability Guidance)

The need for food traceability systems dates back almost a century (UN Global Impact, 2014). In the decade of the 1920s, the concept expanded the horizon of many European countries, which until then faced hardship to streamline high-value food products in the market. Adding a layer of information around the origin of the product would build consumers' trust and would lead to an increase in trade. The concept caught on and the sales of products such as French Champagne took off.

Over the last two decades, traceability systems have however changed their focus. Gradually, schemes moved from guaranteeing the origin of those high-value products to ensuring product safety towards supermarkets and more empowered consumers. Food scandals and other food safety-related incidents accentuated the need for consumer protection. According to Bosona & Gebresenbet (2013), food quality and safety incidences can potentially cause national and international crises in economic and marketing relations; and Kenya's horticultural exports have been affected on several incidences because of phytosanitary-related interceptions with a total of 51 interceptions in 2017[1], 31 being on fruits and vegetables.

The evolution of global food safety standards as well as local realities have played a key role in the Kenyan horticulture sector through collective action by producers and policymakers to influence the competitiveness of the sector in the global economy of qualities (Ouma, 2010). A perfect example of such interventions that are geared towards a competitive horticulture sector is the launch[2] of the national horticulture traceability system (HTS) through a public-private sector partnership.

Traceability systems are currently being implemented in the Kenyan horticulture sector, even though most of the smallholder producers do not realize that they exist or even understand the importance of traceability implementation. Opara (2003) defined traceability as the use of supply chain information to not only provide assurance or guarantee to the stakeholders (especially the consumer) on the origin, location and life history of a product but also to assist in the management of arising issues such as breach of food safety and product quality. In essence, a traceability system is therefore a setup that facilitates an integrated supply chain management to ensure accountability of food safety and quality at any given point.

According to Gichure *et al.* (2016), the success of implementing traceability is mainly attributed to good organization and personnel perception; and so, does food safety management. These are facilitated by proper documentation (record keeping), compliance to quality management standards, capacity building on food quality & safety and traceability management, as well as proper monitoring of the quality management system.

In the recent years, blockchain technology has become very popular especially as a tool for assuring traceability and transparency (Jeppsson & Olsson, 2017). Even though blockchain

[1] https://ec.europa.eu/food/sites/food/files/plant/docs/ph_biosec_europhyt-interceptions-2017_summary.pdf

[2] https://www.agricultureauthority.go.ke/kenya-government-launches-system-to-track-horticultural-products/

technology was initially developed for the financial sector, the technology has found an application in the food supply chain as a traceability system. Tian (2016) describes a traceability system based on RFID (Radio Frequency Identification) and the blockchain technology to address the food safety concerns in China, while other reports have shown how traceability using block chain has strengthened tuna fishing by curbing illegal fishing (Visser & Hanich, 2017). With the Kenyan government setting up a taskforce[3] to investigate the blockchain technology and its applicability in Kenya, the horticulture sector should brace itself to the reality of this technology as tool for origins and food safety assurance.

The role of Traceability in Food Safety and Quality Assurance

Traceability improves the ability to trace a contaminated food product back to source. It involves the ability to locate, so-called tracking, a product through the stages and operations involved in the manufacture, processing, distribution and handling of feed and food, from primary production to consumption.

In this context traceability identifies and documents each food business operator, its immediate supplier(s), and its immediate customer(s), except when the customers are final consumers.

According to FSA (2002), the basic characteristics of traceability systems are:

- identification of units/batches of all ingredients and products;
- registration of information on when and where units/batches are moved or transformed;
- a system linking these data and transferring all relevant traceability information with the product to the next stage or processing step.

This 'one-step-back-one-step-forward' principle does not only help to ensure food quality & safety, but also can be seen as an evidence of good business practice or a tool to ensure the sustainability of raw materials; just to name a few "values" – see Table 1.

Table 1: Traceability for sustainability (adapted from "A guide to traceability: a practical approach to advance sustainability in Global Value chains", UN Global Impact, 2014)

Values and Efficiencies	1. Risk reduction 2. Efficiency of operations and consistency of processes 3. Securing supply (and value) chains 4. Selection of suppliers and maintenance of relationship with them 5. Benefits of good reputation
Stakeholder Pressure	6. Fulfilling stakeholder's demands for more product information 7. Ensuring that sustainability claims are true
Regulation	8. Meeting legal requirements
Global Alignment	9. Expectations, processes and systems are standardized 10. Natural resources are secured and sustained

[3] http://www.president.go.ke/2018/02/27/technology-will-be-major-driver-for-big-four-plan-president-kenyatta-says/; https://www.businessdailyafrica.com/markets/marketnews/hurdles-benefits-of-bitcoins-set-for-rollout-/3815534-4322268-uflil9z/index.html

As emerges from Table 1, the implementation of traceability systems for sustainability cuts across various value chain levels and is applicable to both the public and private divide.

Establishing and implementing a traceability system alone is not sufficient to fulfil food safety and quality requirements in the supply chain, but it should be seen as a complementary tool to guide the activities towards achieving quality and safety (Bosona & Gebresenbet, 2013).

Traceability in practice: planning for food quality & safety in low & middle-income countries

Traceability poses many challenges. If the main aim is protecting consumers against hazardous products, the question then arises on how to:

- Trace each and every step in the journey of a given product;
- Coordinate with different supply chain actors;
- Collect data in a way that best adapts to the different actors;
- Ensure that small-scale food producers implement costly, yet valuable traceability systems;
- Monitor the value chain for food quality & safety issues.

Reconciling the opportunities that traceability systems offer with their challenges in a given context is of utmost importance. In the industrialised countries, traceability systems are for the most part integrated into general business thinking and respond to the existing regulatory and non-regulatory environment. In the so-called low-income countries, contextual challenges are at the forefront. Food traceability systems have been inherently linked to export commodities and designed to better cater for the needs of the actors placed largely at the end of the chain. Traceability systems in domestic value chains are however rare.

The value and importance of traceability systems dilute as the food systems become more fragmented and populated by resource-poor actors. In Kenya, food products destined to export markets often count with some systematic system of tracking and tracing the product back to its source. The trend reverses when food items are meant to reach the domestic market. Whether it is local fresh produce destined to the open market or to higher-end market segments, traceability systems are not a common (business) practice, nor is there currently a demand by consumers nor supermarkets or be a legal requirement.

As a tool for food safety and quality assurance, traceability has its own limitations. Bosona & Gebresenbet (2013) noted that developing and implementing a traceability system for a local (short) food supply chain is not easy, citing an example of barcoding a fruit being sold in the street market and even the resistance by some actors in the supply chain. Lack of information about traceability systems and insufficient knowledge or skills (Jeppsson & Olsson, 2017) to implement them is a huge limitation in Kenya. Even with the little available information or data, there is lack of adequate standardized data and means of data and information exchange (Bosona & Gebresenbet, 2013) between the various actors in the supply chain as well as between the various traceability systems. For a traceability system to effectively provide food safety and quality assurance, it is paramount that; all player commits and participate actively, information and data is shared freely, and there should be value for money so that there is a return on the investment.

1.1 Purpose of study

The general objective of this study was to carry out a desk review of the available traceability systems, and to identify the best options for the domestic horticulture supply chain in Kenya with the aim to provide food safety and quality assurance.

1.2 Traceability Systems

The common denominator of the models (systems) available is the functionality to meet the needs of a variety of actors that operate in complex environments; small-scale producers, value chain actors, food safety-minded consumers, governments, NGOs, and other interested stakeholders. Of the various needs, food safety is the most critical as far as this study is concerned.

2 Systems available in Kenya

2.1 eProd [4]

In a demonstration of demand-driven innovation and necessity being the mother of invention, eProd was born in Kenya by a chili pepper consolidator who was frustrated by the complexity of manually managing thousands of smallholder farmers and complying with the high standard requirements of the export market. Because of its initial success, eProd began expanding successfully to address the needs of various sectors and business models leading to its commercialization in 2015. eProd has since issued 64 active licenses to traders consolidating agriproducts from more than 240,000 farmers of 18 value chains in more than 5 countries, including Kenya. eProd's Managing Director, Almut van Casteren[5] praised the system as a transparent solution to work even with middlemen/brokers and empower them, because the system provides transparency of all the actors in the supply chain. Food safety assurance can be enhanced by this empowerment because even middlemen are recognized as key players in the supply chain.

The eProd license is purchased and renewed on an annual basis depending on the number of farmers in the portfolio of the trader/consolidator, who is the licensee. The license fees cover installation, data backup, and training for 2 months. There are two types of licenses;

a) Up to 5,000 farmers (suppliers): **€ 2,500 per year**

b) Unlimited number of farmers: **€ 4,000 per year**

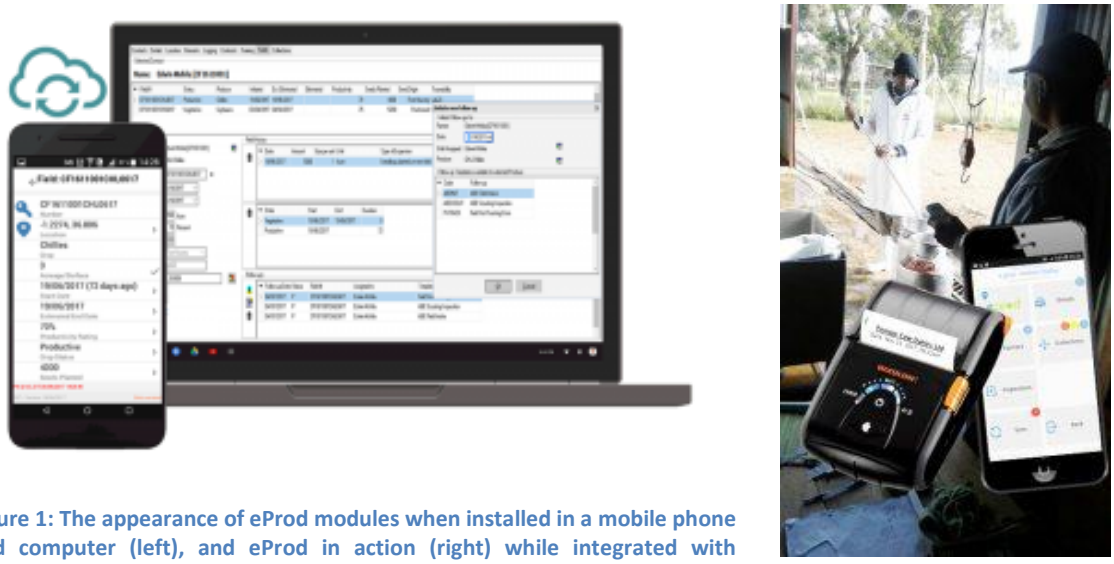

Figure 1: The appearance of eProd modules when installed in a mobile phone and computer (left), and eProd in action (right) while integrated with Bluetooth printer (courtesy: http://www.eprod-solutions.com)

Once the license is purchased, the licensee gets a program installed on a computer, as well as an unlimited number of android apps installed on smartphones of the field/extension staff. The system admin (using the computer-based program) is able to set field staff user functions, assign farmers to field staff, transfer farmers between field staff and/or groups, monitor field staff/groups/farmers,

[4] http://www.eprod-solutions.com

[5] Interview with Philip Chemeltorit (Tradecare Africa) on 23/11/2017

generate various reports etc. The data collected by the system is stored in the cloud (virtual servers) and backed up in physical servers as well as on the administrator's computer.

Product traceability in eProd entails assigning of traceability codes (such as seed lots) which can be managed throughout the value and supply chains. This can be integrated with certification systems (e.g. GlobalGAP, ISO9000, ISO22000 etc.) and support compliance with these standards, thus providing further food safety assurance.

Some of the notable functional features of eProd are;

a) Creation of comprehensive farmer profiles
   - Including GPS location and photos for easy referencing
   - Ability to manage contracts with individual farmers and groups for multiple products & grades
   - Integrated farmer field information
   - Capacity to evaluate and assess credit worthiness of farmers
   - View training profiles of farmers, thus identify gaps and further actions to be taken

b) Improving the productivity of farmers through;
   - Monitoring of field activities to enable better planning
   - Managing input distribution and product aggregation
   - Managing and tracking trainings to support certifications
   - Design of collection routes to optimize efficiency
   - Enabling traceability and quality-based payments
   - Provision of production advice through SMS messaging

c) Management of finances and farmer transactions
   - Quickly adjust pricing in response to market volatility
   - Use individual and group incentives to promote quality and cooperation
   - Provide flexibility in payment methods, including mobile payments
   - Automate repayments for inputs and advances

d) eProd supports monitoring & evaluation (M&E) activities because it;
   - Enables measurement of impact
   - Promotes trust and transparency
   - Ensures that reporting data is accurate and accessible

e) Enhanced business management and employees' administration because eProd; -
   - Ensures reliability and accessibility of data
   - Improves decision-making and planning
   - Monitors the efficiency of field/extension staff

- Promotes trust and transparency to farmers, customers, and other stakeholders
- Reinforces the professionalism of your business and reporting
- Gathers feedback through farmer surveys

f) Flexible System Configurations

- Ability to collect field data through the mobile app both off- and online
- API (application programming interface) integrations for flawless communication and connection with other software (e.g. financial software, weather data) and hardware (e.g. lactoscan, moisture meter, digital weighing equipment, etc.)

g) Effective communication

- Communicate easily and effectively with farmers and employees using integrated email and SMS
- Create reports to share with farmers and other interested parties. The reports are exportable to editable and readable formats such as .XLS, .CSV etc.

2.2 Farmforce[6]

Farmforce was initially developed by the Syngenta Foundation in 2013 but was later sold to the current owner, Farmforce AS based in Oslo - Norway, who commercialized the system. Farmforce was developed as an innovative solution to the myriad of challenges facing aggregators and farmers of crop produce. The system is available in many developing countries of Africa, South America, and Asia where smallholder farming is prevalent. To enhance usability, Farmforce is available in 11 languages; English, French, Spanish, Portuguese, Indonesian, Indian, Vietnamese, Thai, Turkish, Chinese, and Swahili.

In their own words at http://www.farmforce.com/en, *"Farmforce is a Software-as-a-Service solution that simplifies the management of small-holder farmers, increases traceability and enables access to formal markets. It is used to efficiently manage out grower schemes and contract farming programs"*. From this description, Farmforce stands out as an integrated system for not only managing product traceability but also the field/extension officers and farmers. According to Faith Kamenchu[7], Farmforce's project manager, the system is mainly designed for crop value chains and has been seen to manage crop production (yield focus), ensuring traceability and food quality & safety, as well as linking farmers to markets.

The Farmforce platform is mainly cloud-based meaning that all information is stored in virtual servers. The main user (admin or data manager) uses a browser-based web interface to manage all collected data, generate reports, set and manage users and functions. Other users (field officers or extension agents) use an android app which is compatible with all android devices (low-end to high-end mobile phones as well as tablets) to collect all manner of data on the producers/farmers, farm inputs, and the operations carried out from land preparation to postharvest handling.

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[6] http://www.farmforce.com

[7] Interview with Philip Chemeltorit (Tradecare Africa) on 29/11/2017

The mobile app works both online and offline and thus can collect data in an offline mode so that whenever an internet connection is available, the data is uploaded and synchronized with the cloud server. The data collected is sharable with authorized users and thus provide the much-needed information for gaps to be closed and improvement points.

The Farmforce mobile application is integrated with a wireless (Bluetooth) weight scale to enable easy, error-free recording of harvested yields as well as a Bluetooth printer.

Figure 2: The wireless scale (left) and Bluetooth printer (right) which are key in managing accurate traceability. (Courtesy: Farmforce)

The cost of acquiring and using Farmforce is as follows:

a) A one-off setup fee; **€1600** – includes setting up the systems, training and technical support for 3 months.

b) Subscription fee (annual); **€442** per user per year. Mainly counting the field officers (mobile apps), free data manager/admin (payable if more than one).

c) Additional cost for travel & accommodation of the Farmforce staff where applicable.

In summary, the functional uses of Farmforce are;

a) Efficiently manage a group of many smallholder farms and farmers

- Record the physical location, shape & size of fields
- Log and track farming activities, products, staff and equipment
- Organize many farmers into a growing campaign for a certain quantity by a specific date
- Predefine growing protocols that farmers need to follow
- Automatically inform staff of the recommended dosage of seeds, fertilizer and chemicals to be used

b) Improve transparency and reduce the risk of fraud

- Enable "anytime/anywhere" access to the most recent information such as crop cycles, growing activities, input usage, yields forecast etc.
- Add photos and GPS to provide additional certainty

c) Enable field-to-market traceability

- Scan and integrate open-standard GS1 barcodes on harvest collections with external reader in addition to camera phone
- Assign batch tracking numbers to harvests; merge (group), split (sort), track movements, trace which farmers/fields contributed to a harvest
- Generate traceability reports comprising data on farmers, fields, inputs related to a harvest collection
- Manage and track buyers by recording details of who purchases harvest collections
- Integrate a wireless weight scale so that the weight of harvests can be automatically recorded

d) Ensure compliance with global food safety and sustainability standards (e.g. GlobalGAP)

- Access predefined compliance and standards checklists
- Benefit from updates to checklists which automatically integrate new or modified rules
- Receive an immediate compliance score via built-in-self-assessments
- Share assessment results with certification bodies, clients and other interested parties
- Set up real-time alerts to inform field staff if a farmer performs an action that would threaten compliance – for example if a farmer is applying too much of a chemical or harvesting before it is safe to do so.

2.3 National Horticulture Traceability System[8]

The National Horticulture Traceability System (HTS) was established through a project of the Horticultural Crops Directorate of AFA (AFA-HCD) with support from USAID Kenya Agricultural Value Chain Enterprises (KAVES) programme whose aim was improving information (utilization) relating to the production and handling of fresh produce in Kenya (TraceSoft Limited, 2016). The project output was a national electronic traceability system capable of linking data in the fresh produce supply chain from production, logistics, processing, and distribution to local and international markets.

[8] https://traceability.agricultureauthority.go.ke

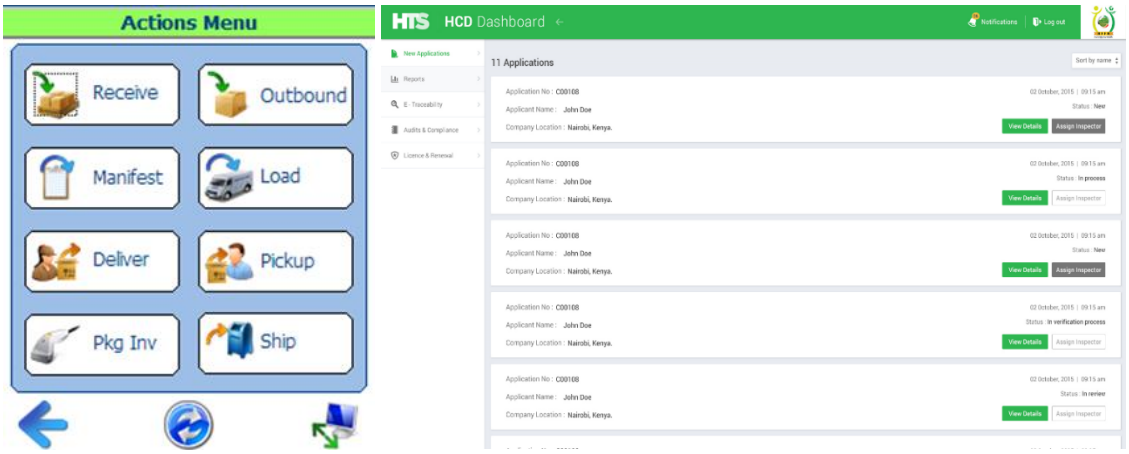

Figure 3: Screenshots of mobile farm journal of the android app (left) and the regulator's web module (right) which is to monitor all processes and retrieve reports

HTS includes an android mobile application (available on Play Store) which has an inbuilt printing software and a barcode scanner as well as a web portal to perform administrator functions such as managing users, monitoring data/information, and accessing reports. The web portal also has a regulator's module, to enable HCD to monitor and regulate the operator and farmers registered under them.

The types of data recorded using the mobile app are provided in Table 2 below. These data are collected at various stages of the supply chain including; planting, pesticide application, as well as at the various stages of postharvest handling.

Table 2: Data parameter recorded and when they are recorded along the supply chain

Data recorded (using mobile app) during production	When data is recorded along the supply chain
• Input Lot/Input Supplier • Farmer Name • Farmer ID/Farm ID • Pack house Name/ID • Harvest Date • Best Before Date • Lot number • Crate ID/Quantity/Weight • Package Serial number/SGTIN • Package Weight/Quantity • Where to /Where From • Waste/Rejects	• Planting/Spraying • Receipt of Produce at Collection Hubs • Dispatch of Produce at Collection Hub • Receipt of Produce at Pack house • Dispatch of Produce at Pack house

The HTS system is still under piloting and thus not yet commercialized. The plan for commercialization entails interested parties procuring the software and signing a service level agreement with a service provider for HTS software components and support. The service level agreement will stipulate the annual fees to be paid by each export firm for the software based on number of farms and number of users. The annual cost to the exporter will be inclusive of server hosting infrastructure and software upgrades.

In order to attain traceability, the system has the following functional components;

a) Produce source registration & identification

- All commercial locations (farms, collection hubs, pack houses) that grow, aggregate and process horticulture products are registered in a single master register. This prevents the assignment of more than one identifier to a given location
- Officially allocating and identifying locations with a unique Location/Premises Identification Number (LIN)

b) Produce tracing

- Products are uniquely identified and their movements/events traced from farm through distribution channels to destination.
- Tracking is done in private and national Horticulture Tracking Database (HTD) using standard data fields and data transfer.

c) Produce labelling

- All information recorded about the origin of the product is printed out and placed on packaging materials and can be accessed by trading partners or consumers.
- The labels have QR code which contains the information of the product thus facilitating instant retrieval of origin data.

2.4 Manual/ paper-based system

Most of the horticultural exporters, consolidators, and a small part of the domestic market players in Kenya are still using the paper-based systems to manage their traceability and certification compliance (where applicable). These are mainly guided by the quality management systems (QMS) or internal control systems (ICS), which define the forms and procedures to be used for each process and situation.

Although manual traceability systems are relatively cheap (consultant fees & design costs) and without annual subscription, the amount of time, manpower, and resources required to implement them is rather tedious, efficiency and effectiveness are also not guaranteed.

With all traceability systems being limited by inadequate standardized data and data exchange (Bosona & Gebresenbet, 2013), the case is worse for paper-based systems because data management and retrieval in this case is very tedious. The data recorded or collected on paper have no other use and the system does not allow for payback through other data utility value such as interoperability, and neither can such data be analysed unless the same are digitized and coded, which is far much more tedious.

3 Other systems not presently in use in Kenya

3.1 AgriPlace[9]

AgriPlace is a centralized platform owned by AgriPlace which is based in Amsterdam, Netherlands. The platform links certification players (farmers, auditors, standard owners, and food companies) to make compliance easy. AgriPlace utilizes smart data management from field to fork, re-using and reducing efforts for multiple certificates and makes the auditing process more efficient by minimizing repetition.

Although AgriPlace is not in essence a traceability system, the platform collects data which can be utilized to provide traceability, especially in a paper-based system. This is because AgriPlace relies on evidences of compliance to standards such as AH protocol, BRC, EU BIO, Field to Fork, GlobalGAP and thus is a digital checklist. Some benefits of the platform are;

a) Management of certifications in one place
   - All documentation is easily stored on the platform, with a safe cloud copy that can be accessed from any device anywhere
   - A clear overview of all certificates and their status.
   - Structured certification (inspections) thus saving time and resources.

b) Easy data collection and sharing
   - Documents and pictures are easily uploaded for compliance criteria to provide evidence and auto answer most of the questionnaires.
   - Assessments are guided by help texts, easy formats and automated decision trees and the assessment and evidence can be shared directly with interested parties.

AgriPlace has just been introduced in Kenya, and because a local partner is yet to be identified, the system has so far not been launched. The platform is offered at **€ 17** per month (no additional charges), and one can obtain a 30-day free trial (demo).

3.2 SourceTrace ESE™ Agri[10]

SourceTrace is a farm traceability software (FTS) designed for any agribusiness value chain and is owned by SourceTrace Systems whose corporate headquarters is in Massachusetts (USA) with other offices in Costa Rica, India, and Bangladesh. The company specializes in agriculture software mobile applications designed for developing economies with a primary focus on sustainable agriculture and empowerment of smallholder farmers.

SourceTrace has two main components, viz; -

a) Mobile application for field/extension agents
   - Able to record transaction on field

[9] https://www.agriplace.com

[10] http://www.sourcetrace.com/farm-traceability/

- Works both online and offline
- Can generate on spot print for each transaction
- QR code enabled application for eTraceability of inputs and produce
- Records each activity which is then sent directly to the web server application

b) Desktop web access for management and central operations

- Compiles data from all the field mobiles as collected and submitted by the field agents
- Retrieval of real time reports & charts as well as advanced analytical reports
- Very useful for decision making
- Effectively able to undertake corrective action plan
- Provides a view of the entire business operation at a glance

The traceability system has several functions, among them;

- Farmer enrolment to capture information directly from smallholder farmers and other providers on the field hence a unified and up-to-date farmer database. This includes the profile of the smallholder farmer, family group, farms and crops and uses GPS technology and photos to trace the source of goods.
- Geo plotting of crop area and crop monitoring module is the perfect way to record field visits allowing to capture photos and notes on each visit.
- An input distribution module which enables the efficient distribution of inputs such as Fertilizers, Seeds, Pesticides and other inputs.
- The system has an inbuilt certification module with ready-to-use templates which facilitates the digitization of Internal Control System (ICS) to support internal inspections, farmers training, and certification process.

3.3 Farmsoft[11]

Farmsoft is developed and supported by Tenacious Systems Limited based in New York (USA). The company specializes in technological solutions to farm management and fresh produce business management including food processing & traceability, food manufacturing, cool store management, quality control, inventory and more.

With Farmsoft Farm Software, a grower/farmer can perform recalls very quickly, with full confidence of accuracy and reliability. It is possible to trace product both up and down the supply chain, over multiple companies (instead of the usual one up and one down traceability). Product traceability can be done back to a grower, area of land, crop batch/patch and all input materials and their related suppliers & batch/lot details. Farmsoft can be integrated with other related software such as postharvest software, and also with several

[11] https://www.farmsoft.com/4/farm-software.html

hardware. Furthermore, the software makes compliance to standards cheaper and easier because of the automated records, generation of reports, and assured traceability.

We have been informed that Farmsoft has an agent in Kenya, but we couldn't get any reliable information to be included in this paper.

3.4 IBM Blockchain[12]

Blockchain, owned by IBM, is a technological innovation of digitally documenting data and verifying transactions, agreements and contracts. It works through a decentralized approach, which links supply chain stakeholders e.g. in a contract farming scheme to facilitate traceability and authenticity of produce; from the farmer, the off-taker/aggregator, wholesaler, the financial service provider, to the supermarket.

The following benefits can be reaped when a horticulture supply chain is managed using blockchain;

- Reduction or even elimination of possible food fraud and errors hence safer FFV
- Improved inventory and supply chain management
- Reduced costs that are common with tedious paper-based systems and courier services
- Increased efficiency without delays that arise from paperwork
- Issues are identified/diagnosed faster and thus solved effectively
- Increased consumer and partner trust

(See also http://spore.cta.int/en/article/blockchains-disruptive-potential-in-acp-value-chains.html)

Just recently (April 2018), Twiga Foods (http://www.twigafoods.com) acquired the blockchain technology by partnering with IBM to introduce a blockchain-based micro-lending (financing) for Kenyan food vendors[13]. The business-to-business logistics company had previously linked farmers of fresh fruits and vegetables (bananas, onions, tomatoes, and potatoes) to more than 2,500 vendors (retailers) across the Country where they realized that the vendors' main challenge was working capital, which limited their distribution. Although the primary objective of this investment is to facilitate a transparent and automated lending process, the technology may lead to transparency (and potentially traceability) of the produce distributed by the vendors if implemented as a traceability system.

[12] https://www.ibm.com/blockchain/supply-chain/

[13] https://www.ibm.com/blogs/research/2018/04/ibm-twiga-foods/

4 Comparison of traceability systems

The 3 traceability systems already introduced in Kenya, eProd, Farmforce and HTS, are compared with regards to costs and their relative (dis)advantages. It is expected that the other systems described will eventually enter the Kenyan market, however currently they are no option yet for the domestic horticulture market.

4.1 Cost of Implementation

An analysis of the procurement and implementation for the three-traceability system for 5,000 farmers per year are presented in Table 2. It is our assumption that 1 technical assistant serves 200 farmers, with one overall system (back-end) manager. We have also assumed that the implementation involves 4 training and support sessions which are paid by the implementing organization.

Table 3: Comparison of cost (in Euros) of implementation of systems for 5000 farmers

		ePROD			Farmforce			HTS		
Category	**Unit Description**	**No. of Units**	**Unit Cost**	**Total Cost (€)**	**No. of Units**	**Unit Cost**	**Total Cost (€)**	**No. of Units**	**Unit Cost**	**Total Cost (€)**
Software	Purchase & License fees	1	2,500	2,500	1	1,600	1,600	1	0	-
	Mobile app user fees	25	10	250	25	442	11,050	25	0	-
Hardware	Laptop	1	400	400	1	400	400	1	400	400
	Mobile phone	25	80	2,000	25	80	2,000	25	80	2,000
	Electronic scale	25	400	10,000	25	400	10,000	25	400	10,000
	Bluetooth printer	25	160	4,000	25	160	4,000	25	160	4,000
	Barcode reader	25	0	-	25	0	-	25	0	-
Set up Costs	a) Cost of the company to come and set up									
	Personnel Training	1	400	400	1	400	400	1	400	400
	Travel and Accommodation	1	400	400	1	400	400	1	400	400
	b) Cost of the implementing organisation during set up									
	100% time for systems manager	12	400	4,800	12	400	4,800	12	400	4,800
	25% time for 25 Technical Assistants @200€/month	12	1,250	15,000	12	1,250	15,000	12	1,250	15,000
			Total	**39,750**		**Total**	**49,650**		**Total**	**37,000**

4.2 Comparative advantages and disadvantages

The table below is a comparative analysis that summarizes the existing traceability systems and how suitable they are for the Kenyan context.

Table 4: Comparative advantages and disadvantages of eProd, FarmForce and HCD-HTS systems

Criteria	eProd	Farmforce	HTS
Availability	Commercially Available	Commercially available	Not commercialized yet (still in piloting)
Affordability	Not affordable for small groups, cost becomes cheaper for larger groups	Cost is determined by number of users. Affordable for smaller groups	Cost not set yet
Adoption	Adopted by 64 licensees in Eastern Africa so far	Adoption rate for licenses not disclosed.	Insights from piloting not yet drawn
Awareness	Marketing and outreach being done with presence in most field days and stakeholder forums	Awareness still limited as they do targeted marketing	Awareness only among the exporting companies
Applicability	Applicable to all value chains	Only for horticulture value chains	Designed for horticulture value chains
Ability (functionalities)	Ability to manage contracts with individual farmers and groups for multiple products & grades Application programming interface integrations with other software and hardware, including (bulk) SMS communication	Ability to automatically inform staff of the recommended dosage of seeds, fertilizer and chemicals to be used Real-time alerts to inform field staff if a farmer performs an action that would threaten compliance	Ability for HCD to monitor and regulate the supply chain players (farmers, consolidators, markets etc.)

4.3 The need for Traceability Systems in the domestic segment for Fresh Fruits and Vegetables

Food safety and quality assurance is increasingly becoming popular in Kenya. The domestic horticulture supply chain in Kenya is dominated (90%) by the wet (open-air) markets, according to our recent survey (unpublished). 10% of trade goes through more formalised segments including supermarkets and direct suppliers. Onyango and Kunyanga (2013), noted that among samples of sukumawiki (kales), tomatoes, mangoes, and amaranth, collected from retail wet markets and supermarkets in Nairobi, Nakuru, and Machakos to contain pesticide residues that were above the acceptable level set by the World Health organization. This was attributed to the excessive and wrong use of pesticides in vegetable production and the non-adherence to the specific pre-harvest intervals. Contamination with biotic agents was also noted and attributed to use of unprocessed manure (slurry), sprinkling harvested produce (to keep them fresh) with contaminated water, transportation of fresh produce in open trucks (sometimes with other non-food products). More contamination was perceived to happen in the markets because of their open-air and wet nature or even by people as they pass by the produce and touch them. In another study, Kibitok & Nduko (2017) sampled prepared fruit and vegetables salads (*kachumbari*) from food vendors in Nakuru found 80% of the samples tested positive for *E. coli*, while 70% tested positive for *Salmonella.* Hygienic handling, proper packaging of the fresh produce, and selling them in marketplaces that are more organized and hygienic were recommended measures of reducing risks of microbial contamination.

With 85% of the fresh fruits and vegetables being marketed in Nairobi County (Matui *et al.* 2016), the respective county government has been struggling to enforce better governance and have recently began to implement tighter scrutiny on the contamination of fresh produce entering its markets[14]. The effects of contaminated fruits and vegetables especially by pesticide residues has been publicised by a variety of mass media outlets including linking the same to low fertility levels in women[15]. The need for investment in product governance including internal traceability of production and handling practices has been recommended as a management and control measure.

The recent quick scan of the horticulture sector by Matui *et al.* (2016) reported noted possible interventions to address food safety to include: efforts towards improving supply chain governance; promotion of social dialogue and innovation platforms to discuss food safety; and provision of support to supply chain actors especially on the implementation of food safety regulations. Some governance interventions are already evident in Kenya, with the operationalization of Code of Conduct for fresh fruits and vegetables (KS 1758-2:2016) as well as the efforts towards the launch of the national horticulture traceability system (HTS). The continued fragmentation of the sector coupled by a lack of leading firms limit the potential of such interventions to bear quick fruits. The quick scan however found demand for traceability, quality and safety of fresh fruits and vegetables is being fuelled by increasing consumer awareness and public interest.

Kenya is already implementing traceability in the export segment with the dairy sector being the first domestic segment to adopt traceability as a measure for managing milk quality (ePROD 2017). The use of traceability in the export segment is however anchored by medium to large processors the domestic segment however is still characterised by small to medium processors a majority of whom still operate business relations that are short term and based on trading. While traceability is recommended as a tool of dealing with food safety and quality concerns in the domestic segment for fresh fruits and vegetables, reliable aggregators and market actors within the market segment that is sensitive to origins and food safety are needed to make sense of investments.

4.4 Conclusion and Recommendation

The importance of food safety and quality in the Kenyan domestic sector cannot be overemphasized. The conversation is happening at all levels. The consumers are become more aware of the same, and supply chain actors are starting to realize the need for them to address the issue because food safety and traceability is not only consumer-driven, but investment-worthy too. Increasingly, the food industry is tailoring goods and services to the tastes and preferences of various groups of consumers in Kenya. Traceability systems help deliver these new attributes to the consumers and are an evidence of value, especially in terms of quality and safety of the product.

Actors in the fresh fruits and vegetables supply chains, especially businesses handling these products can benefit greatly from having traceability systems in place. Global value chains for fruit and vegetable sourcing from Kenya including primary producers, have developed an

[14] https://www.standardmedia.co.ke/article/2001267198/nairobi-county-tightens-scrutiny-on-chemically-contaminated-food

[15] https://www.standardmedia.co.ke/health/article/2001258970/chemicals-in-vegetables-fruits-linked-to-low-fertility-in-women

enormous capacity to track the flow of food along the supply chain, which has resulted in benefits associated to lowering-costs of distribution systems or increase of sales, to name a few. Apart from the economic incentives, traceability systems also help to ensure food safety and product quality and can be used for recall as well as finding possible sources of non-compliance. Unfortunately, in the domestic markets, the current food labelling and packing system cannot guarantee that the food is safe and has a minimum standard of quality. Traceability is often a first step towards achieving supply chain governance by ensuring that every actor plays an active role in maintaining acceptable standards that assure the safety and quality of the produce. Traceability can thus contribute to the development of the domestic horticulture sector into a competitive venture opening up investment opportunities for larger firms to grow.

In this study, we have provided an overview of the traceability systems that are available in Kenya, and their comparative advantages and disadvantages. Choosing and weighing the pros and cons of each system and making a decision on which is the best remains difficult and is largely dependent on the criteria of assessment as well as type of chain and commodity the businesses operate in. There are a number of systems that could potentially be deployed in Kenya with success. Many of those have good technical features to allow users to identify issues with food safety and being able to monitor and trace back products when food safety issues occur. However, the affordability of the different systems being operational such as eProd and Farmforce is a limiting factor. In terms of affordability, we cannot draw conclusions on the HTS, as the system is still on a pilot phase.

The paper-based traceability system is the cheapest option. However, it entails a very tedious process that requires a lot of time, manpower (labour), and requires a lot of paper work, which becomes a burden for farmers and their capacity to be agile with data sharing. Once recorded, retrieving any information from the data is difficult, and the data cannot be analysed and be easily compared and further shared with other actors in the change in an easy manner. These reasons make paper traceability less attractive for supply chain actors that are keen on implementing innovative systems to ensure food safety and quality assurance and are willing to invest in systems that are more transparent, fool-proof, and have added value in terms of data utilization and interoperability.

With regards to the currently available automated traceability systems, we can conclude that:

- In terms of cost, eProd is best suited for a large producer group or a firm in the value chain that intends to improve the efficiency of the operations and would like to offer safer and higher-quality products. Farmforce, on the other hand, would work well for a smaller producer group, or even an individual farmer that wishes to simplify the management of the business and have access to more formal markets. The HTS system has not been tested sufficiently yet to be implemented by value chain actors supplying the domestic market.
- eProd's comparative advantages include;
    1. Ability to manage contracts with individual farmers and groups for multiple products & grades
    2. Application programming interface integrations with other software and hardware, including (bulk) SMS communication

- Farmforce has the following capabilities;
    1. Ability to automatically inform staff of the recommended dosage of seeds, fertilizer and chemicals to be used
    2. Real-time alerts to inform field staff if a farmer performs an action that would threaten compliance
- With the HTS system, the horticulture sector regulator (HCD) is able to monitor and regulate the supply chain players (farmers, consolidators, markets etc.). The system is very promising for uptake by the domestic sector as long as the cost of acquisition are kept low, and the implementation be driven by the supply chain rather than being imposed by the regulator.

As can be seen, each of the systems have their strengths. In conclusion, a good traceability system that becomes a tool for food safety assurance should have the following features;

- Capable of record keeping on pesticides use
- Can track if PHI have been met
- Record yields/volumes hence facilitate mass balancing
- Is able to link batches and keep identity of origin (which farmer's volume is included in that batch)
- Scaling up to unique coding/long term vision of a national traceability system such as the HTS
- Traceability throughout the supply chain
- Gives information back to farmers
- Integrates standards that need to be met
- Can be interfaced with other applications

Based on the extent to which the different systems can integrate the actors who are in the middle of the chain (in the context of the horticultural market in Kenya the brokers or middle men for example), it can be seen that eProd provides the best platform for them and can actually be considered as a tool to not only involve them, but also empower them as partners in the supply chain.

In due time other systems are also expected to become available in Kenya and the business that need them will have a wider range of choices based on the cost of implementation and the functionality of a system as suited to their needs and operations.

We recommend that further analysis should be done to understand how easy the systems are being implemented by the users, how easy it is for them to actually collect and provide the data in the system, and being able to analyze that data for further decision making. This can be done through a survey of the current users of the system.

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Annex: Traceability Systems in Practice

This section presents screenshots and/or architectural designs of the available traceability systems to demonstrate how they work in practice.

eProd

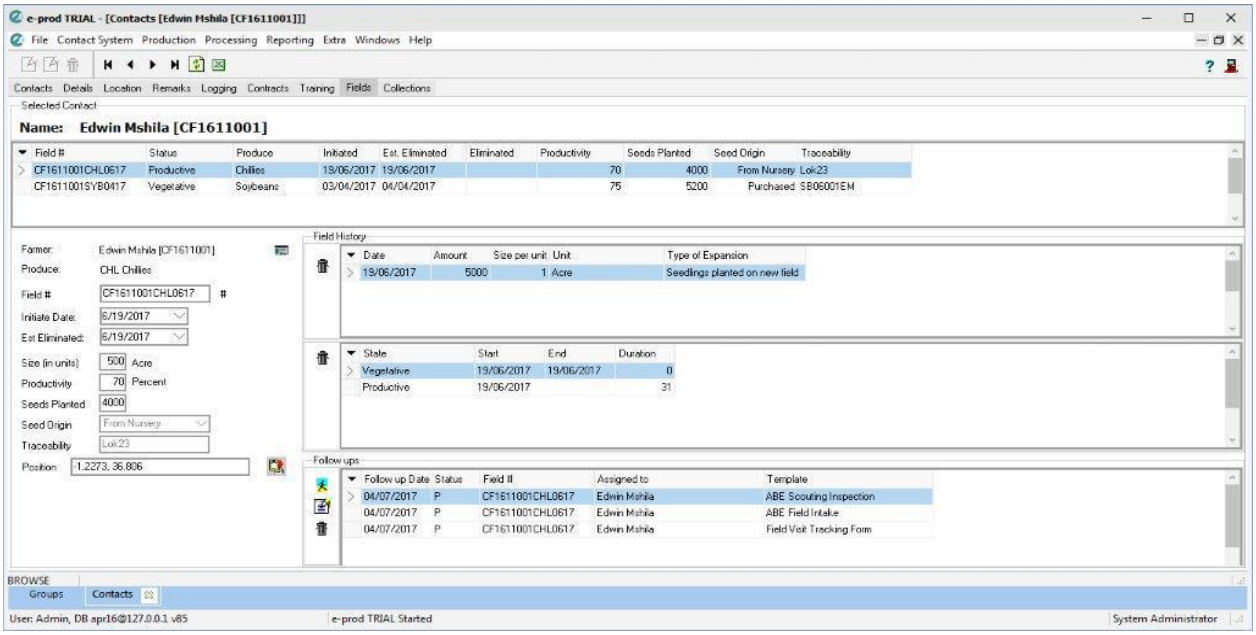

Figure 4: System manager screenshot of laptop display

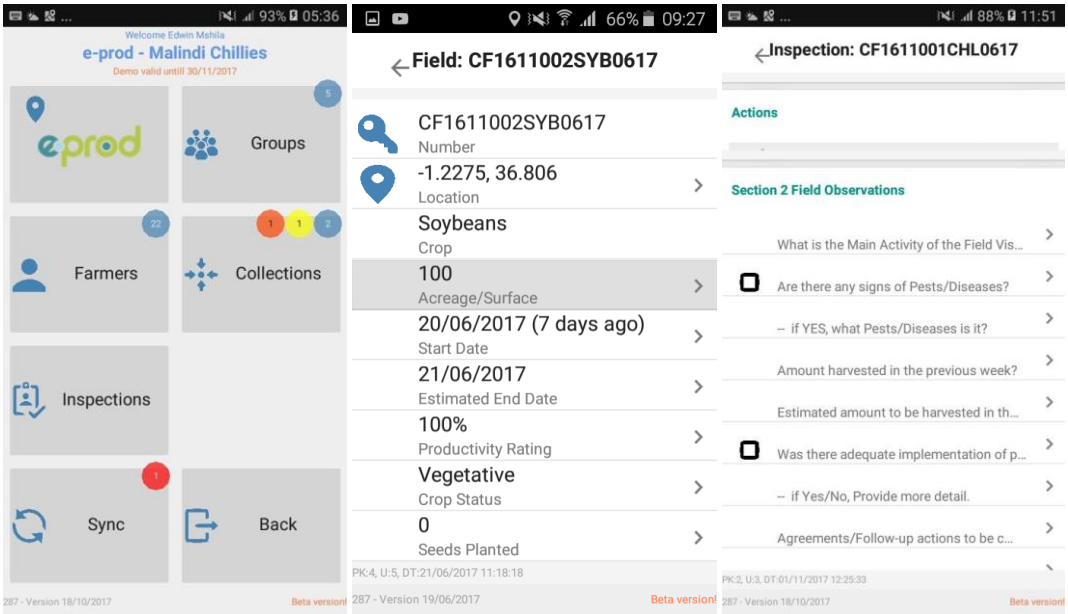

Figure 5: Mobile app home display> field registration> inspection of field/farmer

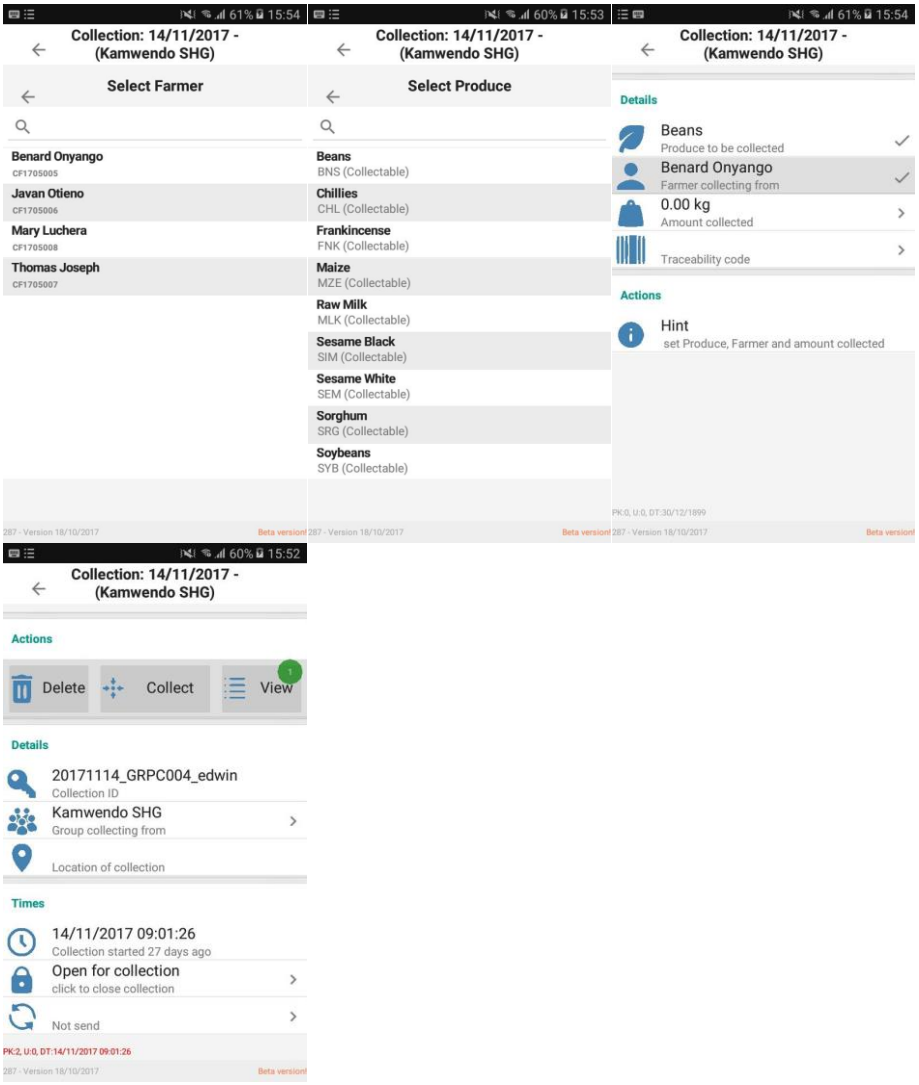

Figure 6: Collection of produce >selection of group> farmer> produce> detail/ status of produce

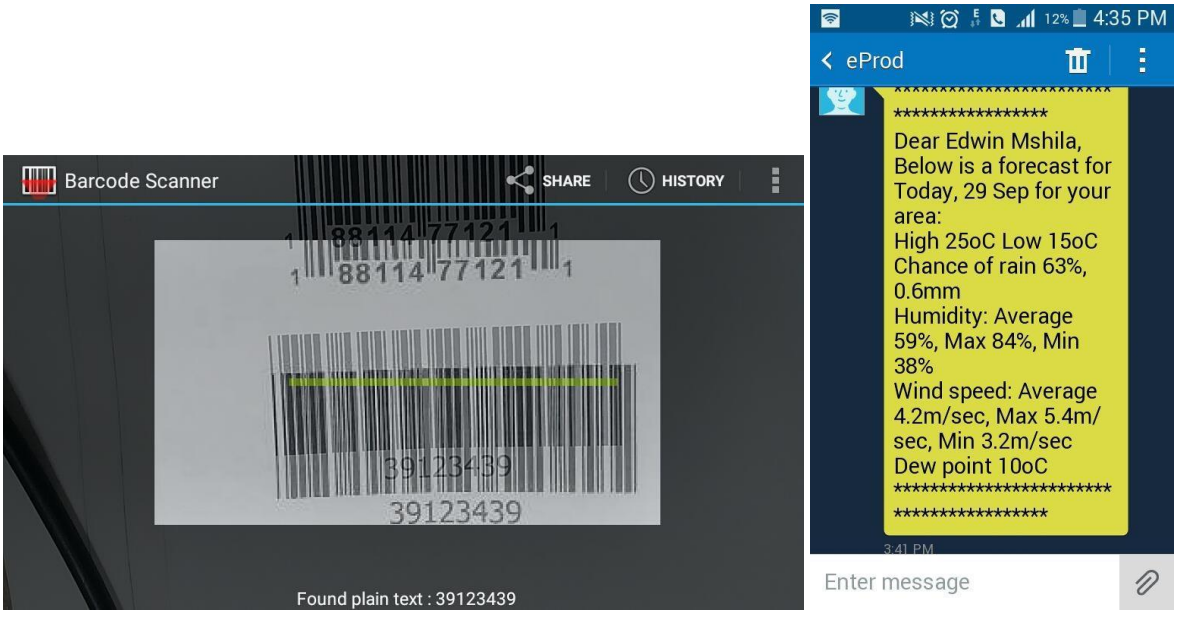

Figure 7: Barcode scanner which is integrated in the mobile app & Weather forecast SMS sent to farmers' phones

Horticulture Traceability System

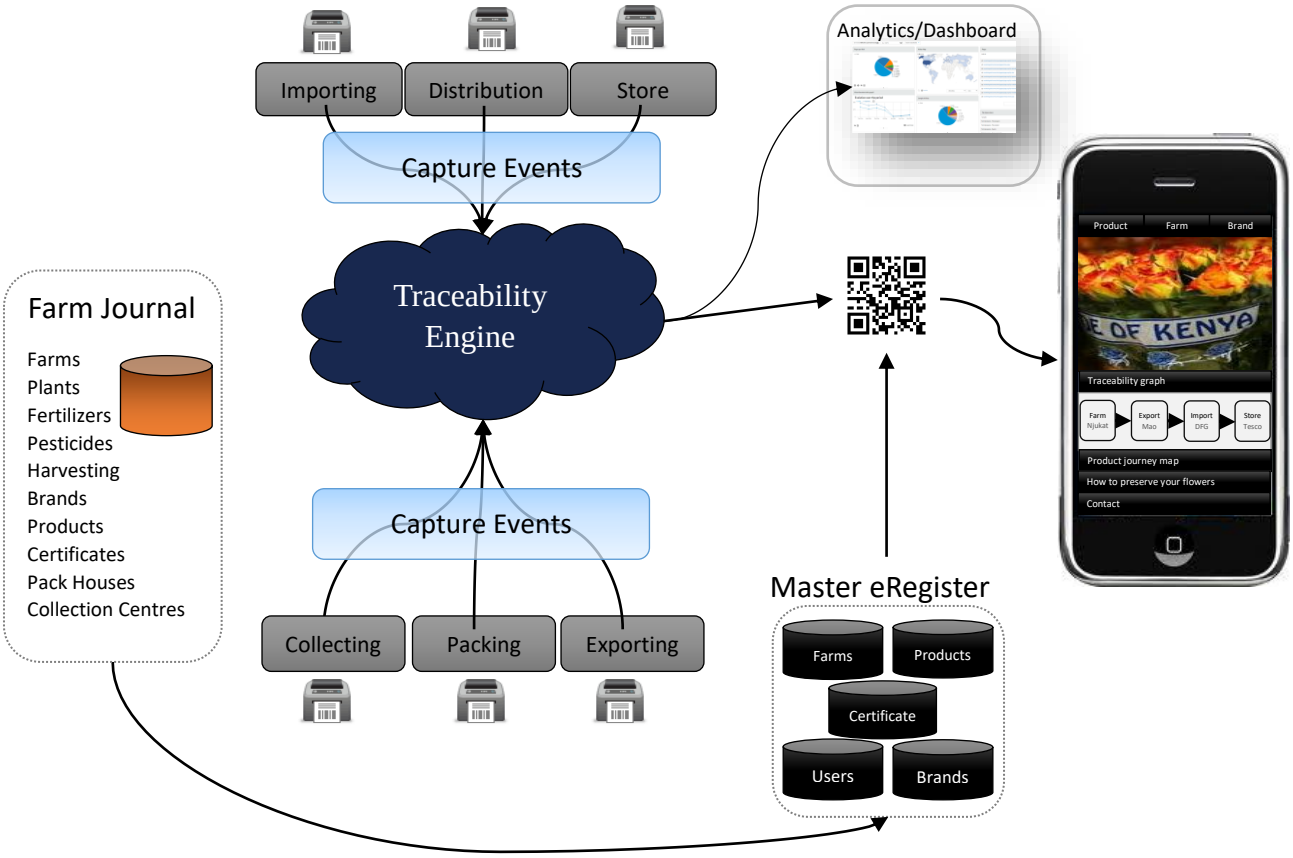

Figure 8: A design map of the National Horticulture Traceability System

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