FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

GHANA TRADE AND INVESTMENT ACTIVITY

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ACRONYMS

AGOA	African Growth and Opportunity Act
API	Application Programming Interface
ARSO	Africa Regional Standards Organization (ARSO)
CABI	Centre for Agriculture and Bioscience International
CoC	Chain of Custody
COLEACP	Europe-Africa-Caribbean-Pacific Liaison Committee
CTEs	Critical Tracking Events
ECOWAS	Economic Community of West African States
ERD	Entity Relationship Diagram
ERP	Enterprise Resource Program
EU	European Union
FAGE	Federation of Association of Ghanaian Exporters
FBO	Farmer-Based Organization
FDA	Food and Drug Authority
GAPs	Good Agronomic Practices
GAVEX	Ghana Vegetable Exporters Association
GENS	Generic ePhyto National System
GEPA	Ghana Export Promotion Authority
GGN	GLOBALG.A.P. Number
GLOBALG.A.P.	Global Good Agricultural Practices
GSA	Ghana Standards Authority
GSP	General System of Preferences
GRA	Ghana Revenue Authority
GTIN	Global Trade Identification Number
GLN	Global Location Number
GSCC	Global Supply Chain Council
HACCP	Hazard Analysis and Critical Control Points
IDH	Dutch Sustainable Trade Initiative
IESC	International Executive Service Corps
IFSSP	Improving Food Safety Systems Project
ILO	International Labour Organization
IP	Information Preserved
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
IT	Information Technology
KDE	Key Data Elements
MOFA	Ministry of Food and Agriculture
MRLs	Maximum Residue Levels
MT	Metric Ton
NIA	National Identity Authority
NIN	National Identity Number
NPPO	National Plant Protection Organization
OACPS	Organization of African Caribbean and Pacific States
PPRSD	Plant Protection and Regulatory Services Directorate
QR	Quick Response
RASFF	Rapid Alert System for Food and Feed
SPEG	Sea Freight Pineapple Exporters Ghana
SPS	Sanitary and Phytosanitary

SSCC	Standard Shipping Case Code
SIFAV	Sustainability Initiative Fruit and Vegetables
SSCC	Standard Shipping Container Code
US	United States
USFDA	US Food and Drug Authority
USSD	Unstructured Supplementary Service Data
VEPEAG	Vegetable Producers and Exporters Association of Ghana
WTO	World Trade Organization

EXECUTIVE SUMMARY

Non-traditional exports play a key role in the Ghanaian economy as major sources of foreign exchange, employment, and livelihood for multiple value chain actors, including smallholder farmers, processors, and exporters. The importance of non-traditional exports notwithstanding, interceptions at respective European Union (EU) Borders have had negative impacts on the businesses and livelihoods of several farmers, processors, and exporters and on long-term market opportunities for Ghana, pointing to a failure to meet market standards.

Between 2016 and 2018, Ghana's Plant Protection Regulatory Services Directorate (PPRSD) attempted to implement traceability systems as a way of addressing market requirements by the EU. USAID has supported one PPRSD traceability initiative, the development of a system by the Optel Group, piloted in 2018, which the PPRSD ultimately did not adopt. PPRSD developed a traceability system, GHTRACE, an electronic data capturing system to register exporters, their farmers, and the location of farms across the country. This system, however, had several implementation challenges limiting its adoption and use by exporters and smallholder farmers.

The USAID Ghana Trade and Investment (GTI) Activity is focused on improving and enforcing quality standards for high-value exports from Ghana, including fruits, vegetables, cashew, and shea. Considering previous attempts at rolling out traceability systems, GTI commissioned this traceability use case study to assess the traceability systems developed by PPRSD and those used by private sector stakeholders, evaluate the challenges, and provide recommendations for the adoption of traceability systems going forward.

Amongst the 13 exporters (including associations and producer organizations) visited within the scope of the assignment, only three indicated actively participating in the PPRSD's public traceability system. The vast majority indicated to be using private systems. These are mostly systems, in which manual notes are recorded onto hardcopy ledgers at different steps in the chain. Larger operations use spreadsheets that are consulted manually in function of particular queries. Only once was a dedicated digital traceability software found actively in use.

PPRSD should assume the role of a regulator responsible for the overall traceability system, both public and private, with a mandate to ensure that a sanitized and well-organized traceability system of international standing could be adopted by other private and international standard-setting bodies. Where an exporter and processor has developed an extensive traceability system, it is recommended that PPRSD build on or links the private system to the e-traceability system to avoid duplication.

In addition, improving the public traceability system requires stakeholder consultations to agree on the desired functionalities of the final system, and technical assistance to PPRSD to implement the improved system. Following the design of respective modules, the system rollout should be piloted and improved based on feedback from stakeholders. The public traceability system needs to be made interoperable with private traceability systems, where already collected datasets can be uploaded into the public system using an Application Programming Interface (API), which is a simple switchboard where data points from two different software are connected.

The private sector's transition of digital traceability systems must be incentivized through cost-shared grants to reduce key barriers to adoption. Cost-share support can lower the onboarding costs during the transition and contribute to the purchase of certain digital assets as well as fixed subscription costs during the first year(s).

1. INTRODUCTION

1.1 Historical context

Mangoes, pineapples, cashews, shea, and vegetables are among the key agricultural exports from Ghana. In 2020, Ghana's export earnings for these commodities were $20 million for mangoes, $8.8 million for pineapples, $251 million for cashews, $1.56 million for exotic vegetables, and $13.7 million[1] for shea.[2]

Although these value chains in Ghana have significant and growing international market opportunities, particularly in the European Union (EU), value chain actors have failed to meet food safety standards in these markets. The issue of meeting standards in the EU and the United States has major implications on market access for Ghanaian products. Failure to meet these requirements could undermine longer term opportunities for Ghana.

Between 2012 to 2015, the EU intercepted 735 consignments of fruits and vegetables from Ghana on account of harmful organisms such as fruit flies, thrips, whiteflies, moths, and other organisms. The PPRSD lacked capacity to identify these organisms, whereas exporters lacked the capacity to trace infected exports to the growers. As a result, the EU imposed an export ban from 2015-2017, triggering an urgent need for a sustainable traceability system and improvements in the enforcement of food safety regulations and export procedures for compliance with EU requirements.

In response, the USAID-funded Improving Food Safety Systems Project (IFSSP), implemented from 2016 to 2019, supported the PPRSD to design and implement a food traceability system, along with other improvements in the enforcement of food safety regulations and export procedures for compliance with EU requirements. IFSSP contracted Geotraceability Ltd. (Optel Group) to design and pilot a national horticulture traceability solution in 2018. As the National Plant Protection Organization, PPRSD, through the support of a local IT partner Silence Star, developed an electronic data capturing system to register exporters, their farmers, and sites of farms across the country. Despite several additions and revisions to the current electronic system being used by PPRSD, the system has had several implementation challenges limiting its adoption and utilization by exporters and smallholder farmers.

GTI is now building on the progress established by IFSSP with a renewed focus on improving and enforcing quality standards for high value exports from Ghana, including fruits, vegetables, cashew, and shea. Considering the history, GTI commissioned this traceability use case study to assess the traceability systems developed by PPRSD and those used by private sector stakeholders, and to evaluate the challenges and provide recommendations for the adoption of traceability systems going forward.

1.2 Objectives of the Assessment

The objectives of the traceability use case analysis are to:

i. Evaluate the functionality of current traceability systems to meet end-market requirements of exports from Ghana;
ii. Identify the necessary and successful characteristics of traceability systems used by exporters and processors from Ghana;

[1] 2020 Analysis and Report on Non-Traditional Export Statistics, Ghana Export Promotion Authority, page 16, available at https://drive.google.com/file/d/1VLS5Td-4tAN7faKqyzTwbNXlw3oxlzJc/view
[2] GEPA, Report On Analysis Of Non-Traditional Exports, 2020

iii. Evaluate the successes and challenges of previous traceability systems developed by the USAID IFSSP Project to identify lessons learned and recommendations for improved performance;

iv. Functionality, and sustained adoption along target value chains to expand Ghanaian firm and farm access to export market channels;

v. Identify the incentives, capacity, access to technology, and coordination mechanisms among supply chain actors to adopt traceability; and

vi. Provide recommendations on best practices for the implementation of a sustainable traceability system, which meets industry standards to be adopted by exporters, packhouses, or other value chains in Ghana.

1.3 Methodology

Key stakeholders in the sector were interviewed in person over a two-week period in June 2022. Additional interviews with international organizations and importers in Europe took place remotely as a follow-up. A total of 19 stakeholders were interviewed within Ghana followed by another 12 key informants outside of the country through online video meetings.

An open-ended respondent interview checklist was used, which allowed interviews to focus on topics of interest to the respective organization in search of additional insights. Interviews were recorded and insights summarized. A presentation with key insights and recommendations was delivered to the GTI team and additional feedback was integrated.

2. BACKGROUND TO AGRICULTURAL EXPORT OF TARGET CROPS

2.1 Trade from Ghana to US/EU for target crops

The EU is currently the largest market for Ghanaian agricultural exports. According to the Europe-Africa-Caribbean-Pacific Liaison Committee (COLEACP) E-data platform,[3,4] pineapple has been the major fruit crop for export in 2020, however, it has reduced significantly (11,708 MT compared to 12,733 MT in 2019) in recent years, due to competition with other export countries in Central America and shifting variety preference from smooth cayenne to the more demanding MD2 variety. On the contrary, fresh-cut pineapple is a fast-growing export (549 MT in 2020 compared to 37 MT in 2019) commodity. Mango is a slightly growing export crop (4,985 MT in 2020 compared to 3,770 MT in 2019), despite the pest pressure from Bacteria Black Spot (BBS) Disease. Mixed fruits processed into fresh cuttings has reduced (95 MT in 2020 compared to 146 MT in 2019).

Currently, vegetables (eggplants and chili peppers) export has remained almost negligible since the export ban was lifted. The Asian (or ethnic) vegetables[5] exports currently stand at a modest and slightly growing level (612 MT in 2020 compared to 530 MT in 2019).

Figure 1: Exports of fresh products from Ghana to EU28 (MT) from 2006-2020

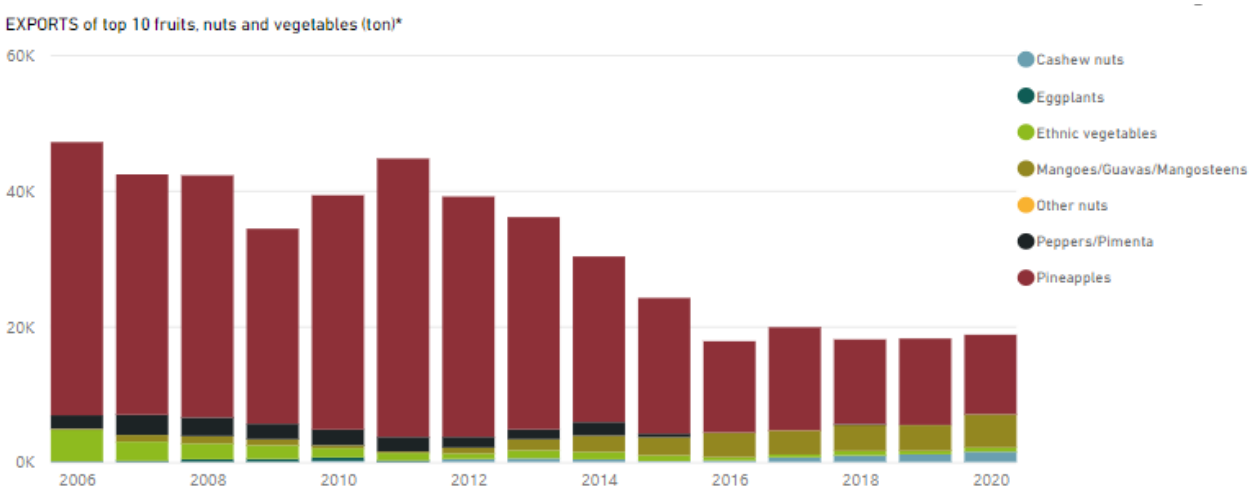
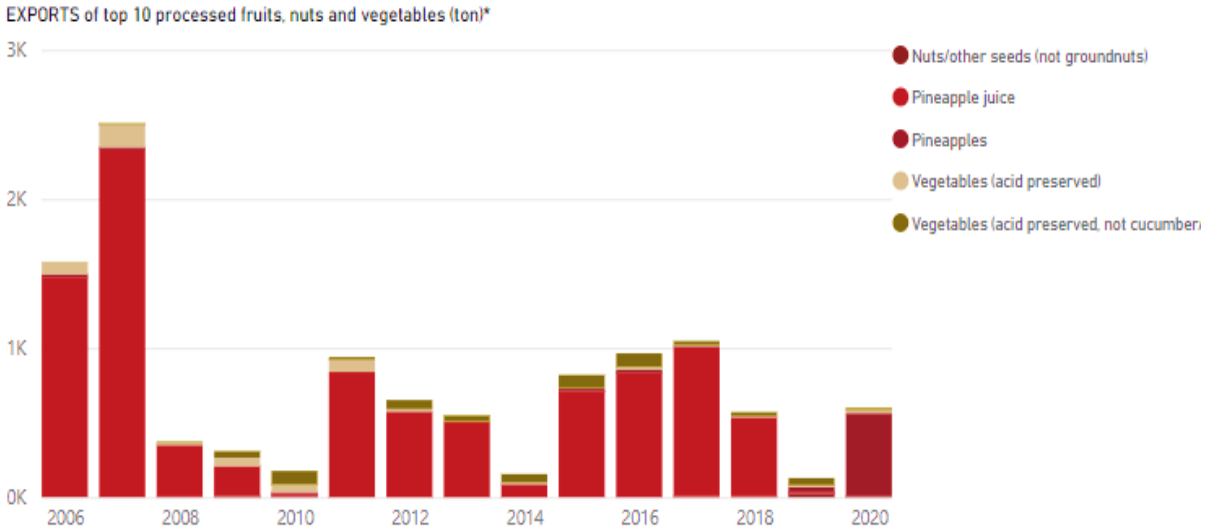


Figure 1: Exports of processed products from Ghana to EU28 (MT) from 2006-2020



Within the EU28 major destination countries for the above fresh fruits and vegetables from Ghana are Belgium (36%), France (25%), and the United Kingdom (21%). The highest importer of processed fruits is the Netherlands (76%). It is important to emphasize that Ghana accesses just a tiny fraction of the EU market (about 1% for pineapple and mango).

The situation for cashew and shea is rather different. Ghanaian cashew is largely exported to Asia (Vietnam and India), as only 1,282 MT and 6,451 MT (shelled and unshelled, respectively) are sold in the EU, covering only 3 percent of the total volume sold.[6]

Ghanaian shea butter and its derivatives represent circa 38,319 MT and are worth $736 million. These are largely exported to the EU (especially to Denmark and Belgium), covering 63% of the exported shea from the country.

The U.S. market, an estimated $5 billion for non-traditional exports from Ghana, holds significant opportunities for fruit, vegetables, shea, and cashew nuts from Ghana under the General System of Preferences (GSP) and the African Growth and Opportunity Act (AGOA). [7] Despite these opportunities, Ghana's exports to the U.S. market are very low. Fruit exports to the U.S. market from 2017-2019 averaged only $132,000.[8] Although there are no special preferences for shea in the U.S., the market opportunity is growing.[9]

2.2 Interceptions and export bans of exports from Ghana

The EU observed an increasing number of harmful organisms in exported vegetables from Ghana, and after several audits between 2012 and 2015; the EU took measures to address the risk posed by the import of specified commodities originating in Ghana. Commission Implementing Decision (EU) 2015/1849, adopted in October 2015, temporarily banned imports into the EU of five commodities (Capsicum, Lagenaria, Luffa, Momordica, and Solanum L., other than S. lycopersicum L.) from Ghana.

Various improvements were implemented by the National Plant Protection Organization (NPPO) of Ghana, including additional training of inspectors, the introduction of standard operating procedures for export certification, and improved traceability through the supply chain. A new inspection facility was installed at the main point of exit, and inspectors' technical knowledge has generally improved. Specifically, the Government of Ghana established a Ministerial Taskforce for Export, and the NPPO developed a roadmap for pest reduction, established a traceability system to support implementation of International Standards for Phytosanitary Measures (ISPM) and EU Directives, and training of NPPO staff.

An audit done in 2017 concluded that PPRSD had made sufficient improvements, and the ban was lifted on December 31, 2017.[10] In June 2019, the PPRSD, on account of local interceptions at the Kotoka International Airport due to harmful organisms in leafy vegetable exports and notifications from the EU, issued a ban on all exports of leafy vegetables to the international market.

There have not been bans on mango and pineapple exports, however, the increased prevalence of pests and diseases has affected the yield and competitiveness of these two key commodities. The

[6] International Trade Centre, Trade Map, https://www.trademap.org/, accessed 4/7/22
[7] Ghana National AGOA Strategy, 2016, page1,
[8] UN Comtrade Database, https://comtrade.un.org/dta/
[9] Ghana National AGOA Strategy, 2016, page 1, https://agoa.info/images/documents/15271/Ghanaagoastrateg.pdf
[10] EU, Directorate-General For Health And Food Safety, Final report of an audit carried out in Ghana from 12 September 2017 to 21 September 2017 in order to evaluate the system of official controls, Dg (Sante) 017-626

presence of pests, such as fruit flies and mealy bugs, has been a major source of concern for EU and U.S. market regulators and consumers, contributing to mango and pineapple rejections. To prevent infestations from these pests, farmers have been using insecticides, which, when excessively applied, increases pesticide residue levels, making the fruits harmful for human consumption and potentially, in excess of Maximum Residue Levels (MRLs), which increases rejections.

Under the latest EU regulation, each exporting country's NPPO needs to provide assurance that production of the particular crop takes place on pest-free farms, regions, or country. However, as Ghana does not have "pest free" areas, the country has adopted a "systems approach" to address harmful organisms from pests. The systems approach combines a series of measures, including registration of value chain actors and farms, surveillance monitoring, application of cultural control practices, pre-harvest control measures, sanitation, post-harvest inspections at point of exit, and Sanitary Phytosanitary Standards (SPS) inspection.

Produce is required to remain traceable along the whole chain of custody, with segregation of different lots under the concept of "Identity Preserved."[11] It also requires a management system in which stakeholders access regular training, take responsibility, document their operations, and proactively report and communicate to the regulatory authority. A phytosanitary certificate is only to be issued by the NPPO based on a risk-based assessment of compliance by the various actors in the chain.[12]

In December 2017, PPRSD, Ghana's National Plant Protection Organization (NPPO), with support of the international organization CABI, presented to the EU a road map with steps toward compliance with these updated directives. It includes procedures for approval of packhouses, monitoring of control systems at the packhouse, roles for all actors in the value chain, inspection of consignments at Point of Exit, and the checklists to be used. The road map also indicates that all exporters are expected to maintain backward traceability information for each consignment. A unique registration Code number given to each exporter will be included on the exporter's label and a unique Produce Code will be a source of document traceability for the consignment.

Also, PRRSD developed several protocols on phytosanitary measures which explain how the systems approach will be implemented within Ghana and supervised by PPRSD. The document further includes requirements for export, sanitary protocols expected on the farm, monitoring/trapping approach, scientific evidence about its effectiveness, and awareness and extension efforts. It is important to note that the protocol for mango prescribes that all exporters need to be GLOBALG.A.P. certified.[13]

With most of the attention targeting the fruit and vegetable chains, there is far less attention to the perennial tree crops of shea and cashew. Neither product has been affected by any import ban in the past years, nor are they part of the scope of PPRSD`s systems approach. Therefore, no protocols with phytosanitary measures exist for the cashew and shea value chains. However, this does not imply that there are no import requirements defined for these products. The European Commission Regulation establishes maximum levels for contaminants in cashew nuts in its contaminants control

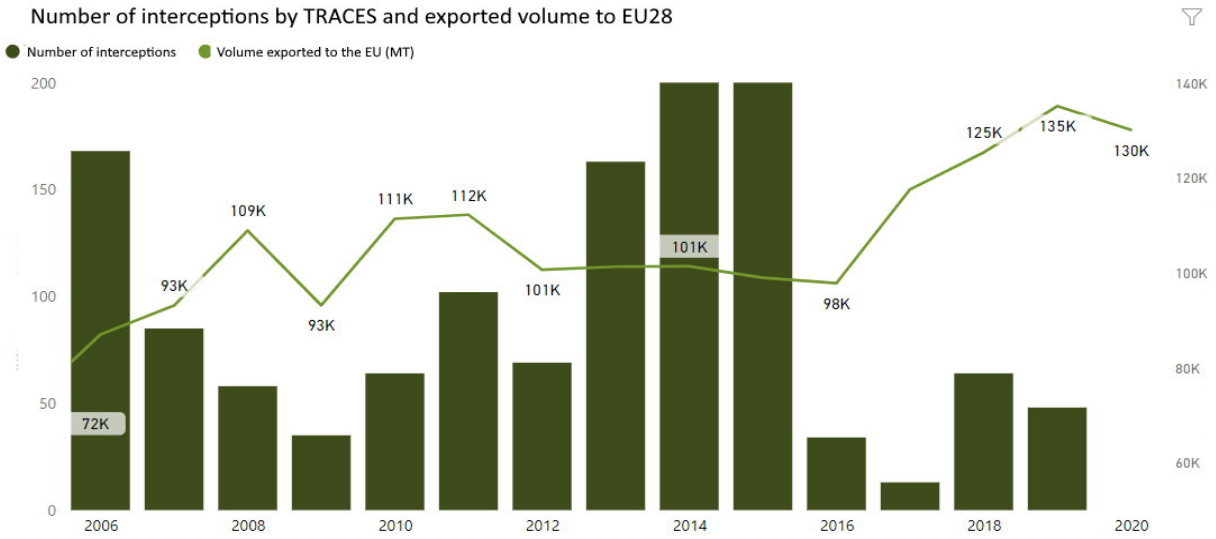
[11] I.P. is a chain of custody model whereby each lot, batch, quantity, or consignment of certified product is treated separately and clearly separated in both physical product and in associated documentation from products throughout the supply chain.

[12] COLEACP Guidelines on the export of fresh mango, 202

[13] Phytosantary Measures By Ghana's NPPO To Address Important Amendment To Eu Plant Health Regulations Implementing Directive 2019/523 Affecting Export of Chilies And Peppers (Capsicum) – To Ensure Produce Is Free From The False Codling Moth, 2019

(Regulation (EC) No 1881/2006). These include the presence of mycotoxins (especially aflatoxin), pesticide residues, micro-organisms (salmonella and E. coli), and heavy metals.[14]

Figure 2: Interceptions by TRACES and exported volumes (MT) 2006-2020



Since the improvements implemented in 2017, there has been a drastic reduction in phytosanitary interceptions of agricultural produce between Ghana and the EU. The latest data for 2019 shows only 48 interceptions, despite increasing trade volumes. Still, these interceptions relate largely to the crops of interest with ethnic vegetables taking up the majority (18) followed by mango (9) and aubergine (7). The 48 interceptions related both to pests (thrips, whiteflies, moths) and administrative non-conformities (21).[15]

Further, the EU Rapid Alert System for Food and Feed has only detected interceptions since the start of 2022 related to agro-chemical ingredients. Similarly, the U.S. Food and Drug Administration (USFDA) recorded 631 rejections of imports from Ghana between April 2022 and 2014, with 85 percent of these rejections on food items.

2.3. Legal and regulatory framework on food traceability in Ghana

Ghana has established national legislation on food safety and developed standards for fruits and vegetables. Legislation on food safety in Ghana is based on the Public Health Act, 2012 (Act 851), which, among other aspects, legislates the manufacturing, packaging, distribution or sale of food in the domestic market.[16] In addition, the Act establishes the Food and Drugs Authority (FDA), which is mandated to "provide and enforce standards for the sale of food, herbal medicinal products, cosmetics, drugs, medical devices, and household chemical substances."[17]

The Plant and Fertilizer Act 2010 (Act 803) establishes the PPRSD, which is mandated to undertake plant protection and pest control, regulate the import and facilitate the export of plants and plant materials. This mandate includes surveillance of plant-growing areas, inspection of plant

[14] Ayeduvor, Obeng and Adomanko (2020). Understanding SPS Requirements for Ghana's Exports to the EU: Focus on Cocoa, Cashew and Tuna products. Geneva: CUTS International, Geneva
[15] COLEACP e-data available on https://www.coleacp.org/e-data/, consulted 7/7/22
[16] Agbezuge, Sylvester, Ensuring Food Hygiene and Safety in Ghana: a Legal Perspective, page International Journal of Humanities and Social Science Vol. 8 No. 6, June 2018, https://ijhssnet.com/journals/Vol_8_No_6_Jne_2018/8.pdf
[17] Article 81, Public Health Act 851, https://www.moh.gov.gh/wp-content/uploads/2016/02/Public-Heath-Act-851.pdf

consignments, issuance of phytosanitary certificates for export of plant and plant-related products, conformance of plant imports and exports to the International Plant Protection Convention (IPPC), and enforcement of pre-export examination and any other inspections required by the country of destination. PPRSD is the designated NPPO and a member of the International Plant Protection Convention (IPPC).

Food traceability is not explicitly covered in the Public Health Act (Act 851) 2012 and Plants and Fertilizer Act (Act 803) 2010 of Ghana. However, the mandates of the Food and Drugs Authority and Plant Protection and Regulatory Services Directorate allow for the enforcement of food safety requirements and therefore, traceability. PPRSD, under the MOFA, is largely responsible for implementing the Plants and Fertilizer Act. The FDA, under the Ministry of Health, is responsible together with PPRSD for implementing the Public Health Act.

In 2015, Ghana also adopted a Food Safety Policy with the objective of coordinating food safety institutions, strengthening existing legislation and regulations on food safety, developing the food borne diseases surveillance system, and ensuring that infrastructure such as laboratories are established for effective food safety management to benefit locally based food processes who target local and international markets.[18]

The FDA's mandate includes registration of all actors in food manufacture, import, export, distribution, and sale, subject to satisfactory compliance, based on inspections by FDA of prescribed standards, and prescribed codes of good manufacturing practices. The FDA is a member of the CODEX Alimentarius. By their membership of IPPC and Codex Alimentarius, PPRSD and FDA are required to implement traceability requirements in their standards and processes.

The Ghana Standards Authority (GSA) is responsible for developing, publishing, and promoting standards in Ghana through standardization, metrology, and conformity assessment activities.[19] GSA has developed product quality standards for fresh mangoes and pineapples,[20] dried fruits,[21] and fruit juice[22] for the international market. In addition, GSA has also developed good agronomic practices (GAPs) standards aimed at promoting safe food production, post-harvest handling, and distribution using good and environmentally sustainable agricultural practices for the Ghana Green Label,[23] a local certification targeted at fruits and vegetables sold in the domestic market.[24] The Green Label Certification was initiated in 2011 and rolled out in 2014. As of March 2022, Ghana Green Label has 900 farmers and 4 packhouses certified.[25]

Ghana has been a member of the World Trade Organization (WTO) Agreements on SPS Measures and Technical Barriers to Trade since 1995. It has also been a member of the IPPC and the Africa Regional Standards Organization (ARSO) at the continental level, and at the regional level in the work of Economic Community of West African States (ECOWAS) to harmonize regional trade standards. Ghana is also an active member of the Codex Alimentarius.

Despite all the domestic legislation and initiatives on food safety regulation and standards, these regulations are not enforced, principally due to lack of capacity in terms of laboratories at the regional level, a limited geographic coverage of services, staffing of regulatory agencies, inability to

[18] Ghana Adopts Food Safety Policy, https://www.afro.who.int/news/Ghana-adopts-fod-safety-policy

[20] Ghana Standards Authority GS 546:2017
[21] Ghana Standards Authority GS 1037:2013
[22] Ghana Standards Authority GS 1034: 012 and GS 1091:2014
[23] Ghana Standards Authority, GS 1054:2019
[24] Ghana Green Label, https://www.Ghanagreenlael.org/about/history/
[25] BFT Online article, https://thebftonline.com/2022/03/30/over-900-farmers-4-packhouses-have-subscribed-green-label/, accessed 6/7/22

enforce their mandates domestically, and the lack of extension services to producers to fulfill their food safety responsibilities. Additionally, a large section of the Ghanaian public has little awareness of the food safety standards and do not put a premium on certified foods.

However, producers and exporters in Ghana who target international markets are required to meet the standards required by buyers within destination markets. This document presents the relevant standards required by regulators, buyers, and consumers in international markets targeted by Ghanaian exporters. The document also summarizes (in Section 5) the requirements for each of these standards for ease of use.

2.4. Legal and Regulatory Framework in the EU

The EU General Food Law Regulation (Regulation 2002/178/EC) establishes that only safe food and feed may be placed on the Union market and defines basic criteria for establishing whether it is safe.[26] It defines traceability as "the ability to retrace, through all production, processing, and distribution steps, the progression of a foodstuff or of a substance intended to be incorporated or that could be incorporated in a food product." This legislation is the cornerstone of the EU regulatory framework, because it covers the entire agri-food sector and all stages of production, processing, and distribution of food and feed. It defines general requirements for operators relating to own controls to check compliance with EU and national food law, food and feed safety, traceability, and withdrawals/recalls of unsafe food and feed. It also established the Rapid Alert System for Food and Feed (RASFF) — a network for the swift exchange of information relating to food and feed risks.

Relevance to phytosanitary issues is found in Directive 2000/29/EC. This legislation lists regulated harmful organisms and provides protective measures against their introduction into the EU.[27] In addition, it lays down the conditions for plants, plant products, and other materials to be introduced and transported in the EU. For importers of fresh fruit and vegetables, the traceability of products is compulsory. To fulfil this obligation, one must document the sources of the product and be able to hand over proof of origin for all fruits and vegetables and proof of compliance with international standards when undertaking activities related to the Convention.[28] The International Standards for Phytosanitary Measures provide a basis, in addition to EU import requirements, for evaluating official export controls in contracting parties. Ghana is a contracting party to the IPPC through its national plant protection organization, PPRSD.[29]

More recently, Directive 2000/29/EC was upgraded into 2016/2031 and prohibits the import or use of certain organisms and materials. It introduces a proactive approach to prevent the introduction of pests into the EU. By focusing on preventive measures, thorough surveillance of the territory, and preparation for possible outbreaks, member states aim to reduce yield losses and the high costs associated with control measures. Phytosanitary import controls on plants and plant products from third countries will be strengthened to avoid unintentional disadvantages. Pending a risk assessment, the import of some of high-risk products from non-EU countries can be banned and all plants will have to be accompanied by a phytosanitary certificate issued by the country of origin when imported

[26] https://ec.europa.eu/food/horizontal-topics/general-foodlaw_en, accessed 6/7/22
[27] EU, Directorate-General for Health and Food Safety, Final report on an audit carried out in Ghana from 12 September 2017 to 21 September 2017 in order to evaluate the system of official controls, Dg (Sante) 2017-626
28 International Plant Protection Convention (1997) Produced by the Secretariat of the International Plant Protection Convention
[29] Council Decision of 19 July 2004 approving the accession of the European Community to the International Plant Protection Convention, as revised and approved by Resolution 12/97 of the 29th Session of the FAO Conference n November 1997 (2004/597/EC

into the EU.[30] The list of harmful organisms is frequently updated through Directives 2017/1279/EC, 2019/523/EC, 2019/2072/EC, and 2021/2285/EC. Pests of concern and currently related to the horticultural sector in Ghana are identified as follows:

- False Codling Moth (Thaumatotibia leucotreta)
- Fruit Flies (Tephritidae family)
- Stem Borer (Neoleucinodes elegantalis)
- Fall Army Worm (Spodoptera frugiperda)
- Fruit Borer (Neoleucinodes elegantalis)
- Thrips (Thrips palmi)
- Whiteflies (Bemisia tabaci)

The below table shows the various SPS concerns for each of the crops of interest.

Table 1: Sanitary and phytosanitary concerns per value chain

	Quarantine pests								Diseases	Contaminants			
	False Codling Moth	Eggplant Fruit & Shoot Borer	Fall Army worm	Fruit Fly	Stone Weevil	Thrips	White Fly	Mealy bugs	Bacteria Black spot	Salmonella	E Coli	Aflatoxin	MRL pesticides
Vegetables (Asian)													
Mango													
Pineapple													
Fresh cut fruits													
Cashew													
Shea													

Dark grey represents an actual issue in Ghana. Light grey represents a potential issue in Ghana.

More recent is the new EU Directive on corporate sustainability due diligence. Under this legislation, EU based companies will have a corporate due diligence duty to identify, prevent, mitigate, and account for negative human rights and environmental impacts in their operations, subsidiaries, and value chains (direct and indirect established business relationships). The legislation applies to companies with 500+ employees and more than €150 million of turnover while covering the company's own operations, their subsidiaries, and their value chains (direct and indirect established business relationships).[31] Practically, this means that supermarket chains in the EU will be expected to assess their supply chains from Ghana for all agricultural produce. Traceability up to a certain origin level will become a key element to practically implement such a due diligence approach.

2.5. Stakeholder's Roles in Traceable Value Chains

At the helm of Ghana's national traceability objective is the PPRSD. Within this mandate, PPRSD provides training to exporter's staff, packhouses, managers, and out-growers on protocols for growing specific plants as well as how to use the public traceability system. Protocols cover specific high-risk crops and provide guidelines for evaluating the efficacy of different pesticides and other phytosanitary measures (e.g. trapping, sanitation measures) against harmful organisms of concern.

[30] https://www.fasfc.be/plantslegislation, accessed 5/7/22

[31] Factsheet on Just and sustainable economy, https://ec.europa.eu/commission/resscorner/detail/en/fs_22_114

Also, PPRSD conducts surveillance visits on registered exporters, farmers, and packhouses, and makes recommendations to the outgrowers regarding the use of pesticides, pheromone traps, sticker traps, protein baits, and other good agricultural practices. These inspections are scheduled three times per season: planting, fruiting, and harvesting. However, due to low staffing capacity, PPRSD inspections are limited to the time of harvesting. PPRSD takes pre-harvest samples of vegetables for incubation and lab analysis to diagnose insects and nematodes for viruses. A laboratory report that shows no presence of insects, nematodes, or viruses on sampled vegetables will be authorized for harvests for exports. Inspections are also conducted at the Kotoka International Airport and Tema Port exit points. Consignments are subject to phytosanitary and visual inspection by PPRSD staff at the point of exit. Phytosanitary inspections focus on identifying any harmful organisms that may be present in products for exports. Visual inspections focus on the quality specifications of the products for exports. Once the vegetables pass the export inspection, phytosanitary certificates are issued along with additional declarations required for exports to the EU. The traceability (produce) codes for the products are indicated on the Phytosanitary certificates for ease of traceability.

Exporters and processors interface with international buyers for specific quantities and quality of fruits and vegetables. Exporters often hold multiple certifications required by buyers and limit their sourcing network to certified growers. Most exporters maintain their traceability systems as required by the standards they are certified to uphold. Some exporters did not source from certified growers but rather, ensured that the growers produced according to their quality standards, which have been agreed upon with their buyers. Exporters employ agronomists who ensure that outgrowers adhere to and record these good agronomic practices in the traceability system. Exporters may have their own farms from which they source some of their raw materials for exports. Exporters register with PPRSD and provide detailed lists of their producers (name, location of the farmer, type of crop, and farm size). Exporters enter these details into the system before production by the farmer. The information is approved, and an inspection is conducted by PPRSD to confirm details. Following this inspection, the farmer and exporter begin the planting of their produce.

Nucleus farmers produce on their farms and purchase additional produce from smallholder farmers (outgrowers) who produce to the nucleus farm specifications. Nucleus farmers are often linked to one exporter or processor who purchases their products. Nucleus farmers play a key role to support compliance by member farms toward the relevant standards.

Smallholder farmers cultivate or collect commodities, usually under contract farming arrangements. They receive input credit (seeds, fertilizer, and other inputs) and agree on purchasing prices at harvests. They also receive agronomic support from exporters and processors who guarantee markets at harvest. Most smallholder farmers receive training and are required to produce according to the standards requirements of exporters and processors. Smallholder farmers often organize into farmer-based organizations (FBOs) or cooperatives. The FBOs may hold group certifications (e.g., GLOBALG.A.P. Option 2), which may be co-financed by the exporter. Certified groups often keep manual records of traceability accessible to exporters and processors.

Certification bodies provide an independent assessment of certification holders. Ghana has corporate and individual certification auditors who, among other things, ensure compliance with standards and traceability requirements. Generally, certification bodies are quite conversant with PPRSD's traceability system and requirements, however, their role is limited to providing independent assessments on behalf of buyers, exporters, or standards organizations who require their services. Certification bodies in Ghana include SGS, Control Union, and Intertek, which provide services for a number of standards setting bodies.

3. TRACEABILITY SYSTEMS

Section 3 discusses the practical dynamics around traceability systems, including critical traceability functionalities, and the various traceability systems encountered in the relevant value chains. Differentiation is made between the public traceability systems and the private traceability systems (both manual and digital ones).

3.1 Critical Functionalities of Traceability Solutions

Traceability systems can appear in a variety of ways and use different methods based on their objectives. While some are basic and robust with a single use case of tracking the origin of the product, others are fully fledged Enterprise Resource Programs (ERP) covering every possible service in the agribusiness sector. Nevertheless, five functionalities are recognized (adapted from C-lever.org[32]) that are considered absolutely critical for any traceability solution to be worth the money and effort spent. These functionalities include:

a) Registration and identification relate to the process of capturing the relevant identification data (including biodata, where applicable) of supply chain actors as well as the products or batches and allocating a unique identifier to each. Typically, this information is complemented with geo-location data, demographic data, selective supply chain data, and contact information. Photos of the person can be added for visual confirmation as well as their official identity documents.

b) Data collection (about quality, sustainability, or other variables) for both the product, processing units and actors takes place. This information is assigned to the batches, retained, and passed on downstream to the next step. Data entry can take place both manually and automatically. Such data can be stored in a central database (most proven solutions) or decentralized ledger (more innovative solution).

c) The Chain of custody maps the relationships between the various chain actors and tracks the batches systematically both within an organization (internal traceability) and between organizations (external traceability) along the critical tracking events (CTEs). Key data elements recorded are typically a unique identifier for the traceable items and other traits, such as weight, product type, date and time, location, and activity. (See Annex 4.2 for an overview of typical data to be collected by producers and packers under GS1 Standard). As volumes aggregate along the chain, the level of granularity tends to increase (from a single bag or fruit, up to a full container or case). During this phase, control mechanisms can prevent volumes from extending beyond certain yield levels as well as to prevent the unintentional mixing of conforming and non-conforming batches (as defined by the relevant Chain of Custody model).

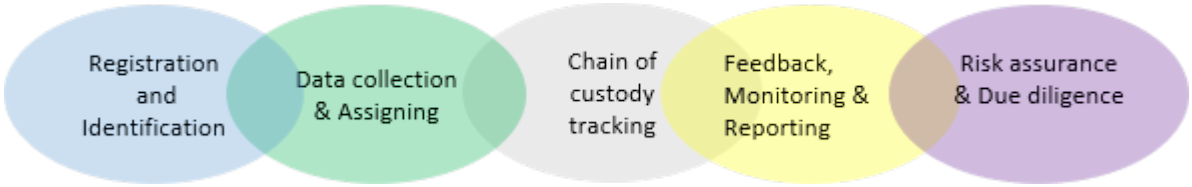
d) Feedback loops, monitoring, and reporting are critical for the business case of traceability. Feedback to the various actors (especially the less empowered ones, such as the producers) will allow them to benefit from their data. Monitoring progress toward sustainability or business targets helps stakeholders to assess the extent to which their efforts are successful. Reporting these results transparently (even negative ones) is part of what it takes to be a responsible business in the 21st century.

e) Risk assurance and due diligence take up an increasingly important role in times when access to production and processing locations is restricted (such as during the COVID pandemic); compliance with standards and identification of potential risks depends on more remote approaches using reliable data. Under these approaches, the focus of the third-party audits shifts from the compliance with specific checkpoints to compliance and functionality of the system

[32] C-lever.org, Evaluation of Digital Traceability Systems in Agricultural Supply Chains to be published by GIZ in 2022

itself. Data can be stored in a central database (most proven solutions) and allow peer-to-peer validation of claims (such as farmgate price). More innovative is allowing stakeholders to scrutinize reported claims by accessing decentralised ledgers through crowd-based validation approaches.

Figure 3: Functionalities of traceability systems



The solutions covered above can be assessed against these five functionalities in terms of compliance. Such assessment can potentially be expanded further in function of the particular needs of the respective stakeholders. (See Annex 4.2 for a structured assessment against these particular functionalities of the public PPRSD system, Green Trace, CropIn and CareTrace).

3.2 Public Traceability System by PPRSD

Under its mandate to implement plant protection services and as NPPO, the PPRSD took up the initiative to develop and host a public traceability system. The system has the following objectives: i) supporting adherence to SPS protocols as defined in the road map, ii) reducing SPS interceptions of exported vegetables, and iii) assuring the chain of custody is traceable up to packhouse and producers and able to conduct recalls.

At present, the PPRSD traceability system is focused on exportable vegetables (and soon yams). The next commodities being considered by PPRSD for inclusion in the traceability system are yams, grains, nuts and cereals (by 2024), processed foods (by 2024) and domestic products (by 2025[33]). This traceability system enables a consignment and its constituent lots to be traced through all stages of production, handling and, transport prior to export, in line with Section 4 of ISPM 7, as defined by Integrated Production and Pest Management (IPPM). The process of developing and rolling out this public traceability system has however had many challenges, some of which are highlighted below.

Former Geo Traceability solution

Under IFSSP, a private software provider, the Optel Group, was contracted to design the public traceability system. The so-called "GeoTraceability" was a complete, user-centric traceability system that covers all the steps required for the export of fruits and vegetables and includes all the operators in a multi-stakeholder value chain. It offered multiple services based on a centralized cloud approach for data sharing, viewing, analysis and report generation covering:

i) Registration of farms, farmers, packhouses, and exporters,
ii) Data collection during monitoring and inspection,
iii) Linking traceability data with phytocertificates and export documentation.

Few value chain actors are familiar with this initiative, and only two of the stakeholders interviewed had a clear opinion to share. These individuals mentioned the insufficient involvement of various stakeholders during the process of its development and roll out. Subscribing companies were

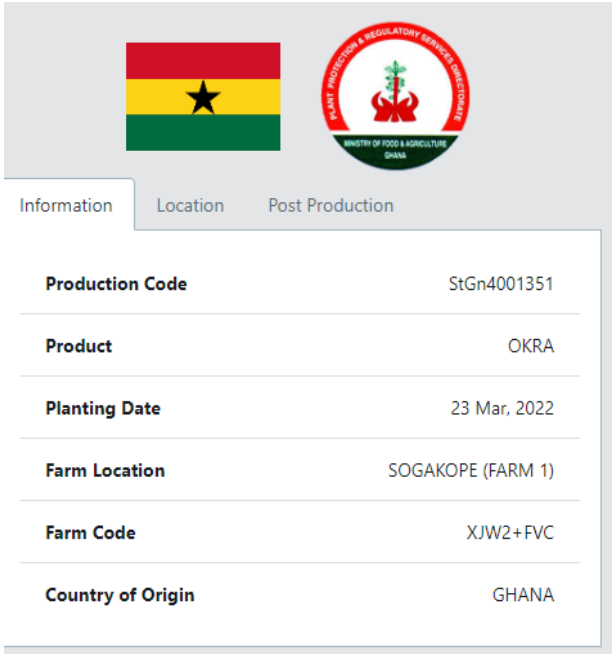
[33] PPRSD, PowerPoint Presentation on traceability, received June 2022

charged an annual fee of $5,000 to make use of the system. A target of 20 paying subscribers in Ghana was defined by program management to justify keeping the system running. Because the target was not achieved, support ceased, and currently, GeoTraceability is no longer in use by any practitioner. As this solution contributed to the lifting of the export ban by the end of 2017, it can be considered a success. Nevertheless, the PPRSD indicated its dissatisfaction with the initiative from the start. PPRSD, while recognizing the need for a traceability system, wanted to own and develop the system as opposed to having a system developed for it. Hence, PPRSD did not adopt the GeoTraceability system and decided to continue on an alternative pathway.

Current GHTRACE solution

With its own funds, the PPRSD procured the services of the Ghanaian IT company Silence Star to design "GHTRACE." The system consists of a web -based interface accessible by exporters as well as a mobile app (under finalization).

Figure 4: Screenshot of the GHTRACE web page after scanning the QR code



GHTRACE offers companies (or producer-based organizations) to register farmers, farms, and packhouses by capturing relevant data as well its geo-location (by single point only). Each farm is issued a unique code for identification. Further it allows field staff of companies to record the farm activities (planting, pest prevention, etc.) taking place on each registered farm.

After harvest the product is received at the packhouse, additional details are added, and a production code issued. The granularity of these codes is defined up to the level of the individual producers and added to the cardboard boxes. For such volume, the system can generate a Quick Response (QR) code for easy identification by image recognition software that can be run on handheld devices. The QR-Code links to a web page that summarizes the relevant details about this particular volume along three tabs:

a. Information: with production code (e.g. StGn4001351), product (e.g., Okra), planting date, farm location (e.g., Sogakope, Farm 1), farm code (location), and country of origin (Ghana).
b. Location: a Google maps interface visualizing a single point representing the farm

c. Post Production: harvest information, date of harvest, date of receipt at packhouse, name of packhouse, batch number and packhouse facility code.

In addition, it offers PPRSD inspectors the ability to record the audit results obtained during their inspections of farms as well as packhouses. Samples taken pre-harvest are sent to the laboratory, which uses the same system to enter the SPS data. The PPRSD officer at the point of exit can enter additional observations based on the visual inspection at the port or airport. Based on these results, a phytosanitary certificate can be issued digitally through the interface and downloaded by the exporter. In the chart below, the GHTRACE system is represented based on its process flow.

The GHTRACE system has now been under continuous development in the last 4 years since its launch in 2018. The interface looks appealing as far as could be evaluated during a short demonstration. Currently, adoption is still limited with a mere 52 packhouses, 153 exporters, 690 farmers, and 1167 farms in the vegetable value chains who have registered.

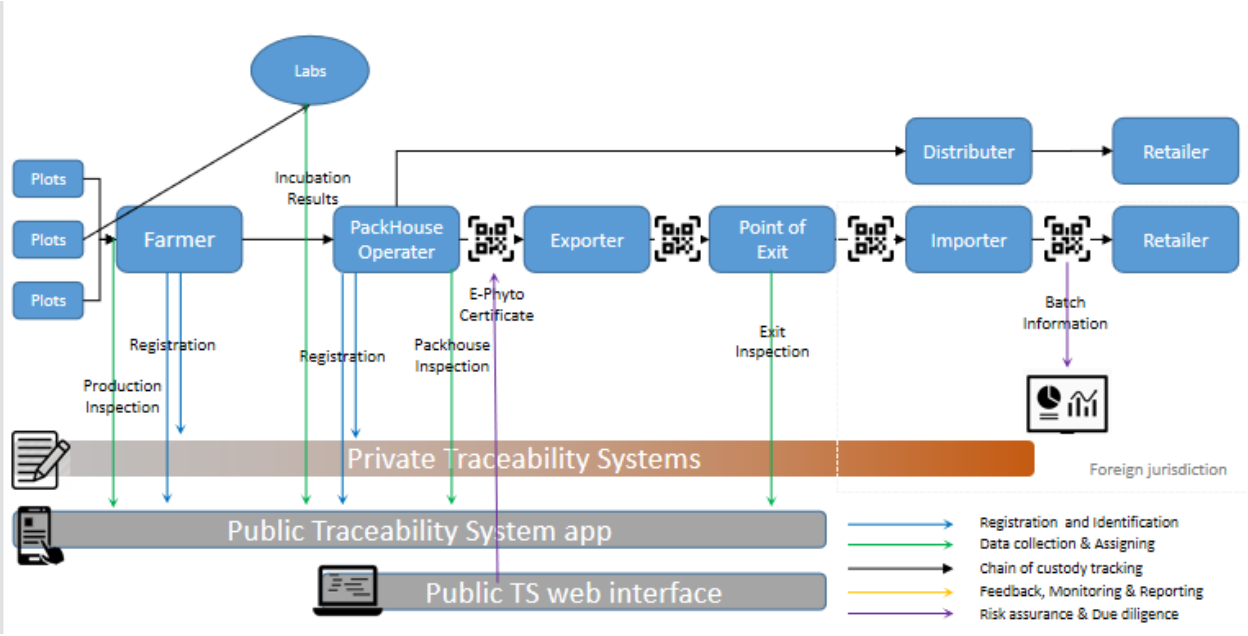


Figure 5: Schematic of the public traceability system

Stakeholder Perceptions of the Current Public Traceability System

The stakeholders interviewed expressed their general concerns and perceptions about the organization of the public traceability system as follows.

- Onboarding into the PPRSD system requires companies to provide datasets for their farmer base in an organized way to the system and frequently update the cultivation and management specifications. While the larger companies already have a sustainability officer on the payroll (responsible for data management) smaller companies worry that this will result in an extra staff cost.
- Farmers and nucleus farmers do not have access to the system, as there are no mobile and Unstructured Supplementary Service Data (USSD). Stakeholders are concerned about data security, especially which parties will have access to sensitive data provided. Data of concern are names and contact information of buyers/suppliers, annual volumes/value, and prices paid for

produce. Several prefer to keep data on manual systems in house and/or submit relatively minimal data to any public system.

The various export companies provided their scepticism about the technical performance of the system from their perspective. Limitations include the following:

- Value chains typically consist of various processing steps. For example, mango is converted into pulp, skin, and juice. These steps are expected to be replicated; however, the current system struggles to replicate these steps analytically.
- There is a lack of standardization of how data is collected. Although most forms are structured by fixed text fields, some information can still be entered manually in open text format.
- There is no adherence to international traceability standard GS1 in the issuing of identifiers for the product such as their Global Trade Identification Number (GTIN), location, such as the Global Location Number (GLN) or palettes (such as Global Supply Chain Council (GSCC).
- Inability to compare registered volumes with the production potential of a farm based on typical yields, which leaves the door open for traceability fraud. Most exporters are not aware of the existence of the mobile app to be used by their field staff. Therefore, they still struggle with the web interface, which is not available in an offline working environment.
- Feedback to the user is insufficient, as users are unable to see uploaded information or access it again for other purposes.
- A practical limitation identified was data control measures of the system. The interface cannot record harvesting of produce until a crop has completed the expected maturation time since its registration. For example, a mango fruit orchard registered this year but planted years ago is consequently not recognized as suitable for inspection or harvest.

Based on these limitations, it is not surprising that export companies who signed up for the system, only registered their packhouse and a minimal number of farmers to showcase goodwill. It appears that the larger numbers of farmers are not yet registered, and their volume is not tracked by the system.

The large number of issues is likely related to lack of an overall vision for the technical architecture of the system, and a tendency instead to make ad hoc modifications. Also, the system currently operates autonomously and is disconnected from other database systems by Ghanaian institutions, such as the National Identity Authority, Ghana Customs Authority, and Food and Drug Authority. This lack of interoperability leads to a duplication of data collection efforts, prevents the provision of additional services to the users, and creates a risk of multiple registrations of the same actors and farms. Although the system is reported to have an API interface currently, there is no evidence of this feature fulfilling its interoperability role.

3.3 Private Traceability Systems in Ghana

Horticultural companies in Ghana that intend to export have their own traceability systems in place. The objectives of these systems are largely threefold. First, the provision of origin data across all steps in the chain provides confidence to clients. In case of contamination, a recall can be executed to take the product off the shelves. Also, it allows for transparency on the conditions of production and processing and allows detection of violations with ethical principles. For example, a non-certified processor can still do its own risk assessment of their suppliers against minimum principles on labor conditions defined by the International Labour Organization (ILO). Secondly, traceability is required by the various voluntary food safety and sustainability standards. Certificate holders are expected to manage the chain responsibly and understand related risks. For example, a certificate holder of a Rainforest Alliance standard is expected to avoid dilution through a range of control measures, such as comparing accumulated annual volumes by each farmer with recent on-farm estimations of the potential yield. Thirdly, the information generated through such systems provides aggregators, processors, and exporters with valuable business intelligence. For example, a pineapple exporter

may wish to understand yield predictions to know the volume contracts can be signed for and the working capital required to safeguard cash flow in various sourcing channels during the buying season.

In addition to these three primary objectives, there are several secondary reasons that practitioners indicate interest in for traceability systems (and not yet covered by their current systems):

- Sourcing management (for example, monitoring extension costs in function of volumes sourced) or profitability assessments (farmers recording farm expenses versus revenue to understand their net farm income).
- Farm Management: tracking field activities, cost of allocated of labor and tools and the harvest volumes per sub plot.
- Communication with their outgrowers (for example, through bulk SMS with reminders on sanitary measures in relation to seasonality or weather) and sourcing transparency (by an automated SMS on the official company price for a received delivery).
- Digital services that can support productivity or strengthen the sourcing relationship (for example, training videos that can be watched when convenient) or even pest identification tools on the side of producers. On the other side, modern tracking devices can record the climatic conditions inside the (cooled) container to assess the state of arrival and support the settling of contractual (dis)agreements.

Amongst the 13 exporters (including associations and producer organizations) visited within the scope of the assignment, only three indicated actively participating in the public traceability system by PPRSD. The vast majority indicated that they were using private systems. These are mostly systems in which manual notes are recorded onto hardcopy ledgers at different steps in the chain. For larger operations, this includes the use of spreadsheets, which are consulted manually in function of particular queries. Only once was dedicated digital traceability software found to be actively in use.

Table 2: Overview of the traceability system uptake by interviewed food actors

			Farmers in chain	Public	Private		
Name	**Category**	**Chain**	**Total**	**Digital**	**Manual (pen & paper)**	**Manual (pen & paper + spread sheet)**	**Digital**
Srighan Farms	Exporter	Fresh F&V	2500	34		2500	
MAPHLIX	Exporter	Fresh F&V	856	330		856	
SPEG	Association	Fresh F&V	530				
Joekopan	Exporter	Fresh F&V	35	35			
Attakrom	Prod. Org.	Fresh F&V	60		60		
Bomart Farms	Exporter	Proc.Fruits	370			370	
HPW	Exporter	Proc.Fruits	950				950
Qualipine	FBO	Fresh F&V	160		160		
Cotton Weblink	Exporter	Fresh F&V	10				
Hendy Farms	Exporter	Proc.Fruits	1		1		
Blue Skies	Exporter	Proc.Fruits	200			200	
Sel Logistics	Exporter	Commodity	4		4		
Savanna Fruits	Exporter	Commodity	4000			4000	

Manual Systems

As illustrated in Table 2, 9 of the 13 visited horticultural companies currently depend on manual traceability systems. In this case, farmers use an informal notebook or pre-printed template which can be filled in a more structured way. Typical records start with an identifier for the farm or farmer, cover agronomic activities on the farm (dates, concentrations, products, etc.) and harvest volumes. Purchases are recorded in carbon copy reception notes covering key information (farmer identifier, volume, value, and quality variables).

Figure 6: Example of a manual traceability ledger

Typically, field officers of the processing company carry these documents to the office for storage or photocopying. For larger operations, the information is entered manually into spreadsheets for further analysis and reporting. In the case of fresh export, the name of the particular farmer is written onto plastic cases for transport from the farm to the packhouse. After cleaning and grading, the same name is transferred onto the cardboard boxes ready for export.

In the case of processed products, the subsequent steps can be recorded similarly by aggregating sales from multiple farmers into a new batch (for example, processed cut pineapple), which is assigned its identifier. In such a case, a batch might consist of several farmers who all contributed to it. The individually packaged products have their own label (product name, weight, use by date, and sometimes GTIN, batch number, or supplier code) on them. Case codes are usually printed on labels and patched onto the side of the boxes for tracking at a higher level of aggregation downstream.

In case of a recall request, these manual documents or spreadsheets are consulted based on Key Data Elements (KDE) provided (date of packing, location of packing, batch number, product). Through a consecutive process, the trajectory of the product along the chain can be traced back to its respective farm or farms of production. An interesting note is that in some cases, the product package will not mention the name of the processor to avoid competing importers to hijack the chain. In such a case, the details for the processor and exporter are retrieved from the waybill received by the importer.

For the case of commodities, including cashew and shea, the situation is rather different and depends on the type of market:

- **Cashew** is a crop grown typically by large farmers who can produce thousands of metric tons. Semi-dry cashew is transported from the farms to an aggregation site where the nuts are dried up to the required moisture level. Here, samples are taken to identify bio-

contaminants (aflatoxin) and tested by certification bodies. Dry cashew is then re-bagged and loaded into a fumigated container. Such a single large commercial farmer can fill a container, which simplifies traceability tremendously.

- **Shea** is a crop grown in the wild on community lands and harvested based on customary arrangements in the community. Shea nuts are boiled or steamed and further processed to extract the shea butter out of the kernels. This butter is heated and filled in liquid form into liquid tanks within a shipping container. As a typical bulk commodity, the volumes of thousands of respective farmers are bulked together under the principle of physical segregation. Markets in Asia offer little incentive to provide additional information on the origin of the crop or for sustainability certificates. This situation is rather different for western markets, including the EU and United States. When sustainability certificates are required, there is an elevated need for traceability in the chain. In this case, each processing step allows the generation of a unique code (based on the day of production or sequential). As multiple volumes are aggregated, these codes and their relationships are recorded manually into spreadsheets. This way it allows the chain to be traced upward in case of recalls and to conduct physical audits on the contributing farmers.

Digital Systems

Recently, there has been rapid growth in the availability of dedicated traceability software for the agricultural sector. Based on a recent study,[34] there are more than 65 different software packages available, each with its own speciality and specifications. In this section, the digital traceability solutions encountered during the field assessment are presented: Cropin by HPW, an older initiative (now phased out) called TraceCare by Blue Skies, and Green Trace by Green Label standard.

- **Cropin by HPW:** HPW is a Swiss-owned fruit processing and export company, based just out of Accra. They source from about 600 pineapple and 350 mango farmers, as well as from their own farms. The company holds various certificates such as GLOBALG.A.P, Organic EU, Bio Swiss, FairTrade, BRC, and exports mainly to markets in France, Switzerland, and the United States. HPW adopted the use of a digital traceability system "Cropin" with various objectives in mind.

  Cropin is a global ag-ecosystem intelligence provider. Its services enable various stakeholders in the agri-ecosystem, including financial services providers, to adopt and drive digital strategy across their agricultural operations. Using cutting-edge technology like artificial intelligence, machine learning, and remote sensing, Cropin creates an intelligent agri-tech system to digitize operations from farm to fork.[35]

  In the case of HPW, it supports data collection and analysis of its internal management system toward the various standards. The number of farmers grew beyond what could be handled manually. Secondly, the data collection (on production and yield estimates) by their field staff provides key business intelligence to plan their operations and sales. Remarkably, most farmers in the certified operation still fill their farm records with pen and paper. These records are digitized by HPW field officers through a mobile app that synchronizes with the web interface after reconnecting to the internet. Despite the use of this system, HPW still runs a separate accounting software, "SAP," which remains disconnected from the traceability software.

[34] C-lever.org, Evaluation of Digital Traceability Systems in Agricultural Supply Chains, to be published by GIZ in 2022

[35] CropIn website, url: https://ww.cropin.com/, accessed 15/7/22

- **TraceCare by Blue Skies:** Blue Skies is a British-owned processing and export company also based just out of Accra. The company employs 3,300 staff and sources from 200 larger-than-average outgrowers. Blue Skies also holds a range of certificates such as GLOBALG.A.P., IFS, ITI, BRC, FairTrade, and Soil Association, as well as various ISO food safety and traceability standards. Its juice and ice cream targets the domestic market, and freshly cut fruits are packaged for daily export to 15 supermarket chains in UK and EU.

  To give consumers more insight in the origin of the products, a pilot was run with Marks & Spencer using the Trace Care system. Traceability data collected manually was entered into a custom tool, on which basis a unique QR code could be printed on the product packaging. This code placed on individual products linked to a custom web page showcasing the respective farm and/or famers who produced the fruit. Unfortunately, the pilot was discontinued and today, the QR codes only lead to a more generic webpage by the supermarket chain.

Figure 7: QR code on packaged product

- **Green Trace by Green Label Standard:** Green Label is a voluntary domestic standard initiated in 2014 by various stakeholders in the Ghanaian horticultural sector. Its ambition is to offer healthier and safe food onto the shelves of Ghanaian retailers. The standard, designed as a steppingstone, is largely aligned with the principles of GLOBALG.A.P. on the theme of food-safety and Good Agronomic Practices. Farmers and processing companies are trained by a team of accredited trainers to prepare them for a formal third-party audit. These audits are conducted by three accredited certification bodies based in Ghana (SGS, Control Union, Intertek). Currently, the reach of Green Label is 4 certified packhouses and 900 certified farmers. A custom set of record templates is available to participating actors to keep track of relevant information. Although the initiative is promising in ambition, a more convincing business case needs to be developed to convince farmers to participate. Certification costs fall within a range from 300 GHS (single) to 3000 GHS (group), and although certification may open new domestic market channels for suppliers, there is considered to be a lack of premium prices offered on the market for Ghana Green Label-certified produce. Also, monitoring of the impact in terms of certified volumes and fraud prevention are topics that will need more attention soon to build credibility.

  Green Trace is a custom-developed digital solution for certificate holders to showcase the traceability of their produce thereby boosting the assurance to the initiative. On a web interface, the packhouse operator enters relevant data (serial code for a product such as

GTIN, name of product, volume received, package weight, number of packages). Green Trace then issues a unique QR code for each product within this batch. This implies that each product (for example, an eggplant) on the supermarket shelf has its own serialized QR code. Consumers are presented with a basic web page summarizing the above information with traceability to the packhouse.

In the current form, the Green Trace system can act as a first step toward chain transparency and assurance of compliance with the corresponding standard. The next steps would be to extend traceability to the farmer level, standardization on the entry of farmer names (no open-ended entry, but pre-loaded names which have been verified and harmonized with the National Identity Authority), and the ability to include intermediary value chain actors (such as aggregators) in the chain. The digitization of the manual farm records would also offer the potential to facilitate decision making during the auditing process and boost assurance.

Figure 8: Product with Green Label on its packaging and screenshot of the web page after scanning the QR code (right corner)

3.3. Success factors to the adoption of traceability

The main factors influencing the adoption of traceability include market incentives, capacity, value chain cooperation, costs, interoperability, and access to technology are discussed below.

Market incentives

Traceability typically has multiple objectives. Within Ghana's horticultural sector, the primary objective is still the mitigation of food safety risks. Not only as demanded by the relevant regulatory framework, but by all supply chain partners who feel responsible to safeguard the food value chain in their custody. Most food standards already include components on sanitary practices and food safety (such as HACCP) for which a traceable chain of custody is key. Since prime actors in the European market largely demand adherence to these standards, these create not just a commercial incentive but an absolute minimal benchmark to access the market. For smaller market actors, there is still tolerance for non-certified produce.

Over recent years, other objectives became increasingly relevant to the sector. Brand identity can benefit from following a transparent approach about origin and adherence to sustainability principles of interest to consumers in a certain niche. The reputation of companies is vulnerable, if sourcing takes place without any transparency of the upstream actors and their business practices. Through a traceable chain, end-users can be provided additional information about social, environmental, and financial aspects at the level of the farmers or locations. A due diligence approach makes use of this information to assess the extent to which upstream suppliers comply with particular ethical principles as defined in a code of conduct. Such a code of conduct typically summarizes the principles and topics of interest to the values of the organization and/or its buyers.

In 2022, the demand for this sustainability information is still low in the fruit and vegetable markets. Only for shea, there is an elevated interest due to the large number of out-growers which are often disconnected from the importers in consumption countries by multiple intermediaries. Most sustainability standards require chains to be traceable however practitioners are free to choose how they achieve this. Most voluntary standards are satisfied with a manual traceability system as seen in the examples above. Response time to any information requests is typically accepted for up to 1 working day. Only certain in-house schemes (for example, MaxTrace and FairFood, etc.) follow the principle of complete digital transparency in a specific digital tool as part of the verification approach.

Optimization of operations and business intelligence is another objective that traceability can contribute to. The digitization of operational activities can lead to identifying opportunities for improving overall organizational efficiency. These include reducing input or labor costs, identifying complementary training requirements, improving workstation safety, reducing the costs related to incidents, losses, theft and waste, and improved management of business relations with chain partners. However, the stakes of traceability are not solely "defensive," traceability is also a performance lever for companies. The visibility it provides on current and past processes contributes to operational excellence and supply chain management.

Despite the potential benefits identified, it is challenging to calculate the return on investment accurately as it depends on a range of intangible factors, often out of the operators' control. There is no guarantee how many food safety incidents or reputational damages can be prevented by this particular intervention alone.

The below table shows the extent to which traceability solutions offer an opportunity to address these various themes across the different domestic and export chains in Ghana. Light grey represents a potential opportunity, dark grey an actual opportunity in Ghana.

Table 3: Potential for digital traceability systems to address issues in Ghana context

	Domestic		**Export**			
Category	**Fresh F&V**	**Processed Fruits**	**High-risk crops w. quarantine pests**	**Fresh F&V**	**Processed Fruits**	**Bulk Commodity**
Example for Ghana			Mango, Chili, Eggplant, Gourds	Pineapple, Papaya	Fruit salad, cut mango, cut pineapple, etc.	Shea nuts, cashew nuts, cocoa
Regulatory requirement						
Mitigate food safety risks & Recall						
Food Safety Standards						
Sustainability Standards						
Business intelligence						

& operations						
Consumer interaction, Branding & Marketing						

Light Grey: some/partial potential. Dark grey: strong/widespread potential

Capacity

The majority of the traceability solutions can be initiated by core staff with solid analytical and administrative skills without specialized IT expertise. More important is the availability of a person who can spearhead the process and act as a single point of contact within the organization. Taking up such responsibility is unlikely to be realistic without investment in human resources. This involves investment in extension agents and office staff who are responsible for ensuring that data from the field are adequately captured in traceability systems. This may come at additional cost to value chain actors who already bear high cost in obtaining and maintaining certifications.

Even more important is the support provided by the organizational leadership to commit to the vision of transparency through traceability. Sourcing chains in low-income countries are typically characterized by some opaqueness in terms of prices and payment terms. A transition rarely comes without resistance due to the financial interests at stake by various intermediaries or staff.

Most traceability software providers offer support services to their (new) clients during onboarding and setting up the system. This support exists in the form of phone, chat, and online calls as well as physical visits on the ground. While this can make a huge difference for a smaller practitioner, it rarely comes free of charge.

A major barrier is the need to change business processes to match the solution. Software that is in line with current business processes is more likely to be adopted than software that requires process changes. A major concern is an unforeseen disruption that such a transition could create for ongoing processing and export operations. When time schedules are tight (especially when products are shipped by air daily), reliability and robustness are of a higher priority than digital features. Disruption can be minimized by running this first pilot version in parallel with the existing data flow in the organization. The drawback of extra work is negligible compared to the devastating effect of malfunctioning traceability software (TS) which has replaced earlier systems. Only after pilot versions for a given module have been reviewed, tested for all given circumstances and considered perfect, one can consider integrating the TS into the core operations of the organization. Keeping the former hard- copy system running for a bit longer is definitely wise from a contingency perspective.

Costs

The steepest cost is usually experienced during onboarding, both for the software provider and for the subscriber. This transitioning process typically takes several months to be assured that the digital solution can offer the services expected by all stakeholders. Such stakeholder and technical adjustment processes can best be split into cyclical phases. Each phase consists of both desktop review and field review by the ultimate user. The sooner the end-users are provided the opportunity to give feedback, the more efficient the improvement cycle will run. It is common to see that the first version can be reviewed in just a day. Later versions might need up to one or two weeks of field testing to explore all different scenarios encountered. Typically, a pilot phase can take between 3 to 5 iterations before functioning as intended. The efficiency of these cycles depends on the development team understanding the user side of it and knowing what the users expect in advance. With several modules to be developed through multiple iterations, it becomes clear that implementation is not a matter of weeks but often months, and time translates into costs.

Additionally, firms need to prepare for investment in digital assets such as smart phones, scanning, and remote printing devices. For all devices, it is important to consider the longevity of their battery (especially in rural environments with irregular power supply). Mapping locations will require dependency on a Global Navigation Satellite System (such as GPS, Galileo, Glonass, etc.). Other user-related aspects are screen brightness (for use in full sunshine), durability (phones get dropped) and waterproofing (heavy rains). The estimated cost currently stands at $160 for a smart phone and $320 for handheld scanners or printers. Further, the ability to interact with farmers directly will depend on physical field visits by extension staff. Depending on locations basic motorcycles to be used in West Africa tend to start at $700, whereas off-road versions stand at $3,500. Field travel also requires facilitation for fuel and staff upkeep.

Traceability solutions come with a wide range of cost structures. Most charge on a subscription basis, whereas a smaller number apply a commission based on the number of users or volumes. For a large scenario of a processing company with 40,000 farmers, 10 field staff and 10 office staff exporting a volume of 10,000 MT annually, commercial service fees range between $10,000 for a basic solution up to $200,000 for highly ambitious systems, including block chain integration and direct interaction between farmer and consumer. All in all, realizing such digital ambition including subscription to the traceability solution, (temporary) admin staff and management hours, training, and handheld devices depends on a minimum estimated investment of $30,000.

Cooperation

The horticultural chain in Ghana is considered relatively short, with a minimum number of intermediaries and a rather simple product flow, with limited aggregation and mixing. Within the horticultural sector, several associations unite stakeholders on matters of interest, including for example the Sea-Freight Pineapple Exporters of Ghana (SPEG), the Vegetable Producer and Exporter Association of Ghana (VEPEAG), and the Federation of Associations of Ghanaian Exporters (FAGE), and others. In preparation for the rollout of the public traceability system, PPRSD says that it has already conducted stakeholder consultations to develop a system appropriate for all. Still, it appears there is a need for a more intense approach to achieve a higher level of ownership.

This contrasts with the chain for shea, which covers more remote regions of the country, for which the product is aggregated in bulk and stakeholders have different levels of literacy, internet connectivity, and exposure.

Also, there is an opportunity for cooperation with The Sustainability Initiative Fruit and Vegetables (SIFAV). SIFAV is an initiative that aims to actively contribute to a more sustainable fresh fruit and vegetable supply chain regarding economic, environmental, and social impacts with the funding of the Dutch Sustainable Trade Initiative (IDH). Social standards that have gone through an independent benchmarking process and that are found to be equivalent are included in the SIFAV "Baskets of Standards." Such benchmarking ensures that all standards accepted meet a minimum level of assurance and quality set by these benchmarks. By working with baskets of social standards, SIFAV is aiming to drive harmonization to support the alignment of market requirements to best practices and promote transparency and comparability. The baskets also provide choice for supply chain actors ultimately resulting in higher efficiency, lower costs, and less audit duplication.[36]

Cooperation can only be achieved when supply chain partners trust one another. Concerns relate to the sensitive nature of the data that must be shared among supply chain partners for a traceability system, not the relationships per se. The majority of stakeholders consider a traceability system only promising if the data confidentiality is guaranteed by the data infrastructure.

[36] SIFAV, https://www.idhsustainabletrade.com/news/sifav-updates-its-basketsof-social-standards/, accessed 7/4/22

Unique identification is an important principle that deserves more attention in several aspects. During registration of value chain actors, there is a risk of double registration resulting into potential orphan data and consequently double impact counting or dilution of certified volumes. Cooperation with the dedicated government institution, the National Identity Authority (NIA), will allow linking registrations to the national identity code. Similar cooperation is possible with the Ghana Customs Management System and with the Europhyt system for the exchange of the ePhyto certificates.

Interoperability

Interoperability is the ability for multiple information systems (and their respective actors) to exchange and use data among themselves. Only when data is passed on to the next actor can real-time knowledge on supply chain product context be made available to interested stakeholders down the value chain. Two types of interoperability are recognized: content and technical. Content interoperability relates to the presence of definitions, indicators and metrics, and technical interoperability relates to databases, protocols, and interfaces.

Standardization guides actors and provides them with shared formats, which can contribute to the overall interoperability. Most food actors in Ghana are not yet digitized, and this offers an opportunity to do things right from the start. Any data provided to the public traceability system or accessed from it can still be structured and formatted in a way which facilitates the use by all relevant stakeholders.

Design of the digital system should envision both live features for data exchange (such as through an API, for example with the REST protocol) but also manual channels for users who are less digitalised (through uploading our exporting CSV file formats).

Of particular interest is building interconnectivity with the IPPC ePhyto system. This system converts paper phytosanitary certificate information into a digital phytosanitary certificate. This electronic exchange between countries makes trade safer, faster, and cheaper. The generic ePhyto National System (GeNS) is a centralized system to facilitate the creation of such e-certificates. It is a multi-tenant web-based system developed for countries without a system to produce, send, and receive ePhytos electronically. Ghana has been actively exchanging information through the Generic ePhyto National System (GeNS) for several years.[37]

An interesting innovation is the Information Preserved (IP) concept. IP is a more contemporary Chain of Custody (CoC) model building on the availability of digital information in traceable chains. Origin and characteristics data are retained (corresponding to the "cumulative model[38]") and aggregated in the function of the volume contributions at each processing step and retained downstream (rather than discarded, as is traditionally the case with the binary model, referring to conventional versus certified volumes). As such, the mixed volume obtains an aggregated sustainability score (for specific checkpoints of interest) and underlying information of the contributing lots. In the commodity chains such as shea (but also, already in cocoa and coffee) there is an increased interest to follow this approach as alternative to the traditional certified versus conventional categorization of the batches.

Technology

Currently, there are at least 62 digital traceability systems available on the market[39]. Most are off-the-shelf solutions that can be subscribed to with minimum levels of IT expertise. Other solutions are custom developed for the functionalities of a particular client and their operational needs.

[37] IPPC Secretariat, IPPC Guide to Implementing he Generic ePhyto National System, 201
[38] USAID, The Enabling Environment ForFood Traceability System Success, 2021
[39] C-lever.org, Evaluation of Digital Traceability Systems in Agricultural Supply Chains, to be published by GIZ in 2022

Within Ghana's horticulture sector, there is low awareness about the availability and potential of digital traceability solutions, due to the absence of many success stories. This situation contrasts with other chains in the region, such as cocoa, where most international exporters run dedicated traceability software to address the various challenges within the sector.

Whereas there is often a perception that internet network coverage restricts adoption, this tends to be less of an issue. Most popular digital traceability solutions tools are already designed to operate in an offline environment and synchronize with each other and the cloud when connectivity reappears. Most vegetable and fruit farms for export are also located closer to airports or ports in the south of Ghana, where internet coverage is more widespread.

Ownership of smart phones is equally less of a limiting factor in this region. Most farmers close to Accra are digitally literate and able to handle these devices to some extent. This opens up opportunities for direct communication, peer-to-peer verification, and direct data entry by the farmer without depending on field officers. The situation in the shea and cashew chain value chains stands in contrast due to its more rural growing environment.

The few modern companies expect that new traceability software needs to be able to connect to, and exchange data with other software packages already in use. This applies to Enterprise Resource Programs (such as SAGE or SAP) or accounting software (such as QuickBooks or Odoo). For these users, its ability to be operable across all (or `interoperability`) is a critical aspect during the selection of potential software.

4. CONCLUSIONS AND RECOMMENDATIONS FOR INTERVENTION

4.1. General Conclusions

Since 2018, Ghana's PPRSD implemented a web-based public traceability system as a major requirement for access to the EU market. The public traceability system has, in part, contributed to the lifting of the EU ban on vegetables. Its use is currently mandatory for vegetable exporters targeting the EU, UK, and U.S. markets. Exporters in the fruits (mango and pineapple) are not required to use the public system. All vegetable exporters interviewed during the assessment use the system, however, those in the mango, pineapple, shea, and cashew value chains have adopted private traceability systems, mostly using manual data collection forms which are satisfactory to the certifications they hold.

Though the PPRSD intends to extend the public traceability system to other crops, such as yams, mango, and pineapple by 2024, a majority of the stakeholders interviewed were not aware of the public traceability system. Those who were aware indicated their perceptions, including concerns about additional staffing and human resource requirements to provide regular data updates, the cultivation and management specifications, access to mobile and offline versions for use by nucleus and smallholder farmers, the requirement to pay facilitation fees (for transport and logistics) to PPRSD to conduct field inspections, feedback and automated reminders to all users to continue processes in the traceability system, and the ability to issue electronic phytosanitary certificates. Also, the PPRSD system at the time of the assessment could not generate relevant custom reports (e.g., farmers) due to field visits in the upcoming week.

On the other hand, private traceability systems, though mostly manual, were adopted by value chain actors as a market requirement by the voluntary food safety and sustainability standards they hold and enable them to execute recalls where necessary. Private traceability systems also enabled the generation of business intelligence information such as yield forecasting, cost management, training, extension support and communications with value chain actors.

As PPRSD intends to extend its public traceability system, it must recognize a number of success factors at the enterprise level for adoption including market incentives, capacity, costs, cooperation, interoperability and availability of technology.

4.2. Recommendations on the Legal Framework

To ensure further adoption, the legal framework and mandate of PPRSD on traceability need to be strengthened to include current and emerging roles of NPPOs in traceability in their legal mandate. PPRSD could be made to assume the role of a regulator responsible for the overall traceability system, including public and private, with a mandate to ensure a sanitized and well-organized traceability system of international standing that could be adopted by other private and international standard setting bodies. PPRSD could also work with district- and regional-level agricultural extension officers as trainers, using the MOFA's existing structure. The role of private inspectors will still be relevant, as they will serve as independent auditors. Where an exporter and processor has developed an extensive traceability system, it is recommended that PPRSD build on or link the private system to the e-traceability system to avoid duplication.

Strengthening the PPRSD's legal and regulatory mandate could also involve a review of existing legislation (Plant and Fertilizer Act 2010) to include current and emerging roles of NPPOs in traceability in its legal mandate. PPRSD could be made to assume the role of a regulator responsible for the overall traceability system, including public and private, with a mandate to ensure a sanitized and well-organized traceability system of international standing that could be adopted by other private and international standard-setting bodies. This approach will reduce redundancies and

overlaps that private sector stakeholders experience subscribing to several traceability requirements which affect their cost of operations.

In connection with this mandate, there needs to be a clear structure of cooperation and relationship between the role of PPRSD and the Ghanian FDA to ensure regulatory cooperation between these institutions and reduce overlaps and costs to businesses as they are often required to register with both institutions.

A governing committee under public/private partnership is expected to identify the strategic vision of the e-traceability system in line with the needs of the specific stakeholder categories. This oversight could be undertaken by a public private dialogue platform made up of the regulator and value chain associations such as FAGE and SPEG. The Ministerial Task Force that worked to lift the EU ban could also be considered, if the membership could be expanded to include actors in mango and pineapple sectors.

PPRSD requires a strategic change management approach to provide a well-structured and organized traceability system for Ghana. The strategic approach implies that the organization needs to take necessary steps over the medium to long term to ensure that it rolls out traceability for all crops under its mandate. Currently, it seems to respond to concerns in key export markets, so adopting and rolling out traceability is more ad-hoc than strategic.

Change management is critical for PPRSD as it needs to adopt an overall responsibility for traceability in the country by working with all stakeholders as a regulator and involving private sector certification bodies and auditors in the fulfillment of its functions. The current role of directly providing traceability and being the independent inspectors and auditors stretches the limited staff and financial resources of the organization. If PPRSD could develop a training and certification system that involves private auditors who could be licensed at a fee by PPRSD and made responsible for nationwide inspections of registered exporters and processors, PPRSD would be better positioned to regulate the work of these certification bodies and auditors. PPRSD could then further assume the sole responsibility of ensuring exportable products meet the SPS requirements for the destination markets at the point of exit.

There needs to be a clear working relationship with defined roles and responsibilities between PPRSD and the providers of the current e-traceability system. This will ensure that PPRSD has ownership of the system and that further developments to the system will remain with PPRSD and not the service provider.

4.3. Recommendations on PPRSD Inspections

PPRSD does not seem to have the logistical, staff, and financing resources to conduct the required inspections for an effective e-traceability system for all farms and packhouses in all the value chains under its mandate. Consistent with its role as a regulator, PPRSD can focus on establishing an ecosystem for actors to adhere to traceability requirements. This implies that PPRSD will register, train, and certify private certification bodies and inspectors, who will conduct the inspections on its behalf. These certification bodies and auditors will be able to reach many farmers and exporters and ensure compliance with sanitary and phytosanitary measures, and traceability requirements. Private certification bodies and auditors can contribute effectively to field monitoring, inspection, and training of farmers. PPRSD could also work with district- and regional-level agricultural extension officers as trainers, using the MOFA's existing structure. The role of private inspectors will still be relevant, as they will serve as independent auditors.

Where an exporter and processor has developed an extensive traceability system, it is recommended that PPRSD build on or link the private system to the e-traceability system to avoid duplication.

4.4. Recommendations on Private Sector Digital Transition

The first aspect to address is to create more awareness of the potential benefits of digital traceability tools and the availability of the solutions on the market. A comparative assessment of the solutions for particular use cases representative of the Ghanaian value chain actors, in the focused sectors, is required. Solutions that appear "fit for purpose" can be shortlisted for further interaction. Shortlisted solution providers can then be invited to showcase their software directly to the prospective users, through live online sessions and the generation of user-friendly booklets and videos. Testimonies by actual clients can help to balance out such marketing pitches with more practical and objective insights. A guiding tool (such as a decision-making flowchart) can be developed to help prospective users to identify which solution fits their particular needs most.

The transition into digital traceability further needs to be supported (incentivized) through subsidies, to take away the key barriers identified. Cost-shared grants can lower the onboarding costs during the transition. Such grants could contribute to the purchase of certain digital assets as well as fixed subscription costs during the first year(s).

The availability of local Ghanaian expertise for the shortlisted solutions will increase the efficiency of the help desk services by the solution providers (understanding local context, same accent, or local language, etc.). A partnership with the shortlisted local solution providers could co-invest in the training and coaching of on-the-ground support staff with the purpose of making the on-boarding processing more cost- and time-efficient.

Further, there is a need for stronger business models that reward actors for sharing relevant food safety and sustainability information about the production and processing conditions. Engagement with importers and brands in the E.U./U.S. needs to identify which principles and information can add value to the product. In other commodity sectors (such as cocoa and coffee), this approach is already changing the more direct sourcing channels by selling such data on top of the actual product (such as farm gate price paid, living income gap reduction, yield gap reduction, farm profitability improvement, etc.). Having a better understanding of the market sensitivities will allow the Ghanaian actors to collect the relevant data on the ground and sell.

Harmonization across the many standards will help to provide a better return on investment of certification as well as improve market access into the EU/UK. An equivalence mechanism can be explored in cooperation with other international initiatives to reduce the burden of certification on the Ghanaian export companies. One such initiative is SIFAV, which has already identified 11 different labels (or combination of) under the social (and water) themes for which participating supermarket chains accept equivalence.

Cooperation with the various standard organizations is also recommended to explore the advantages from digitization of the Internal Management Systems of the certification holders. Ultimately more progressive auditing approaches can be explored, whereby the availability of this digital data collection and verification systems can be audited with fewer field visits to farms and packhouses. Such an approach would offer the potential to reduce the cost of auditing through third-party certification bodies.

4.5. Recommendations on the Public Traceability System

Stakeholders are concerned about data security and protection. This implies that going forward, the e-traceability system should have more transparency about the access rights of various stakeholders involved and clarity on how each ultimately uses the data. Although PPRSD can be in the lead as regulator, it does not necessarily imply that all data points are accessible by this organization. Its security features improved for users, data protection, and access should be fully controlled to assure confidence to stakeholders of the security of the system.

Under GTI, there is potential to improve the current public traceability system by providing technical assistance to the IT team within PPRSD. First, there needs to be more clarity on the desired functionalities the final system is expected to fulfil for all stakeholders. To do this, a more elaborate stakeholder consultation round is proposed to understand expectations, create goodwill, and identify the key services required. A structured approach is recommended following a modular design. Each module can then be designed and executed comprehensively in more detail and subsequently piloted and improved based on priorities set by the stakeholders.

Participation and future satisfaction by sector actors can be increased by offering value-adding services through the system. The system's core modules can be compulsory and collect all necessary information for PPRSD to use as a regulator. Additionally, there can be optional modules that offer specific services to the users. These modules can be offered at a commercial fee to cover the system's running costs. One potential service can be to assist farmer users to assess their farm profitability by reconciling the farm expenses throughout the season and comparing with their peers growing the same crop.

Another potential service is to provide weather updates and reminders on pest and disease management practices for their particular crop, using the input of a localized risk model. Others would relate to the establishment of a track record on produced volumes, which can contribute to the risk rating by financial service providers to allocate products (business loans, micro finance, insurance).

Logically, such secondary-use cases can only be developed practically by offering other digital actors to connect to the public traceability system. Therefore, interoperability with other commercial service providers (insurance companies, microcredit providers, remote sensing, etc.) and with the private traceability solutions (Cropin, etc.) is an important principle. (See Figure 10 for a graphic representation). On the side of the data inflow (represented by downstream arrows in Figure 10) there is a huge opportunity to build on existing farmer databases available with exporters (and definitely with certificate holders). As a minimum, these datasets are expected to be loaded through a manual interface in XLS or CSV format. More advanced would be a live link with private traceability systems used (for example, Cropin) to exchange particular data points of interest (for example, the chemicals used, date of application, and an identifier of the farm). Such live links can be provided by an Application Programming Interface (API), which is a simple switchboard where data points from two different software are connected.

On the outflow side (represented by upstream arrows in Figure 10), there is an even larger need for interoperability between downstream actors, clients, and governmental institutions. Again, it needs to be possible to extract shared information for particular use cases at the user's convenience. Such datasets can then still serve to fulfil the needs of particular clients or monitor the performance of audited farmers. Also, standards organizations can then benefit from the availability of such information, as it contributes to the use of risk-based approaches (and possibly reduce dependency on costly certification bodies). A live link through an API is the most recommended technical approach to achieve efficient data interoperability.

Domestically, there are several other government institutions where this information can contribute and take away the burden from manual document exchange. FDA, GSA, and Customs all have their management systems that would benefit from a digital exchange of inspection results, exported volumes and interceptions. Most relevant is the interoperability with ePhyto, rather than the current physical movement of documents.

During the design of the interfaces, there needs to be a consideration of the educational and literacy levels of the different users. Data input by farmers will require a very different interface (such as a graphic smartphone app, or even USSD feature on the phone) compared to the entry of the phyto results by the laboratory analyst. Field officers can be given the role of merely reviewing and editing data provided by farmers rather than entering all from scratch. Consideration for the user profiles

also applies to information output (SMS or graphical feedback to the farmers), which contrasts with more advanced information shared with the downstream actors. Each exporter can be provided access to its relevant dashboard, where only information for its sourcing chain is covered. At PPRSD, such dashboards will summarize the situation at the national level (aggregated across all companies and value chains) as well as operational results by their inspection staff.

Heterogeneity is also seen across the various processing chains. It might be too ambitious (or even undesirable) for a public system to replicate all processing steps exactly. However, it needs to be possible to accommodate the principle of a mass balance model between the input and the output of the tracked volumes and control for any volume adjustments due to rejection, grading, and aggregation. Such mass balance volume prevents claims about traceability or SPS compliance being made for volumes higher than the volumes which entered the system, however, is unable to pinpoint to which batch exactly the claims apply.

As such a system grows, it is key to have the ability to scale and handle larger datasets. This is where standardization helps to assure the identification of the registered farms, farmers, packhouses, and traceable items. During farm geomapping, the risk of geographic overlap can be prevented by showcasing existing and current farm locations onto a Geographic Information System (GIS) interface. Much like one can see a location in the Google Earth software overlaid with an aerial image, such farm locations can be visualized in their superimposed layer.

Automated checks will highlight any overlaps to be addressed. Note that in cases of crop rotation (such as for pineapple), farms (or at least the crop grown on them) will need to be updated almost every two years. The choice between single point and polygons can be made as a function of a risk assessment toward the ethical principle of concern. For simple farm identification, a simple point will suffice (almost all horticultural farms) however for assurance towards zero deforestation or buffer zones from water bodies the much more intense polygon mapping is recommended (for example with cashew cultivated along protected areas).

During registration of individual food actors (farmers, traders, etc.), there is even more need to avoid duplication. It is recommended to register in alignment with the National Identity Number (NIN) as issued by National Identity Authority (NIA). In case a farmer is already registered with a certain company, registration by another company can still be accepted, as long as all relevant data can be retrieved and aggregated for the same individual. This measure is key to preventing dilution of certified volumes with conventional ones.

For international companies with local subsidiaries, it is recommended to adhere to the GS1 traceability standard through the use of Global Location Numbers (GLN), which enable more standardization globally. However, more realistic for local companies is the use of the GLOBALG.A.P. Number (GGN) received when applying for GLOBALG.A.P. certification, which is recognized by GS1 and sometimes available on the packaging label. In case the company is not certified as such, we recommend use of the digital address of the company in Ghana (more than the tax identification number, which has overlap issues).

The same applies to the traceable items which are being tracked. The QR code issued through the system and attached by the exporter onto the palettes for the given consignment would allow further interoperability by including both the GTIN (if available) of the product as well as the Standard Shipping Case Code (SSCC). However, since not all exporters make use of GS1, this should remain an optional data field.

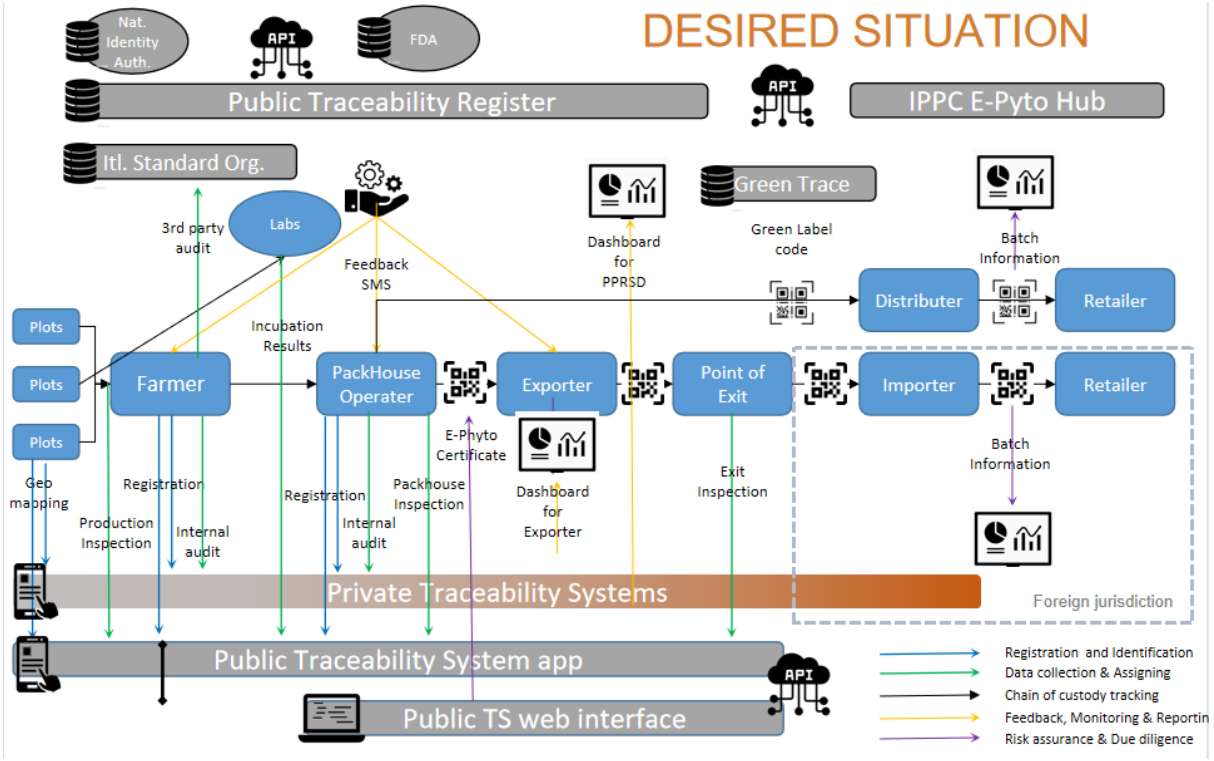


Figure 9: Recommended Schematic of the Public Traceability System

4.6. Recommendations on the Implementation Pathway

Realization of the desired situation should follow an intensive stakeholder process. GTI can facilitate this process, to engage all participants and maintain focus on the ultimate objectives.

A modular design approach is recommended to develop the digital traceability system further. Such a modular approach components of the digital solution are split into a set of loosely coupled functional units (named modules) that can be integrated into a larger application. It allows the development work to be split into smaller well-defined tasks that will fit and operate within a larger structure. Each module is improved iteratively along a build-measure-learn "loop." For each iteration, a small change is made to the technology, after which we test how these changes will affect the key metrics.

The below overview can act as a minimal checklist along the implementation pathway. It mentions aspects which need to be assessed or planned for within the implementation schedule; however, this checklist is not supposed to be used as a comprehensive and complete manual.

Table 4: Steps & Actions to be followed along the implementation pathway

Implementation Steps	**Tasks**
Consultation of Stakeholders	✓Create awareness about objectives and ambition ✓Understand expectations toward public traceability system ✓Understand expectations toward secondary-use cases ✓Identify Data points of interest and willingness to share ✓Understand doubts & fears
Conceptualise the solution	✓Prioritise requirements for the solution

Implementation Steps	Tasks
	✓Identify modules ✓Plan timeline and iterations ✓Assess budget ✓Define metrics of success
Mapping of the current information management system	✓Document the traceability information flow by actors ✓Identify most critical data elements and bottlenecks
Consultation of Stakeholders	✓Present design approach, prioritized modules, and timeline ✓Present selected features in each module ✓Explain implications for users ✓Manage expectations ✓Understand preference on data input and data access/reporting channels ✓List key interoperability connections
Drafting the interface	✓Sketch story boards for interfaces ✓Simulate digitized data flow in a Business Process Diagram
Organise user access	✓Identify user categories ✓Identify legitimate use rules ✓Allocate data access rights per category
Organise data protection	✓Create awareness about data protection policies in relevant jurisdictions ✓Identify data to be made available per user category ✓Explore needs for censorship/ anonymizing/ granularity in relation to storage, access and reporting
Consultation of Stakeholders	✓Present progress ✓Collect feedback and manage expectations ✓Finalize the Business Process Diagram defining the functionalities, data points, roles, and services
Develop Request for Proposals to IT provider	Define a Software Requirements Specifications Document ✓List supported features, differentiated by primary and secondary ones ✓Share the drafted information (story boards and the data flow)
Selection of quotes	Assess cost implications of traceability: ✓Data collection tools ✓Server / Hosting fees ✓Management time ✓Stakeholder consultations ✓Staff trainings / Partner trainings ✓Differentiate fixed start-up costs vs recurring operational costs
Contracting of the IT provider	Identify aspects to include in the contract: ✓ Level of required customization ✓ Staff availability ✓ Timeline of testing, review, and improvements ✓ Development / customization support ✓Define preferred software and hardware interface and implications
Starting with the highest prioritized module:	
Define the structure	✓Design Entity Relationship Diagram (ERD) per module ✓Design wireframes per module ✓Make critical design decisions

Implementation Steps	**Tasks**
Plan pilot	Select piloting organizations. Avoid disruptions by: ✓ Ensure Proof of Concept on a paper trail ✓ Pilot first the minimum viable products without secondary features ✓ Run pilot version in parallel with the existing data flow ✓ Communicate to the stakeholders involved
Documentation	✓Document the technical design ✓Write the training manuals and tools
Support	✓Train support staff ✓Setup the support service
Implement with larger number of stakeholders	✓Train actor staff ✓Listen to feedback and incorporate ✓Address technical issues ✓Pilot updated version
The cycle repeats itself with a next module	
Measure success	Monitor performance metrics Continuously listen to actors for improvements

5. ANNEXES

5.1. Data to be recorded under GS1 standard

Grower/Producer Data to Record

- **Logistics unit ID (SSCC)**
- **Additional grower information (e.g. batch/lot)**
- **Commodity/variety (GTIN)**
- Receiver ID (GLN)
- **Ship date**
- **Ship from location (GLN)**
- Ship to location (GLN)
- Details of production inputs (e.g. Seed, fertilizer, crop protection)
- **Sender ID**

Grower/Packer Data to Record

- **Logistics unit ID (SSCC)**
- Additional grower information (e.g. batch/lot)*
- Commodity/variety (GTIN)*
- Ship to location (GLN)
- Details of production inputs (e.g., Seed, fertilizer, crop protection)
- **Output batch/lot number**
- **Output trade item identification** (GTIN)
- **Trade item description**
- **Trade item quantity and unit of measure**
- **Sender identification (packer/repacker identification) (GLN)**
- **Ship from location (GLN)**
- **Shipment identification**
- **Ship date**

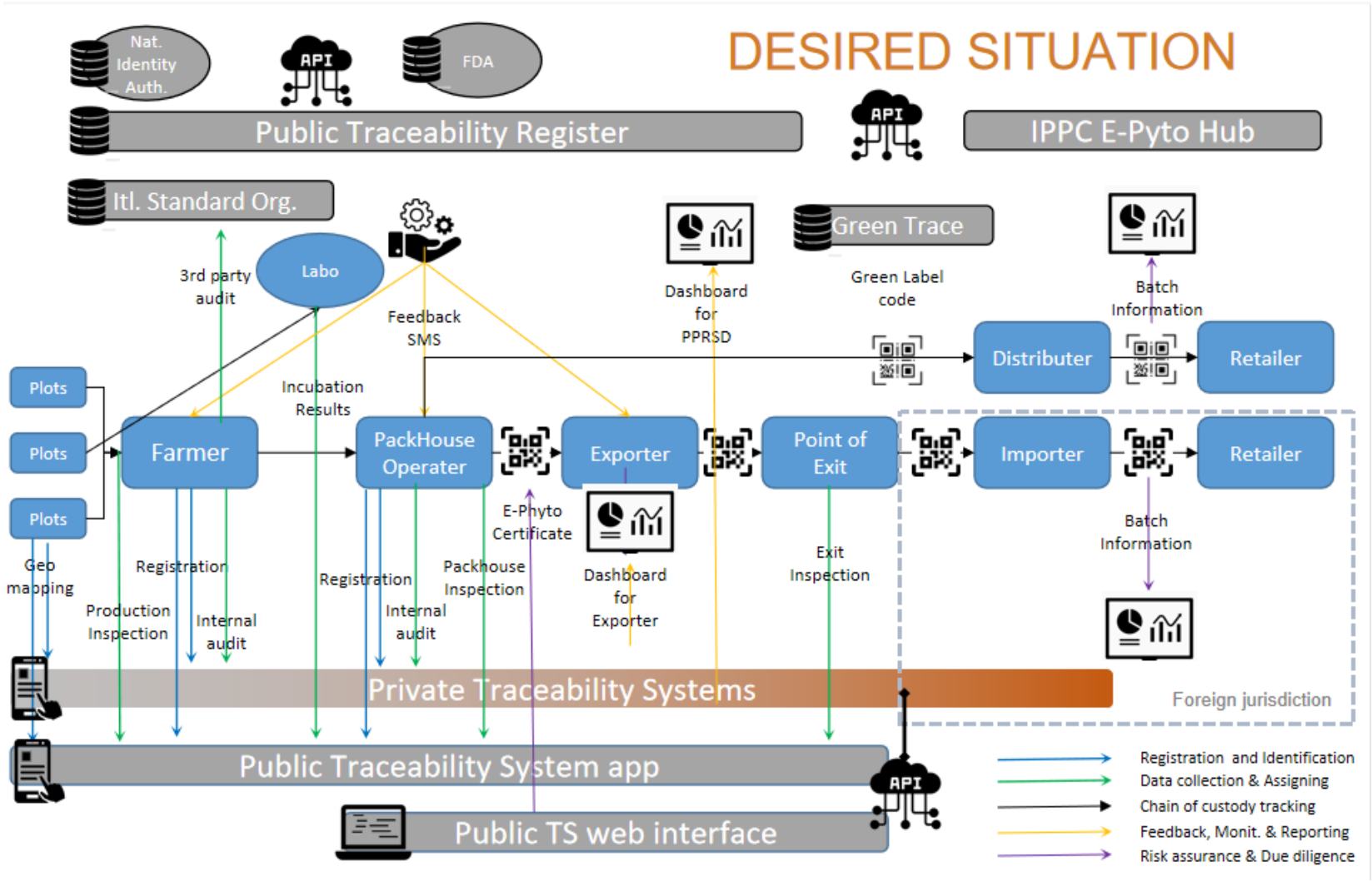
Note: Information in **bold** is typically recorded and also passed on to the next chain actor under the GS1 standard.

5.2. Summarized Assessment for Four Traceability Solutions

	PPRSD	Green Trace	CropIn	CareTrace
Identification and Registration				
Registration of actors	Yes	Yes	Yes	Yes
Geomapping of plots	Single Point	No	Single & Polygon	No
Prevention of duplicate registrations	List submitted by exporter	None	Automated content detection from identity card	None
Data collection and assigning to batch				
Data collection	Related to inspection points	Related to product name/weight/numbers only	Various checkpoints can be defined	
Data entry method	Manual	Manual	Manual and automated	Manual
Documentation by photos & timestamps	Partially	No	Fully	No
Decision making support for certification	Partially	No	Fully	No
Chain of Custody				
Products supported	Fresh F&V	Fresh F&V	Various	Processed F&V
Segment of chain covered	Farm to PoE	Packhouse to consumer	Farm to consumer	Farm to consumer
Distance travelled by data	Many steps back, one step forward	Two steps back only	Many steps back, many steps forward	Many steps back only

	Aggregation & Disaggregation	Partially - to level of box (producer)	No - individual products	Fully flexible	Partially - to level of individual product
	CoC models supported	Identity Preserved	Identity Preserved	All 4 models	Identity Preserved
Feedback loops, Monitoring and reporting					
	Impact monitoring	Partially	No	Various variables at level of producer, farm, batch and region	No
	Feedback loops	No	No	by SMS, voice, email, app	No
Risk assurance and due diligence					
	Peer verification	No	No	by actors through app	No
	Claims	Toward regulatory requirements	Toward Green Label standard	Flexible toward specific themes	Only toward origin
Technical					
	Interoperability	API (REST protocol)	No	API	
	Data storage	Centralised	Centralised	Centralized	
	Export / Import of datasets	loading of spreadsheets by IT team		Export / import of spreadsheets by users	
	GS1 standardization	No	No		
	operational without internet connectivity	Partially through app	No	Partially through app	

5.3. Interoperable Traceability Ecosystem



5.4. Work Program in Ghana and Informants Interviewed

Updated 14th June 2022

Date/Time	Person to Meet	Venue
Monday-6 June 2022		
9:00am	Mission Briefing with GTI/IESC Team	USAID-METSS, #10 Wuogon Cl, Accra, Opp Soul Clinic School
11:00am	Ghana Export Promotion Authority Fred Asante-Omane Principal Export Development Officer 0244268010	Export Trade House Liberia Road, Opposite Cedi House, Accra
1:00pm	Plant Protection and Regulatory Services Directorate Prudence Attipoe-Director Quarantine-0209793292	Pokuase Mayera Road
3:00pm	Shrighan Farms-Pon (MD) 0246 881 154	Medie
Tuesday-7 June 2022		
9:00am	Vegetable Exporters Association of Ghana Felix Mawuli Kamassah-President, 024 419 6228	Agric Mechanization, Burma Camp Accra
10:30am	Sea Freight Pineapple Exporters Ghana Stephen Mintah-0244237807 (President)Bernard-024068501	Ampomah House, Olusegun Obasanjo Highway, Accra,
12:00pm	Federation of Association of Ghana Exporters Ms. Marjorie Abdin, President 0244379173	Ghana Highway Authority Building
Wednesday-8 June 2022		
11:00am	Joekopan-Bernard Opuni-0506735914	Dome-Opp. Sun International School or Tantra, home of the founder-Mother to Bernard
2:00pm	Attakrom Top Fruits and Vegetables Producers Association 0244658155-Mr. Billy	Attakrom, Nsawam
Thursday-9 June 2022		
9:00am	Control Union Barbara Mills +233 20300 3338	Number 10, Noi Fetreke Street, Airport Residential Area Accra
12:00pm	Bomart Farms-Richard-0208956513	DOBRO-(OFF. NSUMIA ROAD) NSAWAM Ghana,
2:00pm	HPW Fresh and Dry James Donkor- Office: +233 50 141 99 91 Mobile: +233 276 25 17 33	Mango, pineapple Adeiso
Friday-10 June 2022		

10:00	Qualipine Farmers Union, Chairman, Edward Ntow - 0243555215	Nsawam
3:00pm	Akorley Packhouse (Cotton Weblink) Davis Korboe 0244942494	Mango Somanya, Eastern Region
Monday 13 June 2022		
9:00am	Victor Avah-0244507530 GAPS CONSULTING LIMITED	METSS Office
11:00am	SGS-Certification Body Atta Adu-Gyamfi-0244617086	SGS Ghana Limited, Former SCOA Yard Main Harbour Road
2:00	Ghana Green Label Certification Anthony Tamakloe, the Executive Secretary 055 843 9499, 050 962 4909	Horticultural Development Unit, Crop Service Directorate, Ministry of Food and Agriculture. Beach Drive Osu
Tuesday 14 June 2022		
11:00am	Hendy Farms, Sandra Snowden 050 055 4130	METSS Office
3:00pm	Blue Skies-Alistair Djimatey -0244793279	Nsawam
Wednesday 15 June 2022		
10:00am	3f Ghana Ltd / Sel Logistics Selassie Faith Dunyo-0246780514 sellassie@sellogisticsservices.com	Tema
1:00pm	Savannah Fruits Alhassan Abu Safian. Certification Manager	F276/5A Fourth Dade Walk Labone, Accra
3:00pm	PBC Shea Limited Alex Walker, 0544100180	Shea nuts Buipe, Northern Region
Thursday 16 June 2022		
10h	Nana, Silence Star	Accra
3:00pm	Team Debrief	METSS Office
10h	Arthur Hanson	PhD student , prev. HortiFresh
Thursday 16 June 2022		
12h	Walter Hevi	CABI office

5.5. Additional interviews (online) after the field visits

Name	Role / Position	Email
Francois Maes	Special Fruit Belgium	francois.maes@danara.be
Sjaak de Bloois	Horti specialist Uganda	sbl@sucafina.com
Jan Willem van Es	Amelia agro farm Jinja	
Ard	chilli, thee, Agricado	Ard@yugung-holding.com
Andre Flohil	Africa groententeelt Go &Grow	
Joop Vegter	Free-lance horticulture consultant in Colombo	jogeve610@gmail.com
Marian Renkens	Project Manager implementing COLEACP	marian.renkens@coleacp.org
Walter Hevi	CABI	W.Hevi@cabi.org
Hanson Arthur	PhD student horticulture - prev HortiFresh	h.arthur@adfa.edu.au
Nursel Gumusboga	COLEACP	nursel.gumusboga@coleacp.org
Maria Oliveira	Manager Sustainability Van Oers	moliveira@vanoersunited.com
Virginie Spits	European Commission Directorate General for Health and Food Safety	Sps@ec.europa.eu
Astrid Baeten	SIFAV IDH	baeten@idhtrade.org

REFERENCES

Agbezuge, Sylvester, Ensuring Food Hygiene and Safety in Ghana: a Legal Perspective, pages 67-71 *International Journal of Humanities and Social Science* Vol. 8 , No. 6, June 2018, https://ijhssnet.com/journals/Vol_8_No_6_Jne_2018/8.pdf

Article 81, Public Health Act 851, https://www.moh.gov.gh/wp-content/uploads/2016/02/Public-Heath-Act-851.pdf

Ayeduvor, Obeng, and Adomanko (2020). *Understanding SPS Requirements for Ghana's Exports to the EU: Focus on Cocoa, Cashew and Tuna products*. Geneva: CUTS International, Geneva

C-lever.org, *Evaluation of Digital Traceability Systems in Agricultural Supply Chains*, to be published by GIZ in 2022

COLEACP e-data available on https://www.coleacp.org/e-data/, consulted 7/7/22

COLEACP Guidelines on the export of fresh mango, 2022

COLEACP, e-data available on https://www.coleacp.org/e-data/, consulted 4/7/22

Council Decision of 19 July 2004 approving the accession of the European Community to the International Plant Protection Convention, as revised and approved by Resolution 12/97 of the 29th Session of the FAO Conference in November 1997 (2004/597/EC) CropIn website, url: https://ww.cropin.com/, accessed 15/7/22

EU, Directorate-General For Health And Food Safety, *Final Report of an Audit Carried out in Ghana from 12 September 2017 to 21 September 2017 in order to Evaluate the System of Official Controls*, Dg(Sante) 017-626

Factsheet on Just and sustainable economy, https://ec.europa.eu/commission/resscorner/detail/en/fs_22_114

GEPA, REPORT ON ANALYSIS OF NON-TRADITIONAL, 2020

Ghana Adopts Food Safety Policy, https://www.afro.who.int/news/Ghana-adopts-fod-safety-policy

Ghana Green Label, https://www.Ghanagreenlael.org/about/history/

Ghana National AGOA Strategy, 2016, page 1, https://agoa.info/images/documents/15271/Ghanaagoastrateg.pdf

Ghana Standards Authority, GS 1054:2019, Good Agricultural Practices Ghana Green Label Scheme - Requirements for Fresh Fruits and Vegetables Conforming to Green Label

Ghana Standards Authority, GS 1034: 012 and GS 1091:2014

Ghana Standards Authority GS 1037:2013

Ghana Standards Authority GS 5462017

https://ec.europa.eu/food/horizontal-topics/general-foodlaw_en, accessed 6/7/22

https://freedomradiogh.com/over-900-farmers-4-packhouses-sbscribe-to-green-label/

https://www.fasfc.be/plantslegislation, accessed 5/7/22

International Plant Protection Convention (1997) Produced by the Secretariat of the International Plant Protection Convention

International Trade Centre, Trade Map, https://www.trademap.org/, accessed 4/7/22

IPPC Secretariat, IPPC Guide to Implementing he Generic ePhyto National System, 2018

Phytosantary Measures By The National Plant Protection Organization Of Ghana To Address Important Amendment To EU Plant Health Regulations implementing Directive 2019/523 affecting production And Export Of Mangoes – To Ensure Produce Is Free From Tephritidae (NonEuropean),

Phytosantary Measures by Ghana's NPPO To Address Important Amendment To EU Plant Health Regulations Implementing Directive 2019/523 Affecting Export Of Chilies And Peppers (Capsicum) – To Ensure Produce Is Free From The False Codling Moth, 2019

PPRSD, PowerPoint Presentation on traceability, received June 2022

SIFAV, https://www.idhsustainabletrade.com/news/sifav-updates-its-basketsof-social-standards/, accessed 7/4/22

UN Comtrade Database, https://comtrade.un.org/dta/

USAID, The Enabling Environment For Food Traceability System Success, 2021