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SUPPLY CHAIN TRACEABILITY IN AGROCHEMICALS

September 2019

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SUPPLY CHAIN TRACEABILITY IN AGROCHEMICALS

FOREWORD

Dear Reader,

Consumers in many parts of the world now want verifiable evidence of provenance as a key marker of product quality and safety. This trend has been propelled by several factors, including the high incidence of food-borne health threats, the growing global trade of counterfeit and illegal pesticides, and an increase in global demand for food from a variety of sources.

Therefore, with the need to meet consumer demand for a consistent supply – and to reestablish public confidence in the agrochemical supply chain – the design and implementation of complete transparency and traceability, from crop protection producer to farmer, has never been more important.

If we are to develop and implement the right technological measures to meet consumer demand for traceability and visibility across the value chain, many supply chain actors need to understand the concepts and implications of supply chain traceability. This includes (but is not limited to) farmers, post-harvest processers, marketers, research practitioners and policy makers.

With this in mind, CropLife International recommends the worldwide adoption of a harmonized traceability solution. This needs to be a key objective for all trading partners, if they are to effectively meet their companies' needs and exceed customer expectations. This report was commissioned to provide a recommendation for supply chain traceability in agrochemicals, and to encourage further discussion with regulators, member organizations and interested parties along the supply chain.

Howard Minigh

President & CEO

CropLife International

EXECUTIVE SUMMARY

The agrochemical industry is heavily impacted by counterfeiting, and the market share of illegal agrochemical products sold in the world has risen the last few years. As a consequence, there is ever-increasing pressure for improved transparency and traceability of products across the entire supply chain. These increasing regulatory requirements stem partially from expectations created in other industries (e.g., food, pharma, tobacco), where traceability efforts are already quite advanced. Experience has made it clear that in the agrochemical industry, there is an increased need for sharing data across supply chain actors in a machine-readable format in order to get the greatest benefit from supply chain traceability. New developments such as advancements in sensors (e.g., 2D data matrix, RFID)[1] and traceability standards (e.g., GS1, EPCIS)[2] have brought additional value, and future developments are expected to take advantage of additional advanced technologies, such as sensors and the Internet of Things (IoT). As electronic data exchange between trading partners gains more importance, ever faster and more reliable automatic data recording and sharing between actors in the supply chain is needed. Consequently, the use of a harmonized, end-to-end supply chain traceability solution – encompassing everything from formulated product to the field – is vital to facilitating data acquisition and exchange between actors across the supply chain.

[1] RFID = radio-frequency identification

[2] GS1 = Global Standard 1; GS1 is a not-for-profit organization that develops and maintains global standards for business communication; EPCIS = Electronic Product Code Information, EPCIS is a global GS1 Standard for creating and sharing visibility event data, both within and across enterprises.

INTRODUCTION

DEVELOPMENTS IN AGROCHEMICAL SUPPLY CHAIN TRACEABILITY

Many sectors have been discussing the term "traceability" in recent years, including the agrochemical industry. This is because companies today typically need to know more about the products that they buy and sell in order to navigate the various complex challenges facing global supply chains. These challenges include the need to source products that are safe, sustainable and ethical. Moreover, some companies are recognizing the benefits of traceability for achieving better performance in product distribution and visibility. However, this comes with an inherent challenge: Companies must first overcome the mistrust associated with validating claims of product identity and traceability. As a growing number of successful pilot schemes have shown, traceability can improve the management of supply chain transactions by delivering greater visibility, and enhance the reliability of transaction information for the participating parties.

To succeed in the digital economy, many companies are realizing that they must manage the integration of business, technology, people and processes, not only within the enterprise, but also across the value chain. As a result, companies are increasingly looking to adopt Supply Chain Management systems that enable inter-enterprise cooperation and collaboration with their suppliers, customers and business partners.

Against this backdrop, Accenture Strategy and CropLife International collaborated to conduct a survey of crop-protection supply chain leaders to better understand the current and projected impact of traceability on the supply chain function.[3]

FIGURE 1: RELEVANCE OF VARIOUS VALUE OPPORTUNITY AREAS ON SUPPLY CHAIN TRACEABILITY

There are still many companies that operate with their data trapped in disconnected legacy systems, and that struggle to connect to newer, more advanced systems. Adopting a harmonized solution for supply chain traceability is imperative, yet few businesses are currently doing so. Nevertheless, traceability solutions are attracting significant interest among companies in the agrochemical

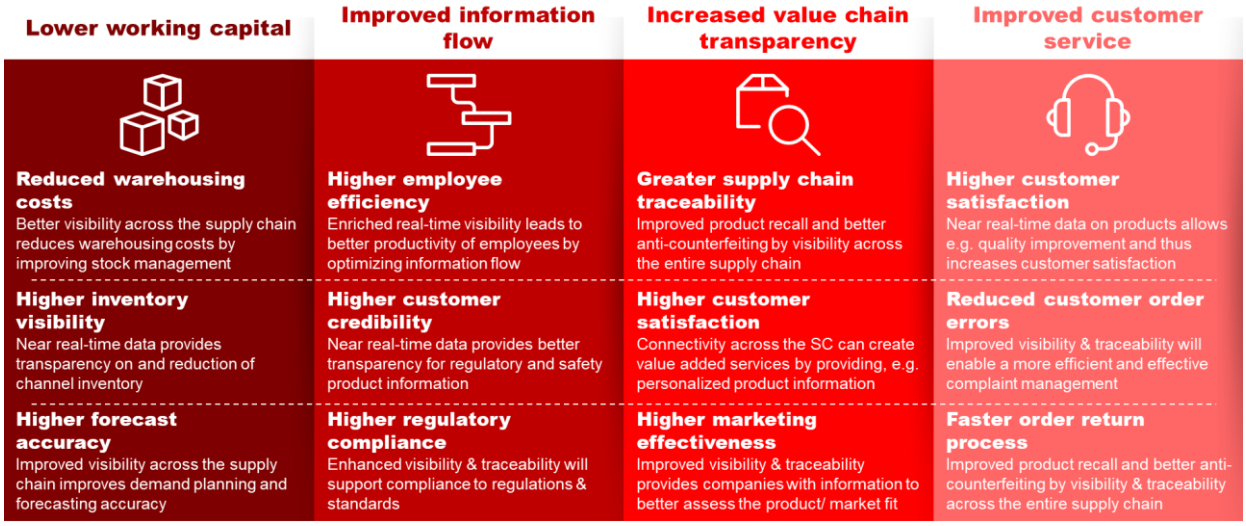
[3] See appendix for additional details concerning this study.

industry, because they offer many benefits that are valuable to diverse participants across the supply chain.

BENEFITS OF AGROCHEMICAL SUPPLY CHAIN TRACEABILITY

As a result of experimenting with traceability solutions, many industries, organizations and companies are starting to discover the collaborative potential for enhancing the workflows in their supply chains. Increased transparency of products, transactional efficiency, reduced costs and fewer staff redundancies are just some of the benefits that could be unlocked through full traceability of the supply chain. These benefits could come from both existing and new ways of operating.

FIGURE 2: THE MOST IMPORTANT VALUE DRIVERS FOR VARIOUS EXPECTED BENEFITS OF TRACEABILITY



Working capital management

In an age of predominantly paper-based records and manual processes, tracing products – particularly during a recall – and reconciling accounts and transactions can be both costly and time-consuming.

On the other hand, when supply chain traceability is fully digitized, key information is stored and made available to the users that need it, with near real-time visibility. Multiple entities can then access and view the information they need from one unified portal, rather than having to communicate individually with various suppliers or purchasers. This leads to more efficient stock management at the distributor level as well as across the whole supply chain, and is likely to lead to cost savings.[4]

Information flow

Sharing information across the supply chain can be highly difficult due to a lack of consistent data and digital capabilities. Connectivity can help to promote transparency and streamline the process of sharing information. This transparency also improves accountability and enhances trust between

[4] Track & Trace Newsletter Nr. 2. Agro CloSer, September 2018.

all participants in the supply chain, because they can each upload their own information and data about their products.

Furthermore, near real-time updates about the product can also be shared, depending on the governance and policies of the network. Trading partners can see where a given product is, who made it, when it was made, and the expected delivery time and date, in near real-time.[5]

Value chain transparency

To date, we have only seen limited adoption of traceability software across the agrochemical industry. However, companies are increasingly investing in traceability technologies to increase visibility into where products are located and where they came from within the supply chain. In the event of a recall, for example, automated food safety software can help support compliance requirements, allowing companies to more quickly access data and detect a problem, based on lot codes, production and expiry dates, and product order numbers.

Customer service

With access to the same set of data, multiple stakeholders in the supply chain can enjoy greater transparency. For the producer, this can mean having more information about the product itself (e.g. how to use it, when to use it, safety information, advice for treatment, dose etc.). Distributors can better manage their delivery times by viewing items currently in the production process, which in turn improves communication and customer satisfaction. Retailers can provide consumers with access to additional product information such as origin, producer and quality, which in turn can build end-customer loyalty, and contribute to a stronger business relationship. All this data could be accessible, for example, via a mobile application that allows a consumer to easily scan a product.

CURRENT STATE OF AGROCHEMICAL TRACEABILITY

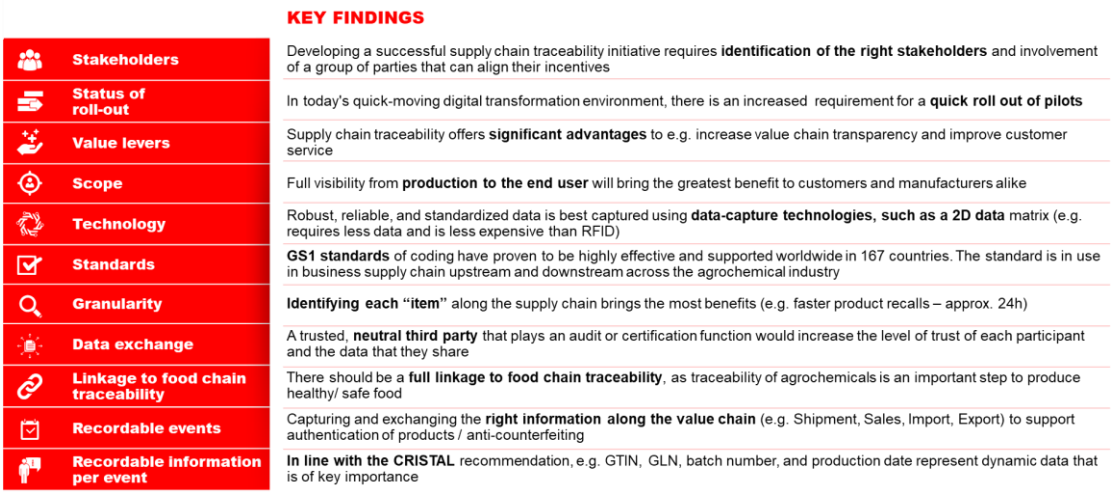
LESSONS LEARNED FROM SELECTED NATIONAL SUPPLY CHAIN TRACEABILITY PILOTS

This study assesses the feasibility of a harmonized approach to enable end-to-end supply chain traceability in the agrochemical industry. An analysis was performed to leverage experience from the Dutch track-and-trace pilot, the French Electronic Data Interchange (EDI) supply chain approach, the North American AgGateway platform, the Argentinian government traceability database, and a pilot conducted by the Turkish Ministry of Agriculture. These efforts were selected because of their advanced rollout status.

Accenture investigated these five initiatives, and the key findings informed our recommendations on how a harmonized supply chain traceability approach can be deployed across the agrochemical industry.

[5] Food Engineering, “Automating food safety management systems can save money, improve quality“, September 14, 2016. Retrieved 16.05.2018 from https://www.foodengineeringmag.com/articles/96123-automating-food-safety-management-systems-can-save-money-improve-quality.

FIGURE 3: KEY LEARNINGS FROM VARIOUS SUPPLY CHAIN TRACEABILITY PILOTS[6]



It is clear that track-and-trace solutions have the potential to protect supply chains in numerous industries, and they have been employed by manufacturers and governments for diverse purposes. Experience from various countries demonstrates that the successful deployment of track-and-trace systems relies on several key factors, which include:

Identification of the right group of parties that can align their incentives

In order to build the right traceability solution, various supply chain actors should be involved. In one pilot scheme in the Netherlands, the consortium parties included global agrochemical companies, distributors, warehouses, a dataset holder, and the administrator of the Electronic Data Interchange (EDI) platform. Once these supply chain actors were connected via the EDI platform, they could all send and receive orders, deliveries and invoices. In addition, the pilot enabled tracking and tracing of agrochemicals on a batch level from filling line up to the farmer, enabling product recall within 24 hours. Traceability technology enhanced clarity of ownership and accountability, as well as visibility within the supply chain, and helped streamline invoicing processes. It is clear from this pilot scheme that without the commitment and involvement of all parties, the benefits of data sharing would not have been realized.

Sharing consistent standardized product data across all actors

Digitally tracing an agrochemical requires consistent data about the identity of the product as it passes through the supply chain. While there is currently no unified "standard" for identity in this context, many organizations have defined identity data attributes in a similar way. For example, the Turkish Ministry of Agriculture defines its key data dimensions as shipment (e.g., order, dispatch, invoice), sales, import and export. In the Netherlands pilot scheme, product information (e.g., GLN[7], GTIN[8], batch number, production date) and volume (e.g., Serial Shipping Container Code) were defined as key recordable events.

Consider user experience across the supply chain

[6] See appendix for additional details concerning the different traceability pilots.
[7] GLN = Global Location Number
[8] GTIN = GS1 Global Trade Item Number.

To facilitate seamless integration of a traceability solution into the agrochemical supply chain, ease of use for all participants is essential. To achieve compliance, the farmer, warehouse manager and all other actors in the product ecosystem should be able to access the same database and warehouse management system using, for example, a mobile app. The same should be true for a consumer leveraging that data.

Standardized product data is best captured using digital solutions

When it comes to capturing standardized product data, information captured by a human can be subjective, unreliable and susceptible to fraud. Therefore, agrochemical supply chain traceability solutions should rely on technology to digitally capture the identity of elements, such as the crop protection agent being used, and monitor changes to the product in real time. For example, the use of sensors can enable the automated capture of consistent, reliable data as a product moves through the supply chain.

In many of the case studies reviewed, a smart tagging mechanism was used to identify either an individual product or box of products through the supply chain. For example, in the Netherlands pilot, a scan of a 2D data matrix was used so that data on the product could immediately be recorded at a given location and time, enabling a product recall within 24 hours.[3]

Sensitive data of key actors should always be protected in the ecosystem

Protection of sensitive data (e.g. customer information, prices) is paramount for a traceability solution: Transactions can include sensitive data about supply chain actors, customers or their products, which must be protected. A rogue or malicious actor with access to this information could adversely impact consumers and capital markets. Therefore, supply chain actors who plan to set up such a solution should only share the data that is required for the process to work. When it comes to data that does not need to be shared with all parties, sensitive information can (and should) be protected with permissions and layers of data.

A trusted third-party validator or registrar is required

Experience with traceability solutions in other industries shows that a validator should be appointed to provide credentials to the supply chain actors who are inputting data, and to ensure the validity of data inputted into the cloud platform. For example, during the Netherlands pilot scheme, the dataset was managed by AgroConnect and GS1 standards body, who validated data compliance based on an external standard at the point of capture.

CURRENT SUPPLY CHAIN STANDARDS

Safeguards for food safety, product tracking and product recalls are becoming stricter in markets across the world. As government regulations tighten, companies are concerned that the supply chain requires more oversight and visibility – yet it is not always easy to reconcile the different track-and-trace requirements that companies face. Various traceability solutions exist for national, regional and global supply chain participants, making it hard to future-proof any choice of technology without international standards and the interoperability they facilitate.

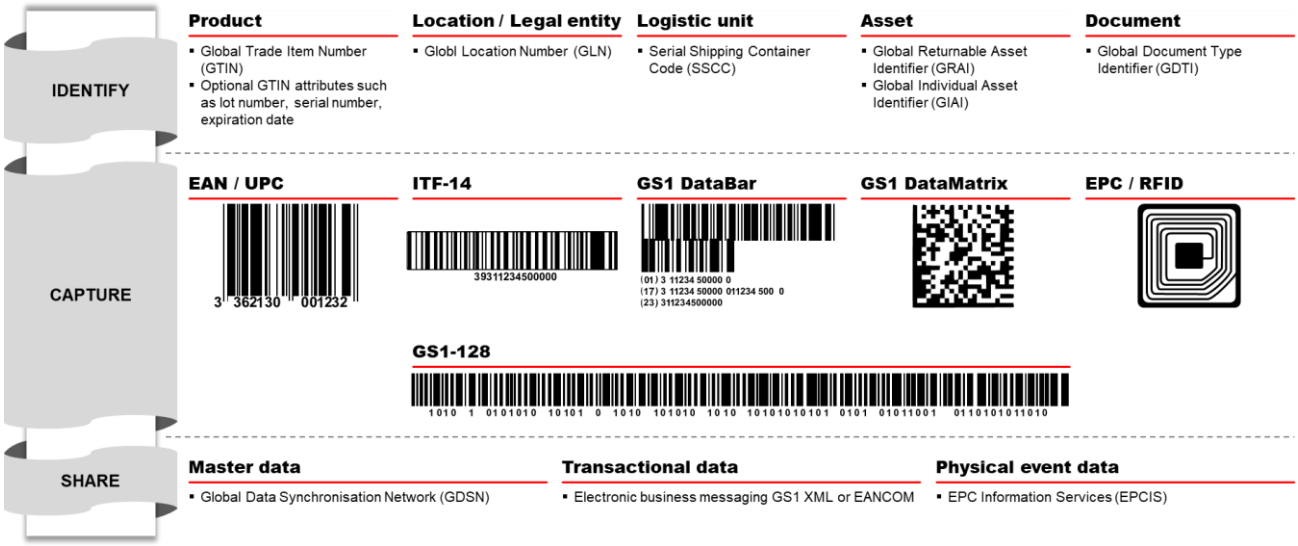
Fortunately, progress is being made in this department by standards bodies like GS1. The GS1 system is an integrated system of global standards that provides accurate identification and communication of information regarding products, assets, services and locations. Of course, there

are other standards in the market, but these are provided mainly by smaller players. Consequently a significant effort is needed to increase their applicability. On the other hand, the “flagship” GS1 is currently the most implemented supply chain standards system in the world.

GS1 Traceability Standard

GS1 devised the GS1 Traceability Standard[9] more than a decade ago to define the minimum traceability requirements needed within business processes to achieve full supply chain traceability. Best described as a meta-standard comprised of other GS1 standards like the barcode, it is used to identify, capture and share essential information about products, locations, assets and more. Version 2.0 was ratified in August 2017 and introduces a layered approach to traceability in order to address the needs of more dynamic supply chains and make better use of current information technologies.

FIGURE 4: GS1 STANDARDS IDENTIFY, CAPTURE AND SHARE RELEVANT INFORMATION



Identify

At the first stage, identification, GS1 standards define unique identification codes, or ‘keys’, that are used by an information system to correspond to a wide variety of items within the supply chain, from physical products such as tins of soup through locations such as factories and warehouses and documents such as shipment forms.

Capture

GS1 identification keys can be fixed directly onto a physical object within the supply chain through the use of well-established technologies like barcodes and radio-frequency identification (RFID) data carriers. This data is accessible by all readers and other hardware that is compliant with GS1 data-capture standards.

Share

Once the data has been captured, it must be shared between applications and trading partners. This requires GS1 norms, including data standards for master data, business transaction data and

[9] GS1, “How GS1 standards work”. Retrieved 16.05.2018 from https://www.gs1.org/standards/how-gs1-standards-work.

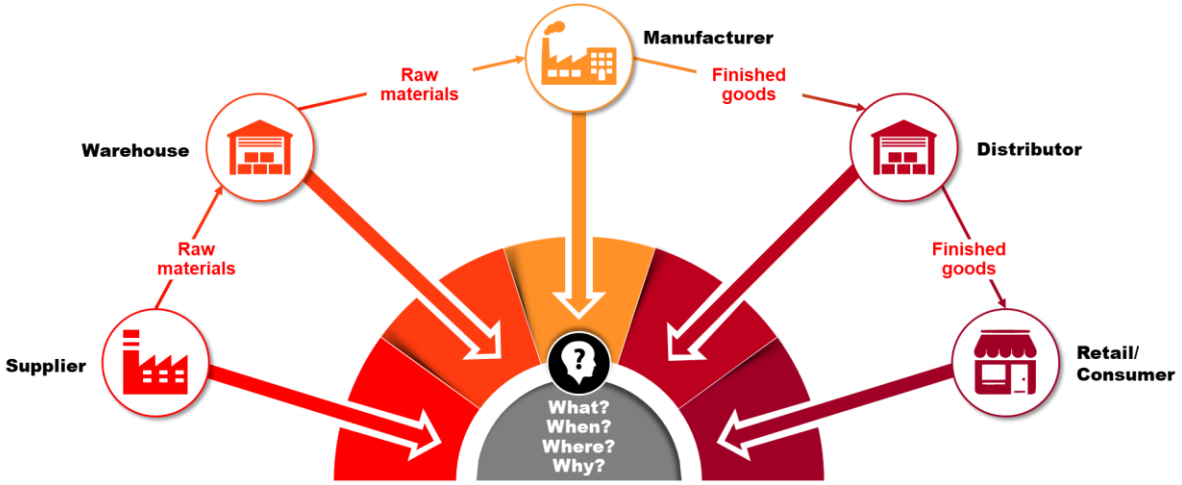
physical event data, as well as communication standards. Discovery standards are also required to help locate where relevant data resides across a supply chain, along with trust standards that ensure data can be shared with adequate security.

The often-complex logistics flows and the variety of participating parties imply that there is also a need for easy physical identification of logistic units. GS1 offers a standard to help accomplish this – the GS1 Logistic Label. This is based on GS1 standards and on best practices gathered in various implementation projects around the world, and it provides guidance on how to physically identify logistic units using the GS1 Logistic Label.

Electronic Product Code Information Services (EPCIS)

A key element of the GS1 Traceability Standard is EPCIS[10], or Electronic Product Code Information Services. This is an open, global GS1 standard for capturing and sharing supply chain information about the movement and status of products, logistics units and other assets. It forms an important part of the GS1 Traceability Standard.

FIGURE 5: EPCIS ENABLES END-TO-END TRACEABILITY OF PRODUCTS ALONG THE SUPPLY CHAIN



The standard is designed to satisfy regulatory requirements for factors like chain of custody and chain of ownership, while also enhancing supply chain visibility to improve operational efficiency and supply chain security. It looks at movements, or "events", in four key dimensions: **what** products are impacted, **when** a time-stamped event occurred, **where** the product was when this event occurred (and where is it now), and the reason **why** this event was observed.

EPCIS is intended to be used in conjunction with the GS1 Core Business Vocabulary (CBV) standard. The CBV provides definitions of data values that may be used to populate the data structures defined in the EPCIS standard. The use of the standardized vocabulary provided by the CBV standard is critical to interoperability, and vital to the querying of data because it reduces variations in how different businesses express common intent.

GS1 Electronic Data Interchange (EDI)

[10] GS1, "EPCIS and Core Business Vocabulary (CBV)". Retrieved 16.05.2018 from https://www.gs1.org/standards/epcis.

GS1 Electronic Data Interchange (EDI) provides the global standards required to enable the automation of paperless business transactions across the supply chain, such as orders, shipping notices and invoices. It covers master data alignment, order and delivery, financial settlement management, and transport and warehouse management data.

LESSONS FROM OTHER INDUSTRIES

Supply chain leakage issues are by no means limited to the agrochemicals industry. Many other industries, from pharmaceuticals to timber, have suffered costly and damaging episodes, and implemented track and trace regimes in response.

Naturally, the circumstances are unique for each industry. However, there are common challenges posed by the implementation of track-and-trace technologies, and understanding these could help in the development of a best-practice approach to implementation that could prove useful for the agrochemicals industry.

To that end, a selection of relevant case studies from different industries is presented below, along with key implications for the agrochemicals industry.

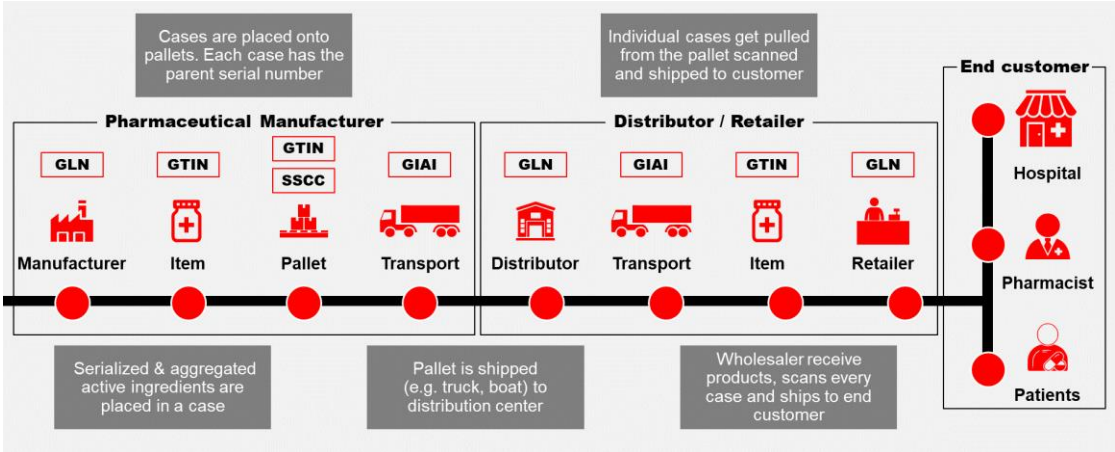
Pharmaceuticals – EU

The European pharmaceuticals industry has experienced serious problems with the production and trade of illegal products. To combat this issue and improve public health in Europe, regulators have adopted the 2013 European Falsified Medicines Directive (FMD), which became EU-wide law in February 2019.[11] This introduced unified safety and control measures for the whole of Europe, including stricter record keeping for distributors, an EU-wide quality mark, and obligatory safety features such as tamper-evident devices.

The FMD also requires medicines to carry a unique identifier in the form of a barcode that contains key data such as product code, expiration date, serial number and batch number. Manufacturers are required to contribute financially to an IT-based verification system at the point of delivery. Once a product is dispensed, it must be scanned and the barcode decommissioned, so that it cannot be reused on a falsified medicine.

[11] European Commission, “EU Falsified Medicines - Directive 2011/62/EU”, Retrieved 16.05.2018 from http://ec.europa.eu/health/human-use/falsified_medicines/index_en.htm.

FIGURE 6: PROCESS MAP FOR THE PHARMACEUTICAL SUPPLY CHAIN



This directive was co-developed by the European Federation of Pharmaceutical Industries and Associations (EFPIA), working together with regulators. The European Medicines Verification Organization is tasked with ensuring compliance. Significantly, while EFPIA members initially responded to the legislation on their own, they soon realized that the support of other stakeholders such as pharmacists was vital to ensure the success of any solution.

Under the EFPIA approach, products are individually marked with a unique identifier, and a pharmacist is required to confirm that the identifier is valid before dispensing the product to the patient. This requires every pharmacy in the EU to be equipped with at least one barcode scanner, and to "decommission" medicines from the European Medicines Verification System (EMVS) database at the point of delivery.

This solution is based on a European central hub that is connected to a series of national or regional data sources, and all manufacturers are required to enter their information into the central hub. This data is then passed on to the relevant regional or national track-and-trace repositories, which serve as the verification platforms that check the validity of a product identifier at the point of delivery.

While the EFPIA approach is based on open standards, some countries had already developed their own national systems in advance of the EFPIA initiative. For example, Germany has created its own national system called SecurePharm, which went live in early 2019. Consequently, EFPIA is working with GS1 to extend the latter's standards to enable migration of this and other national systems. The ultimate aim is global traceability for pharmaceutical products that is fully based on open standards.

KEY FINDINGS

- **GS1 standards were used:** EFPIA uses an approach based on the open standards provided by GS1 to enable flexibility at the country level, while simultaneously ensuring interoperability at the European level
- **Industry association involvement is key:** The EFPIA took a leading role in the development and establishment of an open track and trace standard for the healthcare industry
- **Collaboration is essential:** A track and trace regime is a complex construct that requires buy-in and cooperation from many parties, from manufacturers and distributors to dispensers/retailers
- **Existing IT infrastructures can be used:** A track and trace regime is more effective if the system adopted integrates smoothly with existing business processes and IT infrastructure
- **National requirements may differ:** Track and trace systems must be flexible and adjustable to the requirements and needs of each country

Pharmaceuticals – US

Until recently, the US pharmaceuticals industry depended on a state-by-state approach to securing supply chains and controlling the spread of counterfeit medicines. However, this led to inconsistent approaches on the state level, limiting the frictionless sharing of information and the integration of systems between different states. In 2013, the US government enacted the Drug Quality and Security Act (DQSA), which sought to create a single federal approach to securing the US pharmaceutical supply chain, among other measures.[12]

This act gave the US Food and Drug Administration (FDA) one year to publish guidance for actors in the supply chain on the exchange of so-called "T3" transaction information (transaction information, transaction history and a transaction statement) for prescription medicines. These guidelines were developed with input from a wide variety of stakeholders in the supply chain, including manufacturers, repackagers, wholesalers, distributors and dispensers. Since March 2016, all supply chain participants have had to provide T3 data to each subsequent owner of a pharmaceutical product. A fully interoperable, electronic system for the tracking and tracing of pharmaceutical products across the US supply chain is expected to be online by 2023.

KEY FINDINGS

- **A common, unified approach is required:** Using a state-by-state approach failed to create an effective track and trace regime for the US pharmaceuticals industry
- **Stakeholders must collaborate:** from manufacturers to wholesalers, distributors and dispensers, cooperation across the supply chain is required
- **Implementation involves significant investment:** The delivery of new equipment, training and other support will be needed

Tobacco – European Union Directive

The EU is by no means immune to the parallel trade in tobacco products, and illicit items make up roughly 10% of European consumption. Track-and-trace systems have the potential to be vital tools in the fight against the illicit tobacco trade. Since 2014, tobacco manufacturers have been obliged to comply with the EU's Tobacco Products Directive,[13] which requires a unique identifier to be placed on packaging. This traceability marking contains information on the location and date of manufacture, country of destination and more. And within a five-year period, the tobacco industry is expected to have fully implemented a complete track-and-trace system for cigarettes and fine-cut products such as rolling tobacco.

Tobacco manufacturers operating in the EU face an additional challenge, however: Each EU member state is permitted to specify the code format of tobacco packaging in their respective countries. This largely takes the format of dot code or a 2D data matrix applied to the bottom of the package, or at various other positions for packaging such as cans. Therefore, in order to address the needs of several markets at once, manufacturers must ensure that their production machines are capable of printing 30, 40 or 60 characters onto data carriers.

To make matters more complex, in some countries such as Australia, packaging design regulations do not even allow the application of codes. And in other cases, such as some snuff tobacco packaging formats, there might not even be enough space for the code on the packaging. As a

[12] FDA, "Drug Supply Chain Security Act - Overview of Product Tracing Requirements" September 2015. Retrieved 16.05.2018 from https://www.fda.gov/media/93779/download.
[13] EU, "Revision of the Tobacco Products Directive". Retrieved 16.05.2018 from https://ec.europa.eu/health/tobacco/products/revision_de

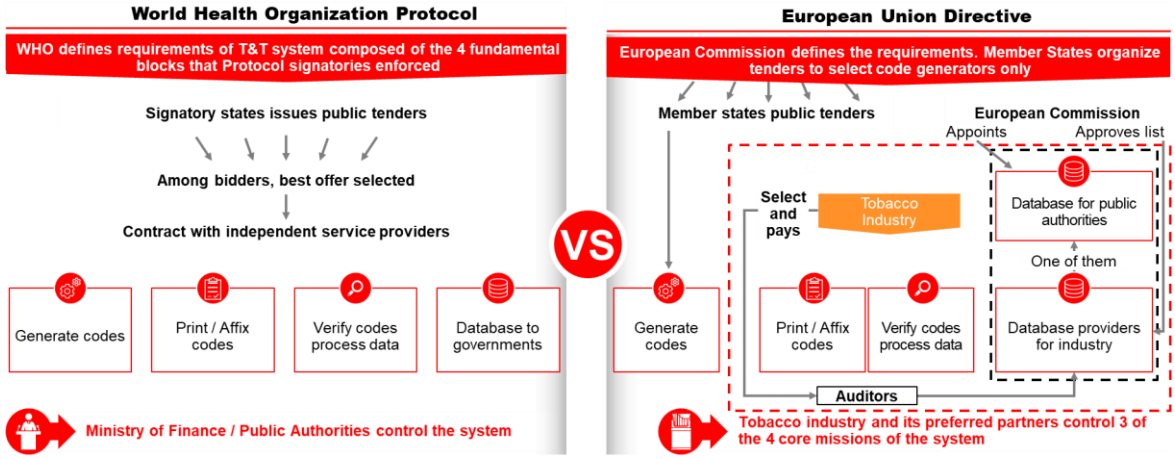
result, several multinational tobacco product manufacturers joined together to form the Digital Coding and Tracking Association (DCTA), to share best practices and jointly promote a track-and-trace system for the industry called Codentify.

Tobacco – World Health Organization protocol

There are concerns, however, that the EU track-and-trace system has certain shortcomings. For example, member states only carry out tenders for the service providers charged with generating unique identifier codes, while the European Commission oversees the selection of database providers. More seriously, the EU scheme requires tobacco product manufacturers to both affix and verify these codes in their factories – two of the most critical steps in tracking and tracing tobacco products. The industry also has a hand in selecting and remunerating both the data storage providers and the auditors appointed to oversee them. Some observers question whether this system can be fair or impartial.

In contrast, the World Health Organization (WHO) Protocol calls for a public, open and competitive tender to select the best service providers, entirely independent of the tobacco industry. These service providers then take on the key missions of track and trace, such as generating unique identifier codes, printing or affixing these codes to tobacco products, verifying on the production line that the codes are linked to the correct products, and providing governments with a database and related alert system.

FIGURE 7: EU TOBACCO TRACK & TRACE SYSTEM VS. WHO PROTOCOL[14]



Under this system, public authorities – including customs, police forces and the judiciary – can control the manufacture, distribution and sale of tobacco products all along the supply chain, and pursue those responsible for illicit trade.

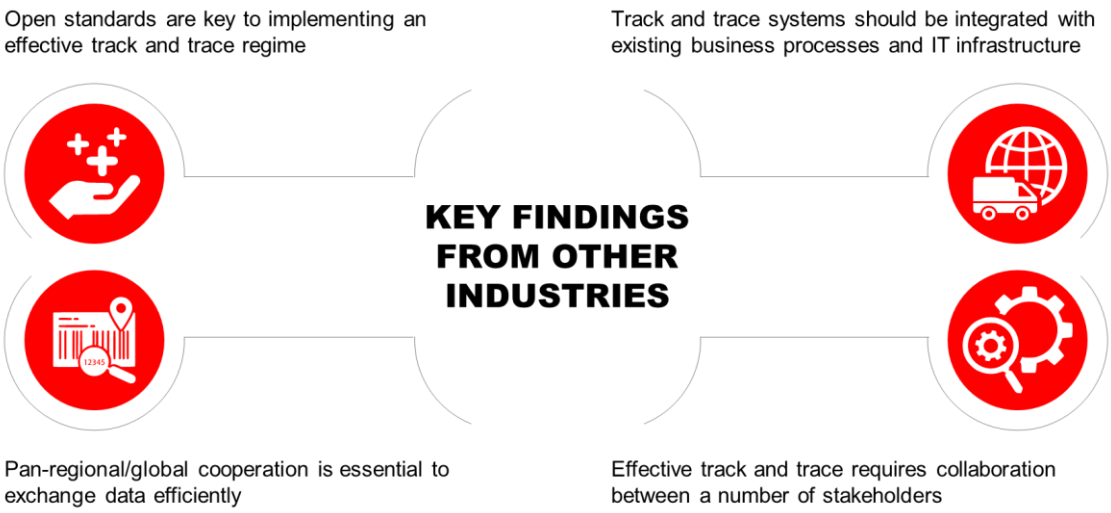
KEY FINDINGS

- **Global standards are required:** At present, there are no globally agreed open standards for tracking and tracing tobacco products as part of the WHO Protocol
- **A standardized system is required:** An international track and trace regime for tobacco products can only be effective if each national system is interoperable with others, and can exchange data efficiently across borders
- **Stakeholders must collaborate:** from manufacturers to wholesalers, distributors and retailers, cooperation across the supply chain is required

[14] WHP, "Protocol to Eliminate Illicit Trade in Tobacco Products" February 2013. Retrieved 16.05.2018 from https://apps.who.int/iris/bitstream/handle/10665/80873/9789241505246_eng.pdf;jsessionid=A9E94B1719167AD6BBE006FFB9770819?sequence=1.

In summary, there is good evidence from other industries that greater supply chain control is possible once certain key challenges are overcome and effective track-and-trace systems are implemented. The experience from other industries suggests several key learnings:

FIGURE 8: KEY LEARNINGS FOR THE AGROCHEMICAL INDUSTRY

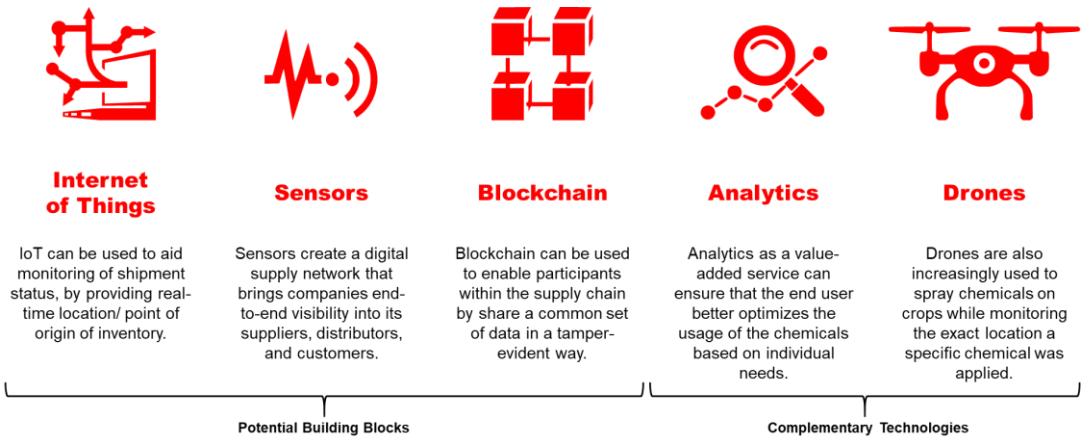


TECHNOLOGIES

OVERVIEW OF TRENDING TECHNOLOGIES

Today, products are passing through the supply chain at rates that have never been seen before. Consequently, companies must quickly adapt to a changing environment by providing customers with increased product traceability. As traceability becomes more and more feasible in global supply chains – thanks in large part to advancements in digital technologies – the full adoption of these technologies can bring additional benefits to organizations. The technologies most likely to play a key role in driving further business benefits are discussed below.[15]

FIGURE 9: SELECTED DIGITAL TECHNOLOGY TRENDS IN AGROCHEMICALS



[15] Forbes, "Top Six Digital Transformation Trends In Agriculture" May 2018. Retrieved 16.05.2018 from https://www.forbes.com/sites/danielnewman/2018/05/14/top-six-digital-transformation-trends-in-agriculture/#468c52c0ed2e.

Internet of Things

With sensors placed on agricultural equipment and materials and around the fields where crops are grown, the Internet of Things (IoT) promises to simplify and streamline the way data is gathered to track crop loads, equipment health and much else. IoT can also aid in monitoring a shipment's status by providing the real-time location of inventory within a facility and tracking the point of origin, days until expiration, and other attributes. IoT's real-time monitoring supports track-and-trace accuracy and scale, leading to improvements across the entire supply chain. With IoT-connected sensors, insights can be gathered to improve operations and ensure compliance and safety.

Sensors

As the cost of RFID technology falls, RFID sensors are increasingly used in the agri-food sector to track comestibles all the way from field to store. With current RFID technology, however, it is not possible to completely scan RFID on liquid consumer packs or packages of high-density powders such as coffee powder. RFID smart labels offer certain advantages over 2D barcodes, such as better tolerance in fully automated reading, and do not require human intervention to passively track the movement of products within closed systems such as warehouses. What's more, multiple RFID smart labels can be read simultaneously. The ability to provide relevant, timely data regarding products can be used to track and trace products, assets, and material flow. Sensors create a digital supply network that brings the company end-to-end visibility into its suppliers, distributors, and customers.

Analytics

It is difficult to overstate the potential of advanced analytics for mining data collected by IoT sensors and predicting trends in the agrochemicals industry. Even before a single seed is planted, analytics can help plant breeders predict which traits and genes will be optimal for crop production in a given scenario and enable farmers to select the most suitable breeds for their location and climate. Data analytics can also be offered by agrochemical manufacturers as a value-added service for customers purchasing their product. This can help ensure that individual users better optimize their usage of the chemicals based on factors such as farm size, crop type, soil health and irrigation type.

At the one end of the supply chain, the need to improve product tracking and traceability and the analysis of product returns provide the greatest potential for analytics growth. At the other end of the supply chain, analytics can be used to indicate which agri-food products are likely to be purchased the most, and which products will fail in the market. In this way, highly accurate forecasts can be made for future agrochemical demand.

Blockchain

Blockchain presents another possible way to beat agrochemical counterfeiters by enhancing traceability. This technology is essentially a highly distributed digital ledger that enables participants within the supply chain to share a common set of data in a tamper-evident way. What's more, records on the blockchain cannot be erased.

Drones

Unmanned aerial vehicles – drones – are a highly cost-effective way to visualize crops that span large areas of land, perhaps in the hundreds of acres or hectares. Drones are already used widely across the US for crop monitoring and to combat drought and other environmental challenges. They can also be used to produce 3D imaging, which can be used to predict soil quality and plan seed

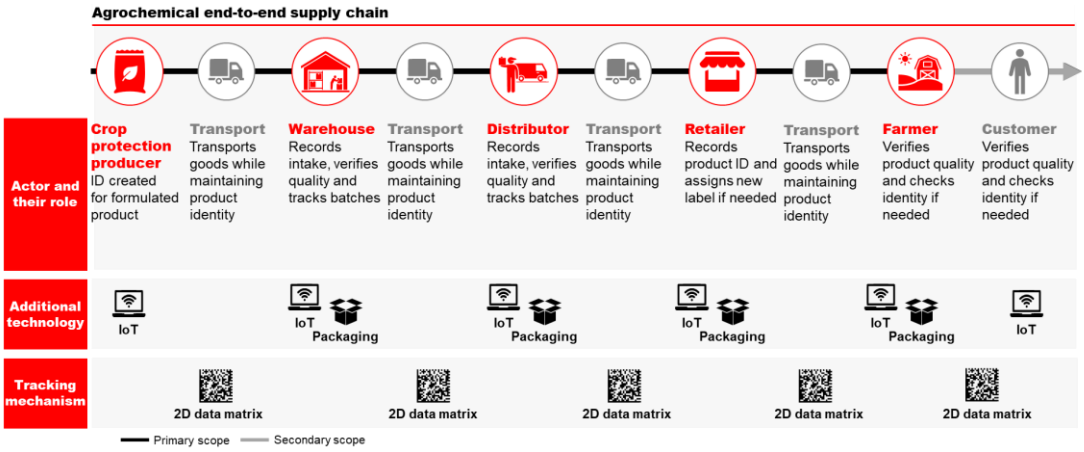
planting patterns. Drones can also support the spraying of chemicals on crops in a highly targeted way while monitoring the exact location where the chemical was applied, the amount applied, and the date applied. In the long run, drones may complement or replace other technologies, such as IoT sensors, and consequently be used to do stocktaking in factories and locate/ identify shipping containers.

RECOMMENDATIONS

A ROADMAP FOR DEPLOYING SUPPLY CHAIN TRACEABILITY

As demonstrated by the successful pilot schemes discussed in this report, supply chain traceability can establish the network needed to reliably register, verify and track goods transferred between distant parties. It can also help reduce operational inefficiencies and fraud by enabling greater transparency and accountability for the information shared between parties. Experience from other industries indicates that tracing a product's progress from manufacturer to the end customer ideally requires an end-to-end supply chain, along with buy-in from all participants.

FIGURE 10: END-TO-END SOLUTION FROM FORMULATED PRODUCT TO THE FIELD



A full description of a supply chain traceability solution would require a great deal of detail. Therefore, this section will outline at a high level what a potential end-to-end functional solution for tracing product identity along the agrochemicals supply chain might look like. Figure 10 shows the key interactions between various supply chain actors. These will be required to enhance all participants' ability to create and maintain product traceability throughout the supply chain.

An interface will be required by each actor

To access the traceability solution and perform key processes, a user interface will be required for each actor (or actor type). All actors must be able to access the user interface on a computer or mobile device. The interfaces should enable a user to perform certain basic functions, such as creating the following records during (for example) import, export, receipt and shipment of goods:

- Business identification
- Site identification
- Batch/item number
- Production date
- Expiration date
- Product hierarchy
- Volume

This interface would be customized by actor type, so that each user can complete their required processes and transactions effectively. Business-specific requirements may also mean further customization of the user interface is required in order to integrate with existing product and inventory management systems or enterprise resource planning (ERP) systems.

The interface should use the globally recognized EPCIS GS1 standard to enable the creation and sharing of event data, both within and across enterprises. This will enable supply chain actors to gain a shared view of physical or digital objects within their relevant business context(s). If actors are only willing to communicate +1 and -1 without full transparency down the chain, EPCIS will not be applicable. This needs to be clearly analyzed on a case-by-case basis and is a vital part of a successful approach to traceability.

Tracing agrochemical products will require unique identifiers

An end-to-end traceability system depends on the creation of unique identities for each agrochemical product, with physical tags or labels applied using mature technologies such as a 2D data matrix or RFID tag. An equivalent digital identifier that can leverage digital systems will also be needed.

To fully leverage this approach, each product will need to be separately identified, rather than blended with other products along the supply chain. If a product is to be blended in some way with others, then a mechanism will be required to group these products into a new identity. Product identifiers, typically a product code in the form of a 2D data matrix on a package label, can be linked to additional digitized identity data within the system.

Due to its inherent speed and accuracy advantages, IoT technology will be required to facilitate product tracking and automate data collection in a reliable, trustworthy format. These IoT technologies will include, but are not limited to:

- A **GPS-enabled** offline digital logbook. This will allow actors such as distributors to record information about the delivery in real time.
- **Mobile-enabled** mechanisms for creating records, generating barcodes, printing labels and scanning RFID tags and barcodes.

Taken together, these technologies will provide a way to capture reliable, consistent and accurate data on an agrochemical product's journey along the supply chain. Any traceability solution is only as good as its data however, so the more accurate the data entered into the solution, the more transparent (and useful) the system becomes for all parties.

Labels and barcodes are already being leveraged by some supply chain actors, but it should be emphasized that a consistent approach is required to capture standardized product data for a complete traceability solution. Great progress is being made by standards bodies like GS1. The GS1 system will enable actors to accurately identify and communicate information regarding

products, assets, services and locations. We recommend that the associated costs and effort of tagging should be further assessed during solution planning.

A closed production system is paramount

It is clear that a closed production system is crucial to establishing a traceable and compliant supply chain, and preventing counterfeit products from being circulated. A closed system also incentivizes non-compliant actors to become compliant with track-and-trace requirements in order to trade within the supply chain.

Packaging is used to maintain product identity

The primary role of packaging in this scenario is to support the key goal of maintaining an intact identity for each product that is separate and segregated. Identity data could be applied directly to the package using a 2D data matrix with key identifiers. As a product moves through the supply chain and gets processed into parts, its packaging also allows the product to maintain its identity. It achieves this by preventing the product from being directly mixed with products from other origins and sources.

Traceability solutions will be required at several points within the supply chain. For example, in order to identify batches of products that are separated out by the manufacturing facility, each batch – which is created based on similar sizing, quality and/or product type – should be packaged and labeled with a 2D data matrix. This will enable actors within the supply chain to track the batch and origin data all the way until it reaches the end customer. As it progresses along the supply chain and its form is altered, it should be packaged in a way that enables transmission of key traceability data through an additional 2D data matrix.

Build a minimum viable ecosystem

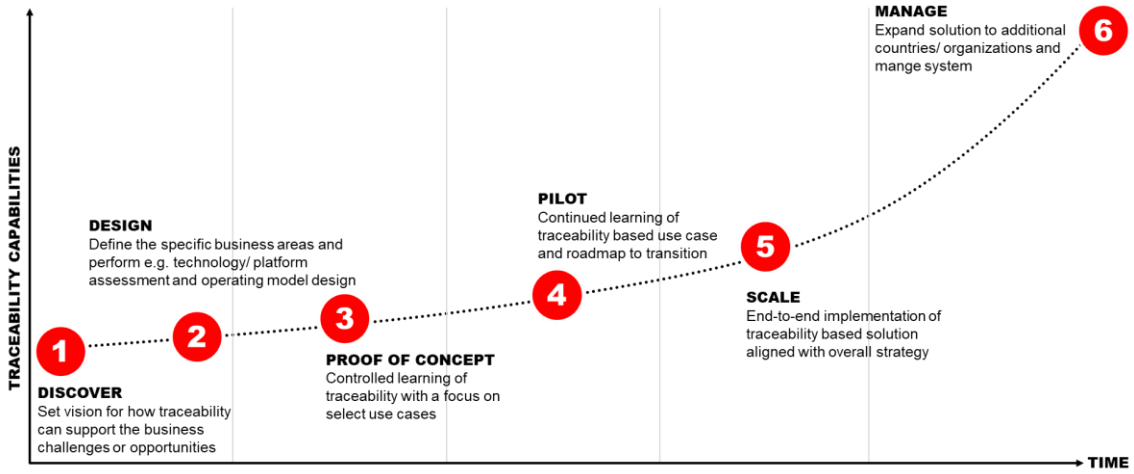
A group of industry stakeholders should be brought together to make a plan and roll out a pilot solution. Each actor would contribute to the chain of custody and test the viability of the solution across the ecosystem. The following is a sample set of actors for a pilot:

- >2 distributors
- >2 agrochemical companies
- >2 external warehouses
- 1 holder of the dataset/ platform

Feasibility conclusion for supply chain traceability

It is clear that the end-to-end supply chain traceability of agrochemicals represents an opportunity to reduce counterfeiting and improve customer credibility. Achieving this goal will require the appropriate business processes to be put into place, along with market incentives, standards and regulations for traceability data, plus a supporting ecosystem. Once realized however, it will provide a model for traceability as a force for social good, which could potentially be replicated across other industries.

FIGURE 11: SUPPLY CHAIN TRACEABILITY JOURNEY



An Agile, Low-Risk Roadmap

The end-state solution for end-to-end traceability does not need to be put into place immediately. It will take time to fully develop. We would recommend that industry stakeholders take an agile approach to testing, refining and rolling out a solution. This will involve a proof of concept and a limited production pilot, ultimately followed by implementation and scaling of a production system. Achieving the buy-in required from stakeholders, and delivering benefits for actors across the supply chain, will require an incremental and iterative approach to solution design.

With this in mind, the agrochemicals industry could aim to start small to prove benefits, assessing and re-assessing the traceability solution at each point. Once benefits become apparent, actors could present major successes to key ecosystem partners in order to grow the consortium and encourage participation. By following these steps, investments in an end-to-end traceability solution could increase incrementally at each stage. This approach also minimizes risk, as actors could decide whether or not to continue the initiative as it progresses.

Within the next three years, an increasing number of agrochemical companies will look for supply chain traceability solutions. We hope that the lessons learned from deployments of track-and-trace systems in other sectors and across the world can be shared more widely to inform and guide developments in the agrochemical industry, and we hope that this report assists in that process.

APPENDIX

GLOSSARY

DCTA	Digital Coding and Tracking Associations
DQSA	Drug Quality and Security Act
EDI	Electronic Data Exchange
EFPIA	European Federation of Pharmaceutical Industries and Associations
EPCIS	Electronic Product Code Information
FDA	Food and Drug Administration
FMD	Falsified Medicine Directive
GS1	Global Standard 1
GTIN	GS1 Global Trade Item Number
IoT	Internet of Things
PoC	Proof of Concept
RFID	Radio-frequency identification
SSCC	Serial Shipping Container Code
WHO	World Health Organization

ABOUT THIS STUDY

CropLife International and Accenture collaborated to carry out interviews in 2019 with key stakeholders for supply chain traceability in the agrochemicals industry, and formulated an industry wide recommendation. During the course of this study, Accenture Strategy conducted phone interviews with CropLife members and interviewed Accenture specialists to understand the benefits/value levers involved, as well as the key features of an effective traceability system. The analysis of various traceability approaches (Netherlands, France, United States, Argentina, Turkey) and the screening of standards/technologies enabled the development of a recommendation and roadmap for a harmonized global agrochemical traceability solution.

This study was led by Raffaella Colombo (CropLife) and Laurent Sebire (Corteva), with support from Ralf Hundertmark (BASF), Edmund Jager (Bayer), Andreas Kotsinaris (Syngenta) and Hanne Bjoerling Pedersen (FMC). This report was developed in partnership with Accenture Strategy, led by Michael Ulbrich and Jeffrey Hammann.

The survey targeted agrochemical companies as well as selected distributors. The 12 stakeholders who participated in the survey hold positions including (but not limited to): Vice President, Supply Chain Manager, Global Visibility Leader, and Global Anti-Counterfeiting Leader. They represented the companies Adama, BASF, Bayer, Corteva, FMC, Holland Fyto and Syngenta, which are headquartered in Germany, Israel, Mexico, Switzerland and the United States.

DETAILS ABOUT NATIONAL TRACEABILITY PILOTS

The team explored case studies, featured below, based on the results of supply chain traceability pilots conducted in Argentina, France, the Netherlands, Turkey and the United States. The following five case studies were found to be the most relevant for the agrochemicals industry, and additionally contained the most secondary information available for analysis.

FIGURE 12: OVERVIEW OF KEY AGROCHEMICAL TRACEABILITY PILOTS[16]

	Netherlands	France	United States	Argentina	Turkey
Stakeholders	• Distributors (Holland Fyto & CZAV) • Industry (Adama & BASF, etc.) • Warehouses (Farmusol & Imperial) • Dataset (AgroConnect & GS1) • EDI Platform (Proagrica)	• Industry (BASF, Bayer, Dow & Syngenta) • Seed suppliers (Syngenta & Limagrain) • Distributors (Interra Log, InVivo, Odalis, Soufflet, SeVeal & Unio Est Agro) • Organization (Agro EDI)	• Organization (AgGateway)	• Organization (Senasa, Trazaquímicos)	• Organization (Turkish ministry of agriculture and livestock) • Industry
Status of roll-out	• Piloted 2019 • Start rollout 2020	• Piloted 2011 • Full rollout 2017	• Piloted 2014	• Piloted 2013 • Partial rollout 2016	• Piloted 2018 • Full rollout 2019
Description	• Tracking & tracing of Agrochemicals on batch level from filling line up to farmer in order to recall within 24 hours • According to the CRISTAL recommendations	• Traceability to identify the origin and destination of products, in order to trace the source of a food safety problem, fraud or in event of a recall • Compliance with Loi D'avenir	• Automatically capture critical components within the distribution in order to be more efficient and connected • Full integration in the European CRISTAL framework	• Traceability for real time monitoring of agrochemicals (formulated products, active ingredients) along the entire production / distribution chain, in order to more effectively manage / control products	• Traceability and identification of agrochemicals, in order to ensure traceability of crop protection products up to the farmer
Value levers	• Improved customer satisfaction • Improved inventory management • Improved invoicing processes • Improved employee efficiency	• Improved customer satisfaction • Improved inventory optimization • Improved employee efficiency • Improved assurance against counterfeiting	• Increased operational productivity • Improved inventory management • Increased customer satisfaction and safety • Improved data accuracy	• Improved compliance with European laws • Improved traceability and visibility in the SC • Improved assurance against counterfeiting • Improved customer satisfaction	• Improved compliance with European laws • Improved use of pesticides on the farm level • Improved recall & returns • Improved trace of origin • Improved assurance against counterfeiting
Scope	• Downstream • From filling line up to farmer	• Entire supply chain, with focus on distribution • From production up to consumer	• Entire supply-chain, with focus on distribution	• Downstream • From import up to farmer	• From production up to retailers
Technology	• 2D data matrix	• 2D data matrix, barcode etc.	• Barcode	• Barcode	• 2D data matrix
Standards	• GS1 identifiers	• GS1 identifiers	• GS1 identifiers	• GS1 identifiers	• GS1 identifiers
Granularity	• Batch level	• Batch level	• Batch level	• Batch level/ Item level for dangerous products	• Item level (Consumer unit)
Data exchange	• Cloud Platform	• B2B EDI messaging	• Web based	• Web based	• Cloud Platform
Linkage to food chain traceability	• Currently not in scope	• Management of information relevant for the food industry	• Currently not in scope	• Currently not in scope	• Management of information relevant for the food industry
Recordable events	• Shipment (e.g. order, dispatch, invoice)	• Shipment (e.g. order, dispatch, invoice)	• Shipment (e.g. order, dispatch, invoice) • Reception	• Import • Export • Shipment (e.g. order, dispatch, invoice)	• Shipment (e.g. order, dispatch, invoice) • Sales • Import • Export
Recordable information per event	• Product information (e.g. GTIN, GLN, batch number, production date) • Volume (e.g. SSCC)	• Product information (e.g. GTIN, article number, batch number, production date) • Volume (e.g. SSCC)	• Product information (e.g. GTIN, article number, batch number, production date, expiration date)	• Product information (e.g. GTIN, article number, batch number, production date)	• Volume • Product information (e.g. GTIN, article number, expiration date, batch number)

[16] EU Regulations, " REGULATION (EC) No 1107/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" October 2009. Retrieved 05.06.2018 from https://eur lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:309:0001:0050:EN:PDF.