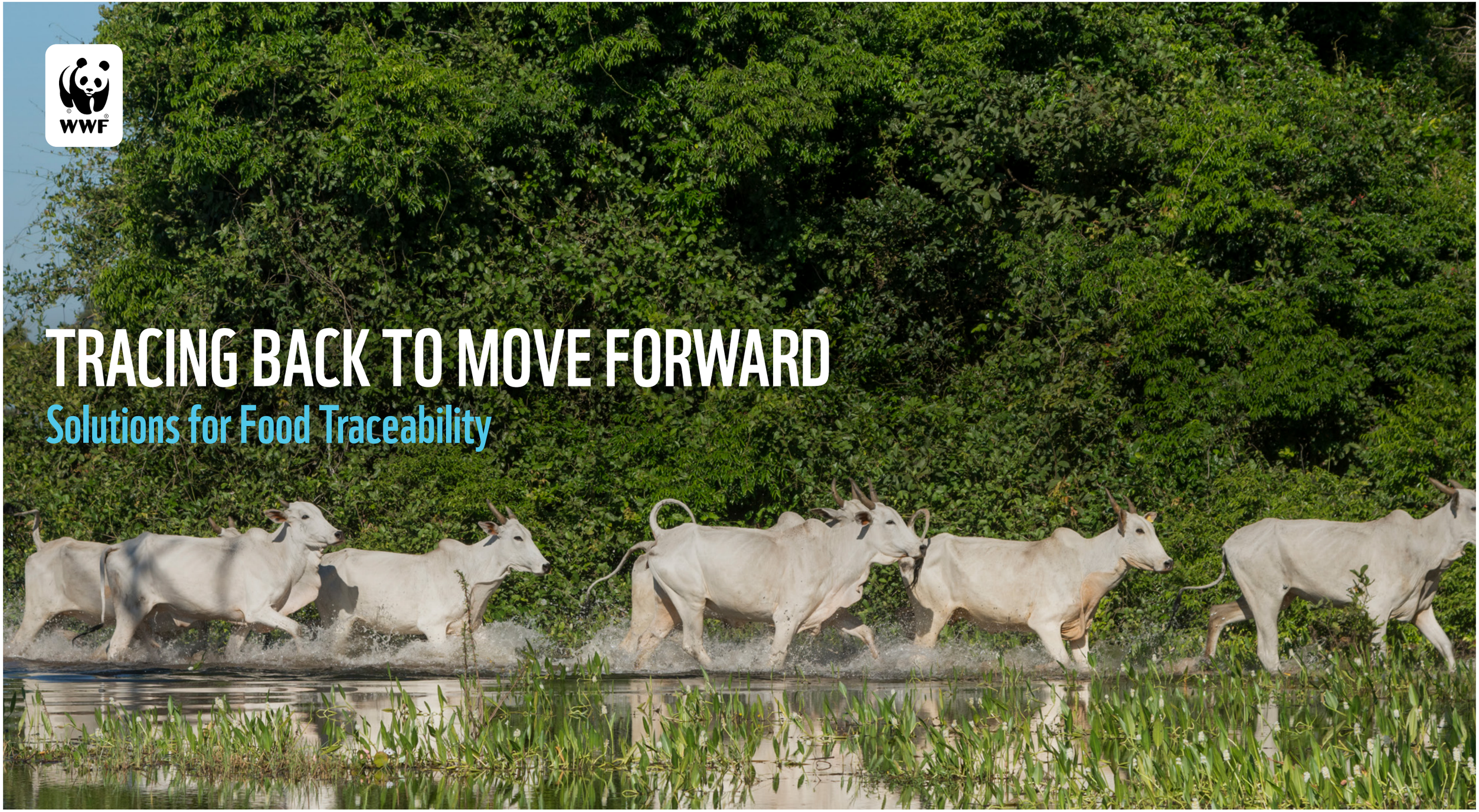

TRACING BACK TO MOVE FORWARD

Solutions for Food Traceability

CONTENTS

Attributions

World Wildlife Fund (WWF) is one of the world's leading conservation organizations. WWF works in more than 100 countries, collaborating with people around the world to develop and deliver innovative solutions that protect communities, wildlife, and the places in which they live.

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Disclaimers

All companies named in this report are illustrative examples. Use of company names does not represent an explicit endorsement from Accenture or the World Wildlife Fund.
All monetary figures are presented in U.S. dollars unless otherwise indicated.
All tons are metric tons unless otherwise indicated.

EXECUTIVE SUMMARY

Our natural resources are critical for both people and planetary health. Increasingly complex global supply chains put a heavy strain on labor, land, water, and energy resources as companies and governments work to feed a growing global population. If resource use exceeds regeneration, natural systems will rapidly deteriorate.

Reducing the negative impacts of food production is hampered by the inability to attribute impact to a single supply chain actor. As an indirect driver, the opacity of supply chains has allowed negative impacts to occur such as socio-economic struggles, human rights violations, environmental degradation, and food borne outbreaks—problems that could be brought to light and overcome with full traceability.

Recently, growing concerns over the environmental and social impacts of food production have caused three sets of stakeholders to take serious action:

- Some **governments** are passing more stringent traceability legislation to provide verifiably safe food to their citizens.
- **Investors** are deploying capital to sustainable business endeavors, ensuring that today's revenue streams do not hinder future growth.
- **Consumers** are working to make more informed purchasing decisions, ensuring their hard-earned dollars encourage ethical and sustainable behavior upstream.

With an eye towards the future well-being of people and planet, it is critical to capture and track information on product characteristics, empowering purchasers at every juncture to use their buying power to incentivize change. While efforts to enhance traceability have been attempted for decades, momentum is building among the purchasing community, suppliers, and governments to advance the traceability agenda.

This report aims to provide a foundational understanding of traceability for food industry actors, touching on barriers in four key commodities—beef, soy, farmed shrimp, and wild-caught tuna—and proposing recommendations to help ensure the success of future efforts. To that end, WWF presents the following recommendations to break down today's business-as-usual approach to traceability and shape the next generation of food production.

RECOMMENDATIONS FOR TRACEABILITY SOLUTIONS

1. Embedded Incentives

Traceability solutions must be designed to reflect the business environments in which they are to be implemented, striking the right balance between cost and benefit for all participants. The solutions should be based on business cases anchored in clearly defined incentives and capable of an eventual return on investment.

2. Incremental Granularity

Traceability tools should attain optimal granularity where benefits exceed costs, and the level of information drives desired behavioral changes.

3. Collaborative Technology Development

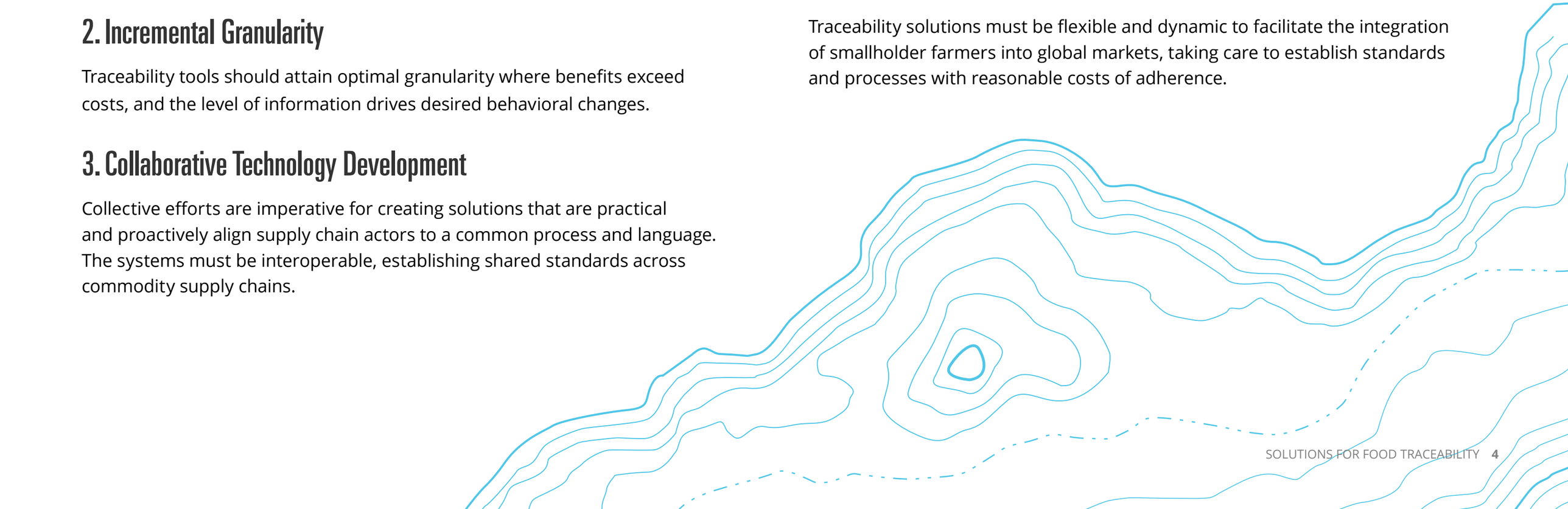
Collective efforts are imperative for creating solutions that are practical and proactively align supply chain actors to a common process and language. The systems must be interoperable, establishing shared standards across commodity supply chains.

4. Equitably Distributed Investments

Downstream actors who garner the largest margins (e.g., importers, distributors, and retailers) should distribute investments to support upstream actors in proportion to the value they expect to gain in providing full traceability.

5. Affordable Access

Traceability solutions must be flexible and dynamic to facilitate the integration of smallholder farmers into global markets, taking care to establish standards and processes with reasonable costs of adherence.



INTRODUCTION

Food companies have historically struggled with labor, social, environmental, and food safety issues in their supply chains. These issues are easily concealed and challenging to track because there has been little demand from consumers, governments, or intra-supply chain companies to materially change the status quo. The resulting system is one where infrastructure, governance, and technologies are primarily designed to optimize costs, leading to undifferentiated products and the commoditization of food, which favors volume expansion and decreased value throughout the supply chain.

The consequence is a global food system that manufactures, trades, transforms, processes, and reprocesses materials for human and animal consumption with little accountability or knowledge of the environmental and social impacts of their actions.

To date, many food companies struggle to trace products back to their origins and often can only trace back to a point of aggregation after the source. This approach leaves consumers and retailers largely in the dark when it comes to food production practices that affect the environment, local communities, labor and human rights, and food quality and safety.

However, there has been a recent renewal of hope as governments enact more stringent regulations. The European Union (EU) and the United States (US) have both begun implementing policies at the federal level that drive forward both sustainability and traceability agendas. Increasingly effective regulations and policies for verifying points of origin and production methods are evidence that countries are taking the safety of their populations and the limitation of nature's regenerative capacity more seriously.

As a result, members of food value chains are becoming more and more aligned on the importance of operating sustainably, and perhaps of equal importance, being able to prove it.

Critical to the realization of many aspects of sustainability within our food systems is the capacity for information to travel between value chain steps, providing operational visibility of upstream actors and assurance to end consumers, whether they be individuals, businesses, or governments. This capability, traceability, offers valuable insights into the impacts that sourcing causes upstream, revealing once hidden information and identifying the actions needed to course correct for more sustainable products. This report outlines the case for traceability, defining terms and outlining the risks traceability helps to mitigate, extrapolating recommendations for designing traceability systems from a diverse set of commodity case studies, and helping to develop solutions irrespective of their purpose or place in the value chain.

DEFINING TRACEABILITY

Traceability is defined as the systematic capability to access any or all information relating to a product under consideration, throughout its entire life cycle, by means of recorded identifications.[1] Traceability is a prerequisite to making any claims on the sustainability and legality of a product, as it describes its journey, history, and identity as it moves through its respective supply chain.

$16 BILLION
IN TRACEABILITY SOLUTIONS

A recent analysis projects that the market for traceability solutions alone will be worth more than $16 billion by 2022.

Source: ***Statista***

THE IMPORTANCE OF FOOD TRACEABILITY

In recent years, traceability has been recognized as an integral tool to identify issues of food safety and food quality by governments and businesses. At the same time, consumers are showing a growing interest in knowing more about their food, what went into making it, and how it got from farm or sea to their plates.

A 2018 study showed that 75% of consumers would be willing to switch to a brand that provided more in-depth product information in addition to what is provided on the physical label.[2] Beyond food safety, traceability is necessary for providing greater visibility into the social and environmental elements that are embedded in any product as it flows through the supply chain.

Food value chains and the companies operating within are under an ever-increasing level of scrutiny resulting from food recalls and safety concerns. Consumer demand for more sustainable foods only intensified in the wake of COVID-19. The pandemic showed us how immediately negative effects can unfold, and the global implications they can have on food supply chains, the environment, and communities.

Global health and economic crises illustrate the fragility of our systems and the varying, intertwined threats to health, economic opportunity, food security and safety, and global supply chains. Making the food sector more resilient to shocks like COVID-19 will provide greater protection for all humans. The lack of collective visibility and viable contingency plans for natural disasters and disease outbreaks emphasizes the razor's edge humanity walks between food system function and collapse.

Through increased transparency and traceability, businesses can better understand their operations and the potential risks and opportunities within their supply chains. Full product traceability can demonstrate to investors, consumers, and regulators that a product is ethically and sustainably sourced. The ability of business to provide such critical information to stakeholders will become increasingly important in the coming decade, not only to maintain reputations but also to realize financial gain.

TRACEABILITY AND RISK

With any food, there are potential reputational risks to the retailer and health risks to the consumer. The nature of these risks is driven by production practices, inputs, and the way products are collected, handled, processed, and marketed.

Without the ability to systematically follow the transformation and transportation from origin to point of sale, there is always a risk that the product could be compromised. Traceability is how businesses and consumers can access the information necessary to make wholly informed choices about the food they purchase and consume.

In the absence of traceability, risks introduced by supply chain actors accumulate as more steps and complexity are added to the supply chain. Retail and food service businesses become ultimately liable for practices and inputs used by others to produce the products they sell. These liabilities can include products that are unsafe for consumption, fraudulent labeling, and production practices that violate human and/or labor rights and cause environmental harm or degradation.

When product identity is absent, an unknown level of risk is inherited by those closer to the final point of sale, making risk mitigation efforts incomplete and therefore, ineffective or inadequate. In general, as the number of components of the supply chain increase (e.g., supply chain length and number of actors), so does potential risk, because there are more opportunities for improper actions. This section explores examples where compromised food safety, reputational risk, environmental degradation, and labor and human rights abuses have persisted in supply chains, in part due to the absence of traceability and transparency and therefore, lack of accountability.

Food Safety

Food safety concerns, including contaminated foods, adulterated ingredients and the presence of unlabeled allergens, can have serious and potentially life-threatening consequences. The CDC estimates that one in six Americans get sick from contaminated foods or beverages each year and 3,000 die. The US Department of Agriculture (USDA) estimates that foodborne illnesses cost more than $15.6 billion each year.[3] So while the health burden impacts consumers, the risk can also result in severe damage to the company or companies' brand reputation and bottom line. For example, the outbreak of *E. coli* in 2019 that was traced back to romaine lettuce from Salinas, California, cost farmers, wholesalers, retailers, and others millions of dollars, produced hundreds of tons of waste, and instantly tainted the reputation of Salinas Valley producers.

Food safety requires the use of a wide range of tools intended to identify both immediate and potential threats to the public. To ensure that food is safely produced and handled, there must be oversight coordination between food supply chain actors, exporting government controls, and importing government processes. These tools can be as simple as routine tests to detect bacteria and as complicated as risk-based algorithms that determine which shipments should be more thoroughly inspected at port.

The limitations of these checks and balances was exposed in 2017 through the Brazilian National Police's investigation, code-named "Operation Weak Flesh".[4] The operation centered on corrupt practices in a large Brazilian meat exporter. It uncovered that the exporter had been bribing public officials and inspectors, falsifying laboratory reports, deliberately processing adulterated product, and diverting shipments contaminated with salmonella bacteria from ports where it could be flagged as high-risk to ports with less stringent testing protocols. This practice occurred over a five-year period with awareness across multiple companies and government organizations. Limited transparency played a significant role in enabling exporters to continue skirting critical safeguards and sell potentially deadly products to countless buyers. Once the scandal was made public, the Brazilian meat industry faced international fallout with both the EU and China, whose governments took action to restrict Brazilian beef imports.

Reputational Risk

Every person in the world has opinions, tastes and preferences that are influenced culturally, regionally, and instinctively. However, an important topic upon which consumers are starting to agree is the desire to know more about the origin and qualities of their food. One survey in 2016 found that among 30,000 respondents, an average of 72% of consumers in Asia-Pacific, Europe, Africa, the Middle East, Latin America, and North America "want to know everything that is going into [their] food".[5] Equally clear is the insufficiency of existing information for today's consumer. While consumers review labels and certifications to inform their own purchase decisions, many believe labels do not provide enough transparency and that the information can be incomplete, confusing, or subject to fraud. Of 1,500 US consumers surveyed, 75% do not trust the way brands currently provide product information.[6] This issue is driven in part by a financial incentive to mislabel products, such as labeling and pricing a less desirable cut of fish as one that is more expensive.

Consumers' collective voice has unparalleled power when focused on a singular issue and can materially impact a company's performance. This was the case in the late 1980s and early 1990s when US consumers demanded changes to the tuna industry's use of setting purse seine nets on dolphin pods to capture schools of tuna beneath them. The public learned of this practice through secret video recordings made by a biologist posing as a cook on a purse seine tuna vessel, well before viral media was popularized. Between 1988 and 1990, through a series of boycotts, petitions, and high-profile celebrity calls to end this practice, the reputational impact drove the tuna industry to commit to no longer buying products that used these capture methods. Months later, the Dolphin Protection Consumer Information Act formalized the Dolphin Safe labeling now seen on tuna cans. In today's increasingly digital environment, consumers are likely to hold even more power voting with their dollars to end harmful practices in food production.

Environmental Concerns

Much of our food is produced by clearing critical habitats such as forests, grasslands, and mangroves to make room for agricultural land. In recent years, growing public concern over environmental degradation and human rights violations has elevated corporate responsibility actions to change practices. Hundreds of companies have pledged to transform their supply chains to protect ecosystems and people. Yet, it is difficult to determine if they prevented environmental degradation and eliminated habitat loss. Traceability and transparency would enable stakeholders at all levels of influence to make their own judgements on how companies adhere to these commitments.

Soy provides an illustrative example of environmental concerns in food production. As soy production expands, it follows other animal proteins into delicate ecosystems, such as the Cerrado savanna and Amazon rainforest. This is often a result of converting land previously used for raising cattle. Because of soy's significant use as a feed ingredient, it is immensely challenging to ensure that soy grown in deforested areas does not enter the supply chain. This problem is compounded because while soy is one of the most widely used proteins for feed, the animals it helps sustain—such as beef cattle in Brazil—are often major contributors to natural habitat loss. Soy is an important commodity in our food system, but because of its predominant use in animal feed and the lack of traceability in animal supply chains, it will take an industry-wide effort to achieve traceability in feed ingredients to ensure companies meet their commitments to remove habitat loss from food production.

Labor and Human Rights

Perhaps the most significant and distressing risks associated with a lack of traceability are human and labor rights violations that can be hidden in products within supply chains. In 2014, a media investigation found that the world's largest prawn farmer at the time, the Thailand-based CP Foods, was buying fish meal from some suppliers that own, operate, or buy from fishing boats manned with forced labor.[7] Fishing vessels in international waters off the coast of Thailand were exposed for exploiting forced labor, trapping migrants on boats for years at a time. The fish that they caught was eventually processed into fish meal for onward sale to feed companies, who sold the feed to shrimp farmers, and then process shrimp subsequently sold to international buyers such as Walmart, Carrefour, Costco, Tesco, Aldi, Morrisons, and others. The origin of wild fish caught for farmed shrimp feed is notoriously difficult to trace because it is the leftovers not sold for human consumption. Much of the fish for fish meal in Asia are unrecognizable because they have been pulverized in the back of trawl nets.

Retailers in markets around the world were shocked by these revelations. Some discontinued purchasing shrimp from Thailand while others were entangled in lawsuits for selling product tainted with forced labor. However, a small group of retailers and brands sought to directly engage the Thai seafood sector to leverage reform shortly after the first articles were public. This group formed the ***Seafood Task Force***, an industry effort that continues to engage the seafood sector in Thailand and beyond to satisfy a desire for greater supply chain oversight.[8]

The events in Thailand led to major public and private sector reforms in the fishing industry. This example demonstrates how the risk burdens fell on retail, farms, and processing companies that had little to no visibility of the feed ingredient supply chain. Recognizing that risk is accumulated with each step in the supply chain, the aquaculture sector can no longer liken itself to the fishing industry where the point of harvest is the beginning of the supply chain. Rather, aquaculture should be viewed as animal production more akin to livestock production where the issues and liabilities of feed and seed inputs must also be addressed.

Evolving Regulations

Traceability agendas are accelerating in many nations through international policy and regulation intended to combat illegal, unreported, and unregulated fishing (IUU) and human rights abuses. IUU fishing has been shown to highly correlate with negative financial impacts, resulting in economic losses of $10 to $23.5 billion per year and representing 11 to 26 million tons of seafood.[9] It can also lead to localized biodiversity loss and decreased food security, particularly when it pushes harvest levels beyond natural carrying capacities or employs unsustainable fishing methods. With extensive, far-reaching studies proving the negative impacts of fishing practices and mounting environmental pressure from conservation organizations, companies should expect regulators to expand the breadth and granularity of their traceability requirements in the near-term.

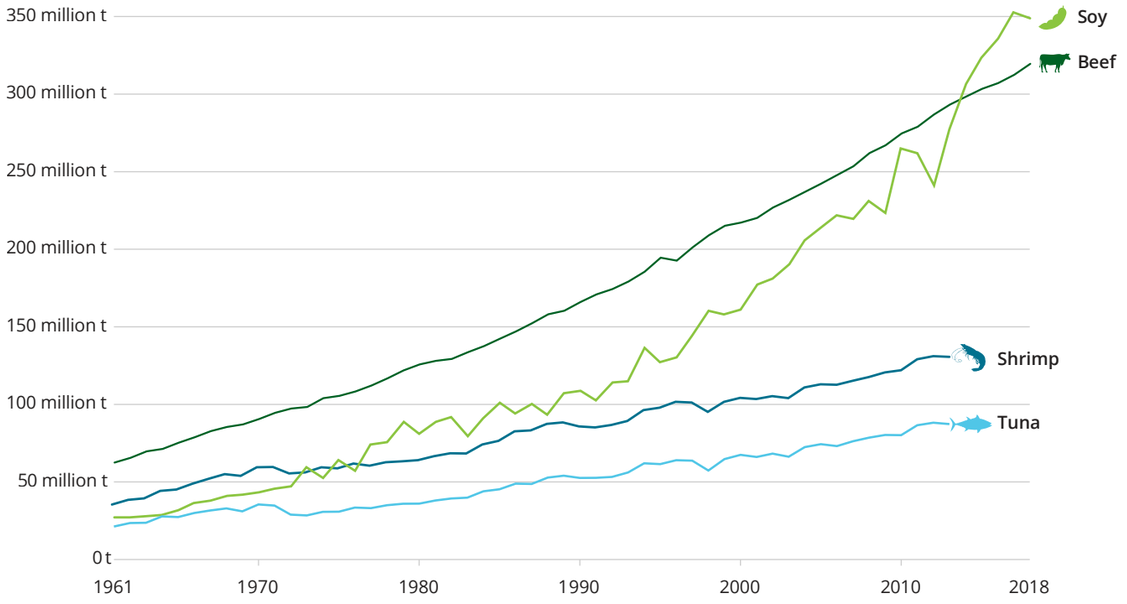
The EU has implemented regulations that only authorize imports from countries that ensure fish and fishery products caught and processed outside the EU comply with a food safety regulatory framework that is equivalent to that of EU member states. In the US, the National Marine Fisheries Service (NMFS) has implemented the Seafood Import Monitoring Program (SIMP), which requires importers to demonstrate that each shipment can be traced back to their catch or harvest. When this regulation was proposed, NMFS was sued by National Fisheries Institute (NFI) and a large group of US seafood companies. The industry representatives argued that the program violated federal law and that their businesses would be harmed by the massive traceability burden they anticipated for importers and their supply chains.[10] The court upheld the legality of SIMP and established a strong precedent for future enforcement of traceability legislation. Failure to comply with regulations set by these new import requirements will result in blocked shipments or substantial fines. Any of these remedial actions can severely disrupt a company's business. While the EU and US are leading the charge on traceability, companies should expect legislation to gradually permeate all major importing markets.

EXAMINATION OF COMMODITY SUPPLY CHAINS

This section details the developmental history of four key commodities and examines the barriers to traceability for each. These commodities—beef, soy, farmed shrimp, and wild-caught tuna—were chosen due to the rapid growth in protein consumption over the past several decades, and to emphasize the need for visibility into how that growth impacts environmental, social and food safety issues.

Before delving into the barriers faced by each commodity, it is important to explore two general themes which together establish the baseline understanding required for accurate interpretation; the key differences between capture fishery and aquaculture-based production models and the additional supply chain complexity resulting from the use of animal feeds.

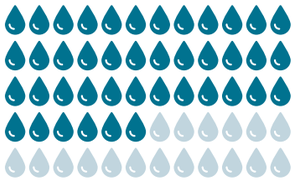
Environmental Impacts of Food Production



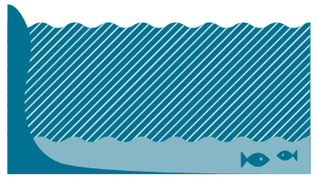
Source: Production of Beef, Soy, Shrimp and Tuna – Our World in data

26% Food accounts for over a quarter of **global greenhouse gas emissions**[11]

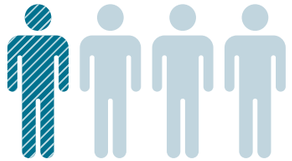
1/2 of the **world's habitable (ice- and desert-free) land** is used for agriculture[12]



70% of **global freshwater withdrawals** are used for agriculture[13]



78% of **global ocean and freshwater eutrophication** is caused by agriculture[14]



AND, YET 1 in 4 people suffer from **food insecurity** globally[15]

It is understood that the highlighted impacts are the result of global food production, and the four commodities shown are an emblematic but not comprehensive view of the industry's growth over the same period.

DIFFERENCES IN CAPTURE AND PRODUCTION MODELS

Food production supply chains (e.g., agriculture and aquaculture) are traditionally viewed as beginning with the animal or the original crop. However, the inputs—such as seed, feed, and fertilizer—all carry their own risks.

Wild-caught seafood supply chains begin with the catch and end with consumer purchase. One of the major challenges to wild capture traceability is documenting activities that occur at sea. For example, fishing vessels often pass their catch to intermediate vessels, which supply them with food and fuel, a practice commonly known as transshipment. Transshipment allows fishing vessels to remain at sea longer to capture more fish, rather than ferrying their catch back and forth to port. This also means that fishing vessel crews can potentially remain at sea for months at a time with no oversight from the authorities. Therefore, it is easier to mix illegal and unreported catch with legal product and escape consequences for IUU or unlawful labor practices onboard the vessel.

This combination of time, distance, and transshipment practices creates a void in the chain of custody, resulting in limited, if any, traceability. Although land-based production systems are theoretically easier to oversee due to their stationary nature, in some countries, the number of producers can be in the hundreds of thousands.

In Vietnam, for example, estimates show more than 220,000 shrimp farms nationwide.[16] Like wild-caught seafood, land-based systems have fragmented supply chains with low capital investment requirements, allowing small- to medium-sized enterprises to participate in the market. The advantage of this structure for downstream actors, e.g., food processors, is that crop failure risk is spread among the many producers that supply them with raw material. They bear little to no risk if an individual operation fails. The disadvantage is that small and medium-sized producers must consolidate their crops to fulfill the needs of a processor, adding more layers to the supply chain and furthering ambiguity.

The scale of the supply chain typically narrows from processing onwards, because there are more defined regulatory mechanisms from trade law to customs enforcement, which provide a higher level of confidence in traceability between actors. Generally, the greatest challenge to traceability is from the point of export back upstream towards the raw material suppliers and on to feed ingredient suppliers.

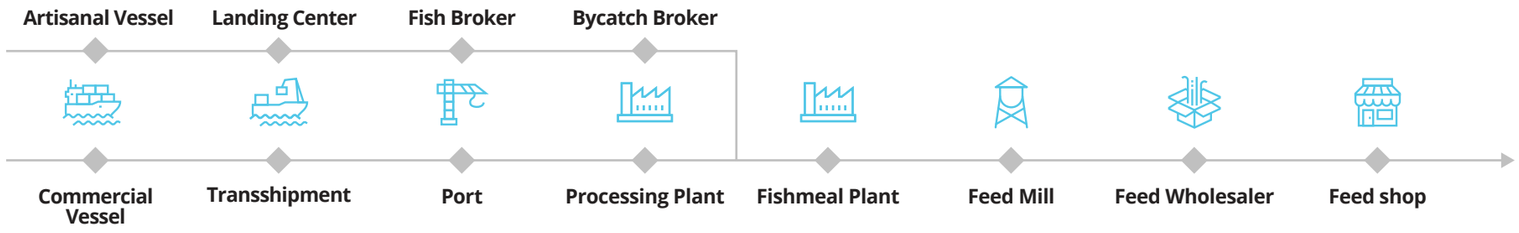
THE ADDITIVE NATURE OF ANIMAL FEED

Animal feeds are generally produced via "least-cost formulation," where feed producers use the cheapest ingredients available at the time to provide the nutrients needed for animals to grow.

However, ingredient prices are not static; as the price of one ingredient rises, alternatives are weighed, and formulations are altered. The feed manufacturer choosing alternate ingredients must also consider the nutritional implications. For example, when weighing fish meal or soybean meal, both provide protein, but fish meal has specific quantities and ratios of amino acids that make it more appealing as a protein ingredient for fish. Replacing it with soy protein does not yield equivalent nutritional value and may require additional ingredients to obtain the same growth results.

Cost and nutrition are critical aspects of feed formulation and production, and the continuous market changes for these ingredients makes feed and the traceability of feed ingredients a moving target. Greater awareness of the risks associated with these ingredients is required for complete feed traceability. While there is a respect for the proprietary nature of feed formulations, some level of transparency should be achieved so producers or buyers of animal food products understand the liabilities, including but not limited to forced labor, IUU practices, corruption, habitat conversion, environmental degradation, poor product quality, and food safety concerns that accompany specific feeds and their inputs.

Illustrative feed ingredient supply chain



BARRIERS TO ADDRESS

There is considerable complexity, inconsistency and uncertainty within commodity supply chains as a result of the variance in scale, extremes of consolidation, fragmentation, and species differentiation. For most products, the harvested plants or animals are not the starting point of the supply chain. There are many inputs—such as the feed meal used during livestock farming—that require their own supply chains entirely. The processes that go into sowing, growing, feeding, and harvesting are all elements that must be considered for their environmental, social, human health, and economic risks. The four major commodities discussed in this paper represent high value food commodities from major production regions. All four commodities have limited traceability and transparency beyond the final processor, and all have well-documented social and environmental challenges.

Building on the 2018 WWF-Accenture report ***Tracing the Supply Chain: How Blockchain Can Enable Traceability in the Food Industry***, there are five barriers that must be addressed to realize traceable supply chains.

Lack of Standardized Requirements

As consumers demand information beyond current regulatory requirements, retailers are asking supply chain partners to collect data based on their needs, which are not strictly aligned with industry standards. This leads to confusion and inflated administrative burdens for upstream actors trying to deal with different asks from their customer base.

Undifferentiated Products

While processing raw materials into a final product, batches from different suppliers are often mixed, making it all but impossible to track raw materials from farm to finished good. Most commodity processing capacity is dedicated to the creation of undifferentiated goods, which greatly limits traceable characteristics.

Scarce Incentives

Documenting product characteristics requires investments of time and capital at all levels of the supply chain. Consumer facing companies, such as retailers and wholesalers, do not equitably compensate upstream partners for the value-added steps required to achieve traceability.

Gaps in Connectivity

While supply chain actors may have the capability to trace products as they flow into their facilities as raw materials and out as finished products, the same processes or platforms are often not designed to track movement between all actors.

Disjointed Regulations

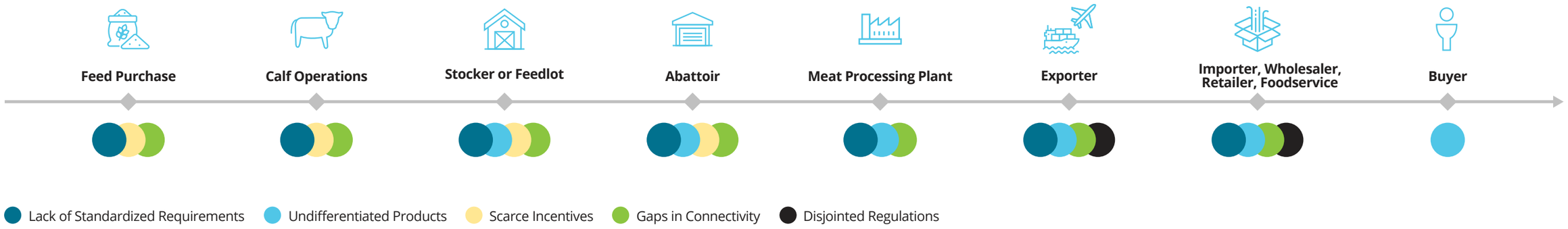
The safety or quality standards that affect market access have largely been determined by individual countries or political unions. Understanding that human rights and environmental limitations are universal, country-level regulations are challenging to adhere to and do not effectively hold transnational companies accountable.

BEEF

Beef production requires a significant amount of energy, water, and land, while also producing waste and greenhouse gases. As global populations and incomes continue to rise, so will the demand for animal proteins including beef. Beef cattle are raised in many of the most sensitive and important ecosystems around the world, including North America's Great Plains, Brazil's Amazon, Chaco and Cerrado, the savannas of Southern Africa and Australia's Great Barrier Reef watershed.

Beef has the largest environmental footprint of all animal protein commodities, more than double the greenhouse gas emissions of the second largest contributor, lamb. Farming practices are of critical focus as the development of ranches accounts for over 65% of total emissions and an estimated 25% of global land use change emissions.[17]

Cattle ranches are often sited within indigenous territories, forcibly displacing long-tenured communities against the protections established by the United Nations (UN) Declaration on the Rights of Indigenous peoples.[18] A recent study by Agencia Publica shows that 114 properties have been certified inside Indigenous territories under the Bolsonaro administration, equating to over 250,000 ha of land.[19]



Key Traceability Challenges for Beef

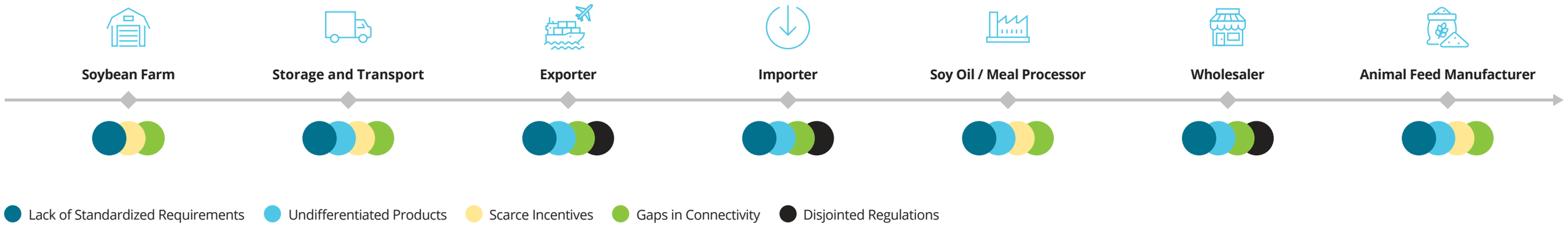
The furthest upstream sections of the supply chain, such as calf operations, are generally smaller and benefit from limited regulatory oversight. While there are some traceability regulations in various places—for example, the Animal Transit Guide (GTA) in Brazil which tracks groups of cattle moving between farms—it does not account for individual cattle.[20] This means that only the most recent movement of cattle is tracked and if cattle are sold more than once (which is not uncommon), all traceability of their connection to the original farm is lost. And once cattle arrive at the abattoir or slaughterhouse, there is no segregation between raw material sources. Processing also allows opportunities to mix products. In many countries, including Brazil, there is a lack of trust in human entry or audit results due to presumed and reported industry corruption.

SOY

Around the world, there is a surging demand for soy—the "king of beans."[21] Since the 1950s, global soybean production has increased 15 times over with three countries—the US, Brazil, and Argentina—producing most of the world's soy. China is the leading importer and is expected to significantly increase import volumes.[22] Soy is pervasive in our lives. Not only are soybeans made into food products like tofu, soy sauce, and meat substitutes, but humans also consume much of it indirectly via meat and dairy. Of the 346 million tons of soy grown annually, about 80% is procured by feed companies for livestock feed.[23]

Soy is the second largest agricultural driver of deforestation and habitat conversion worldwide. In total, the area of land in South America devoted to soy grew from 104 million hectares in 1990 to 282 million hectares in 2010, mainly on land converted from natural ecosystems.[24] Pervasive land use change results in loss of habitats, decrease in biodiversity, acceleration of climate change, and exacerbation of extreme weather events.

A report from the World Development journal found that soy expansion in the Amazon region has increased levels of inequality while continuing the process of land holding consolidation.[25] Despite the large growth in Argentina's soy exports, academic studies have found no systematic relationship between soy expansion and improved living standards of local populations.[26]



Key Traceability Challenges for Soy

Although soy farms are larger and more consolidated than their beef counterparts, soybeans from different farms are mixed during transportation or when stored in shared grain elevators. When this mixing occurs, it is impossible to trace where the soy was produced beyond the regional level, making individual farm accountability difficult. Additionally, once processed, soy is used as an ingredient in a wide variety of products across many industries; only a small percentage is consumed directly by humans. This widespread distribution of soy into the supply chains of numerous consumer goods manufacturers makes it difficult to track the origins of processed soybean oil or meal ingredients.

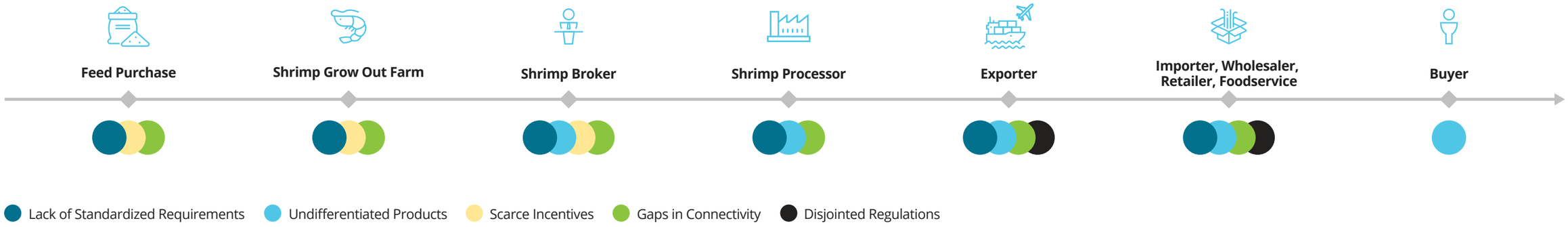
FARMED SHRIMP

The UN Food and Agriculture Organization (FAO) projects that of all animal protein commodities in the seafood industry, shrimp will experience the largest growth in demand in the coming decades.[27] Global shrimp production doubled between 2003 and 2016,[28] spurred mostly by aquaculture, which surpassed wild shrimp harvest to become the predominant source of seafood in 2007.[29] Shrimp production from aquaculture increased 500% from 2000 to 2017, and today, farmed shrimp is the most valuable traded seafood commodity in the world, by volume.[30]

Since 1980, a fifth of mangroves worldwide have been leveled to make room for shrimp ponds,[31] with the top five shrimp producing countries responsible for 53.7% of global mangrove loss.[32] In Vietnam alone, half of the country's mangrove forests have been cleared for shrimp farms.[33]

Although it is illegal to convert mangroves in some export markets like Thailand, Ecuador and India, protection and enforcement must be strengthened in all major producing countries.

The process of shrimp farming is resource-intensive, requiring large amounts of wild fish as a feed input, land, energy, and water. However, there are clear areas for improvements in input efficiency, like land usage. For example, approximately 40% of the 2.4 million total hectares of shrimp ponds produces only 4% of the shrimp.[34] Resources can and need to be used more efficiently.



Key Traceability Challenges for Farmed Shrimp

Shrimp is most often produced in a complex, disaggregated supply chain that obscures the full human and environmental effects of production. Despite relatively small farm size, the combined production of whiteleg shrimp in 2017 from hundreds of thousands of smallholders across India, Vietnam, Thailand, and Indonesia added up to 1.86 million tons (3.7 billion pounds). There are risks in shrimp feed supply chains that must be addressed as well. However, most feed producers do not sell directly to farmers because they are not large enough to command direct buying, and instead rely on a network of feed wholesalers and brokers. This makes tracing the impacts of feed consumed by shrimp within supply chains extremely difficult. Further, the lack of standard reporting is generally absent and not equally adhered to across small and large farms.

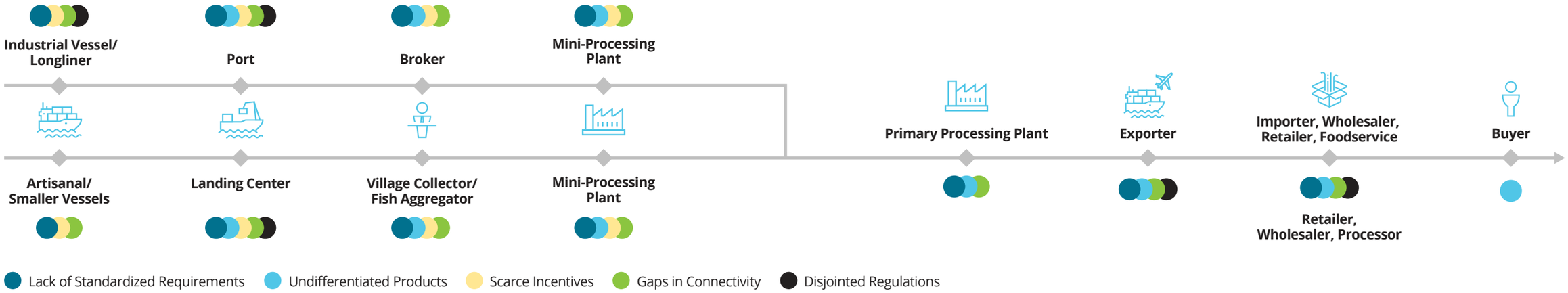
WILD-CAUGHT TUNA

Tuna are among the world's most popular and commercially valuable fish. Taken together, the seven most commercially important tuna species* inhabit all the tropical and temperate waters of the Earth's oceans[35] and support artisanal and industrial fishing in more than 70 countries.[36] World tuna catches have increased steadily since the 1970s, especially in the US, Japan, Western Europe, and emerging economies. Ecologically, tuna is a vital part of marine ecosystems.[37] As a top predator, they help maintain a balance in the ocean environment, stabilizing marine food webs by keeping the populations of prey species in-check.

According to FAO, most tuna stocks are fully exploited, meaning there is no room for fishery expansion. Many are already at risk of collapse. For some species, like bluefin tuna, overfishing has reduced stocks to as low as 5% of their natural levels, rendering sustainable fishing all but impossible.[38]

Increasing pressure to produce cheaper tuna has created an environment rife with harmful practices. Labor practices have especially been put into question. Accounts of abusive conditions and forced labor have caused the US Customs and Border Protection to halt imports from two Taiwan-based fishing vessels during 2020 alone.[39]

* Skipjack, albacore, bigeye, yellowfin, Atlantic bluefin, Pacific bluefin, and southern bluefin tuna



Key Traceability Challenges for Tuna

In addition to monitoring the movement of fishing vessels, which can be accomplished through Vessel Monitoring Systems (VMS), countries must also understand the number of fish species being caught. One way to keep records of fish volumes and species is through a fishing logbook, which each vessel must fill out while at sea. Fishing vessels must then submit their fishing logbook when landing at port. However, these documents are handwritten and difficult to verify and analyze.

Once the fish are landed and sorted at port, depending on the size and capabilities of the fishing vessel, they could go through multiple instances of brokering and processing, especially for catches from smaller vessels. Transshipment adds to the complexity and ability to authenticate catch information. These supply chains also lack a standardized approach to data collection and sharing, which makes it difficult to track product as it moves across country borders.

RECOMMENDATIONS FOR TRACEABILITY SOLUTIONS

As described, barriers to traceability present themselves at multiple nodes of commodity supply chains and remain stubbornly persistent across a broad base of agricultural goods. Although it is not possible for a single solution to address all of the barriers to traceability—lack of standardized requirements, undifferentiated products, scarce incentives, gaps in connectivity, and disjointed regulations—a suite of recommendations to inform the design of holistic traceability solutions can help facilitate change at scale.

Effective traceability solutions, with the goal of widespread adoption, must be low-cost and developed to maximize ease of use by companies, producers, and processors that may differ in language, culture, size, technical capacity, and regulation along a supply chain.

There is serious potential for companies to drive significant accountability by realizing incremental steps towards traceability. As a first step, companies can focus on changes which address the most at-risk areas of their supply chains. These efforts could target high-profile supply chain nodes, desirable product characteristics, or specific biomes, like the Amazon or the Cerrado. Additionally, consumers and regulators can aid traceability efforts by aligning and standardizing their demands of commodity supply chain actors, helping to direct private sector action towards the highest value initiatives.

As a more flexible and adaptable alternative to a single solution, this section puts forth recommendations to lay the foundation for traceability solutions. The concepts are further explored by showcasing practical applications of the ideas described. WWF puts forth these recommendations to inspire companies to take the first steps to accelerate traceability within food supply chains, creating information-efficient markets where purchases serve to reinforce sustainable behaviors and influence irresponsible actors to adopt better management practices. These five recommendations are meant to transcend specific commodities, providing a starting point for developing solutions.

Embedded Incentives

The uptake of any business program is ultimately determined by its business case, and the more profitable an endeavor, the more likely it is to be pursued by executive leadership. Traceability systems, therefore, must strike the right balance between effort and payout, using business cases anchored in solid incentives and capable of achieving an eventual return on investment for all participants.

The clearest business case for traceability systems is market access. High-income markets like the EU and US are demanding verifiable information during the import process. However, benefits extend far beyond a binary qualification for market access. For many food businesses, traceability is perceived as a daunting task with few financial benefits, but in practice, traceability has been shown to create competitive advantage. The key to uncovering value is integrating traceability systems with supply chain management, using traceability data to manage business processes and improve performance.[40] Benefits include enhanced physical qualities of a product (e.g., monitoring temperature history to manage freshness) and reduced costs (e.g., shrinking inventory to reduce working capital). Traceability is also an effective tool for managing and mitigating risks associated with individual enterprises because it maintains tighter control of processes that impact food safety and the wider industry by eliminating the risk of sourcing illegal seafood.[41]

Incremental Granularity

Traceability tools do not need to be sophisticated to drive behavior change in related supply chains. Shellfish monitoring programs in the US, for example, have created a remarkably safe environment for consumers while relying on a batch-level paper-based system.[42] The key to successful traceability solutions is finding the optimal level of granularity where the benefits exceed the costs[43] and the level of information drives desired behavioral changes. Traceability is a spectrum, and companies should think critically about the reasons for their solutions before undertaking capital-intensive projects. Farm to fork traceability at the individual item level may not be possible or necessary in large complex supply chains with multiple points of aggregation (e.g., beef, soy, farmed shrimp, and tuna). Focusing on verifying traceable entities at the logistical unit (pallet) or shipment level (lots) is likely possible with available information and should simply be mirrored during actual processing. As companies seek to differentiate their products, or adjust practices to reflect changing regulations, the granularity of traceability systems can be incrementally tuned without having an outsized effect on the balance sheet.

Equitably Distributed Investments

Due to the geographically dispersed and commoditized nature of most food supply chains, the financial burden of implementing traceability may be borne by the processing and packaging companies while the distributing firms—closer to the end consumer—are able to charge a premium for verified products and reap the gains. This structure partially explains why traceability has been slow to gain ground as a visible value-add marketing tool and why it is mainly being driven by food safety regulations.[44] As companies face the dual pressures of shifting regulations and consumer preferences, food importers, distributors, and retailers should distribute their investments to support upstream actors proportionate to the value they expect to gain in providing full traceability.

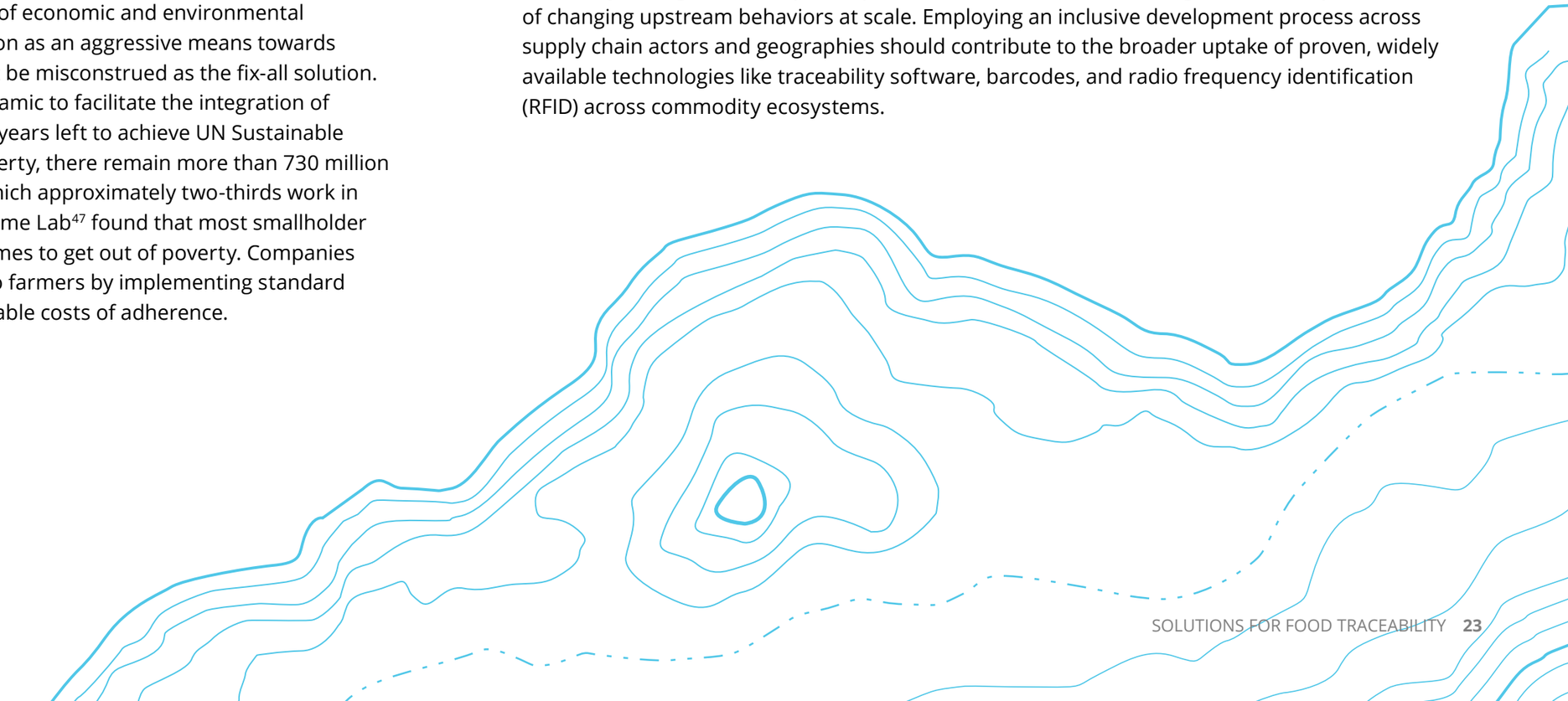
Affordable Access

As research highlights the interconnected nature of economic and environmental development, vertical integration and consolidation as an aggressive means towards traceability and supply chain oversight should not be misconstrued as the fix-all solution. Traceability solutions must be affordable and dynamic to facilitate the integration of smallholder farmers into global markets. With 10 years left to achieve UN Sustainable Development Goal (SDG) number 1 of ending poverty, there remain more than 730 million people below the World Bank poverty line,[45] of which approximately two-thirds work in agriculture.[46] Research in 2018 by the Farmer Income Lab[47] found that most smallholder farmers would need to double or triple their incomes to get out of poverty. Companies should make traceable supply chains accessible to farmers by implementing standard operation procedures and processes with reasonable costs of adherence.

Collaborative Technology Development

Traceability is a nascent concept, which relies upon data synchronization to deliver actionable insights, and consequently must be developed in partnership with supply chain actors who are often as diverse as they are numerous. Collaborative partnerships among competitors are imperative for creating solutions that are practical and proactively align actors to a common process and language. The systems must be flexible and interoperable, establishing shared standards across commodity supply chains. Careful consideration should also be given to the type of data collected and shared across the supply chain; companies must identify product characteristics that drive behavior change but do not sacrifice competitive advantage.

Historically, investments have been weighted towards developed nations, with less than 25% of agriculture and food technology investments occurring in developing countries.[48] Inclusivity during the development process is foundational to creating a solution capable of changing upstream behaviors at scale. Employing an inclusive development process across supply chain actors and geographies should contribute to the broader uptake of proven, widely available technologies like traceability software, barcodes, and radio frequency identification (RFID) across commodity ecosystems.



PRACTICAL APPLICATIONS

Traceability efforts that employ the five recommendations are most effective when a consortium of players—governments, private sector companies, nonprofits, and supply chain stakeholders—work collaboratively to design and implement solutions. Success hinges upon seamless information transfer between disparate systems, companies, and countries. For this reason, traceability can only be effective if all members of the value chain collect, store, and share data in a manner that is reliable and standardized.[49]

Collaboration amongst actors in competitive industries has traditionally been an unviable proposition. However, prominent industry figures like Toby Gardner, the director of the leading commodity traceability technology company Trase, believe there is room for optimism and growth. In a recent interview highlighting the outcomes of Trase's efforts in 2020, Gardner emphasized his belief that the commodity food market is moving from a decade of individual action from companies and countries to a decade of collective action.[50] This trend bodes well for a future where actors coordinate and align information across systems, clarifying and distilling once complex data into digestible pieces of information for companies, regulators, and consumers to access as they wish.

The following traceability solutions are examples of how the above-mentioned recommendations are being applied in different industries. Each example offers critical insight into how the supply chain operations of industry leaders are consistently overcoming barriers to traceability to design the information sharing and accountability systems of the future.

North American Shellfish

Shellfish production has been regulated since as early as the 1700s. However, it was not until the early twentieth century that public health problems associated with shellfish in the US brought a new dimension to the regulatory environment: Shellfish could no longer be sold as food unless it was of acceptable sanitary quality. Shellfish, if not properly handled, can cause illness or even death from Vibriosis, creating a compelling case for a traceability system capable of mapping a single product back to its source. The result has been the establishment of a pre-competitive platform called the Interstate Shellfish Sanitation Conference (ISSC), which is responsible for ensuring shellfish are safe for human consumption. The ISSC establishes safety standards, spanning from biotoxin monitoring to environmental permit reviews, and documents and enforces traceability processes. The shellfish industry is a prime example of a low-cost, manual, paper-based approach to traceability that created a fair environment not overly burdensome to small producers.

Employed solutions:

Element Profile Analysis

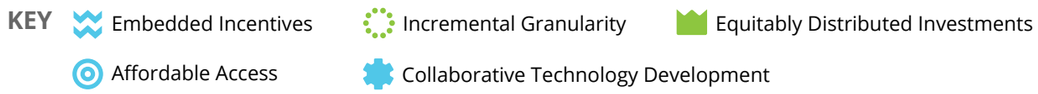
Trace Element Profiling (TEP) offers a peek into the potential future of traceability technologies. Originally used in the field of criminal forensics,[54] TEP analyzes natural concentrations of elements contained within plant or animal tissues. The concentration of each element provides a unique fingerprint which is then mapped to catalogued regions or biomes around the world. By creating a reference library of these varying levels of isotopes in agricultural goods from the major production regions, product origin claims can be objectively validated even when packaging has been removed or counterfeited. Although price is still prohibitive for wide-spread adoption, continued investments in TEP systems will help to drive costs down. WWF views this type of scientific approach as a key validation technique and is partnering with leading companies to build and publicize reference libraries.

Employed solutions:

Cocoa & Forests Initiative

Established as a partnership between the top cocoa-producing countries and leading chocolate and cocoa companies, the Cocoa and Forests Initiative aims to end deforestation by ensuring that no intact ecosystems are converted into cocoa farms.[51] Through the initiative, joint investments are formed between companies focused on improving supply chain mapping. Their goal is for 100% of cocoa to be traceable from farm to first purchase point. Over the past two years, companies have mapped over one million farms in their direct supply chains—492,900 in Côte d'Ivoire and 557,900 in Ghana.[52] In order to achieve full cocoa traceability, companies and federal governments partner to develop country-specific action plans for traceability applicable to all international and national traders.[53] Companies are also independently developing innovative approaches to improve their internal traceability systems, such as integrating GPS mapping and satellite monitoring, barcodes, and blockchain.

Employed solutions:



CONCLUSION

Since the globalization of trade, food has traveled far and wide from producers to end consumers. A thorough review of the literature indicates that food safety scares and illegal adulteration have been reported since the middle ages.[55]

As business matured and integrated value-added processing steps, supply chains have become ever more distributed around the globe. Production, processing, formulation, and distribution could all conceivably occur on separate continents, and undoubtedly within different countries. Yet, despite awareness of historical failures, well-documented risks, and more stringent regulations, food traceability has remained stubbornly unresolved.

Traceability is not something that can be solved by a single company, government, or nonprofit organization. There is an immense need for food industries to quickly pivot from a decade of individual commitment setting to a decade of collective action. Practically speaking, the only path forward is for companies to work together in a pre-competitive fashion, establishing platforms capable of adapting to more stringent regulations and shifting consumer demands, while delivering safe and nutritious food that does not come at the cost of people and planet.

As regulatory authorities are starting to pay more attention to and develop stricter regulations around increased traceability and transparency in food supply chains, it is strategically advantageous for companies to lead or join traceability initiatives before they are mandated to do so. This proactive step would give companies power over their own fate and fortune. After all, they are best positioned to leverage hundreds of years of institutional knowledge to create better practices for themselves while shaping the future of traceability for entire industries.

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Authors

Aaron McNevin
Global Network Lead, Aquaculture
World Wildlife Fund
aaron.mcnevin@wwfus.org

Blake Harris
Manager, Aquaculture Traceability
World Wildlife Fund
blake.harris@wwfus.org

Amanda Stone
Director, Issues Engagement & Communications, Markets & Food
World Wildlife Fund
amanda.stone@wwfus.org

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worldwildlife.org
World Wildlife Fund
1250 24th Street NW
Washington, DC 20037