Chapter 9
A Chain of Linked Nuances

Lisa Jo Lupo

Abstract It seems relatively simple: All of the food we eat originates on the "farm" as produce or animal, then flows downstream through a watercourse of channels to arrive on the consumer's plate. Unfortunately the food supply chain is not quite that simple, nor is it always a forward flow. In fact, it can be argued that the supply chain is actually driven backward, with the demands and expectations of the consumer creating ripples that impact each link of the chain – from retail (grocery, restaurant, or farmers' market) back through distribution, manufacturing, and packing/co-packing, to the farm. And when a customer complaint or positive test result necessitates tracing back to the source and forward for recall and communication, the unique nuances and challenges, the stressors and strains, of traceability at each link – and the potential results of breaks in the chain – are found to create a rather complex torrent of channels that defy the perceptively easy flow of "downstream." Thus, while the flow of the food supply system is often referred to as upstream and downstream, seeing it as a series of links in a chain is, in fact, a better representation: each link is a separate entity but each must seamlessly interconnect with the link to each of its sides for the system to be successful as a whole. This chapter follows that chain (from the consumer backward) to discuss each link and linkage, and the nuances and challenges that are created by the riptides of back-flowing expectations and forward-flowing product/ingredient identification.

Keywords Retail · Upstream · Downstream · Customers · Manufacturing · Farm

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Introduction

Today's food production and distribution system is evolving from processes of reaction to those of prevention. Traceability is, in and of itself, a reactive system – intended to trace a problem that has already occurred back to its source, but, because our world is not a perfect one, and errors and misguided intentional issues do occur, traceability – with its integrated corrective action – is an integral aspect of prevention in the food safety system at each link in the chain.

Traceability is not a new concept, but it is an ever-evolving thing, with today's traceability driven not simply by food safety, but also by consumer demand for transparency and accountability, and the use of their voices and purchasing power to impact the chain of food production.

There are similarities in the impacts, nuances and challenges of traceability between the links of the food chain – and these commonalities have increased with the publication of the rules of the Food Safety Modernization Act (FSMA), intensifying the equitability and responsibility for food safety along the chain by adding or increasing regulation to links in the chain not previously held to such rules – such as that of transportation with its significant impact on distributors, and produce which now has its own specific set of federal rules.

Additionally, some of the generalities of challenges are of the same vein. For example, it is commonly held that tracing backward is more difficult than tracing forward. In forward-tracing, the points tend to narrow down; but backward – most finished product is either multi-ingredient, each of which must be individually traced back, or, if bulk product such as produce or grains, is likely to have been commingled at at least one point in the chain. Thus, the hand-off between links in the chain is of critical importance.

Food products are currently able to be labeled to the case level, but both the desire and growing requirements are to label to the individual product. Is it possible? The ability exists, but the economic feasibility and the attainable accuracy remain in question. Being able to individually label ever-lower amounts of product will not only help to further protect the individual consumer, it will reduce food waste as companies exercise an "abundance of caution" to dispose of not just entire lots but often one lot forward and one lot back, for the ultimate in consumer (and brand) protection. Such waste is evolving from a business concern to a global concern as the world population continues to increase to an expected 9.8 billion by the year 2050. It is such human factors that are driving the food industry to increase its accountability to the consumer – at each link in the chain.

The Consumer: An Integral Part of the Chain

Just as all food ends with the person who intends to consume it, so too do the demands and expectations of and for that food begin with that same consumer. Thus, to thoroughly understand the nuances and challenges of each link in the chain

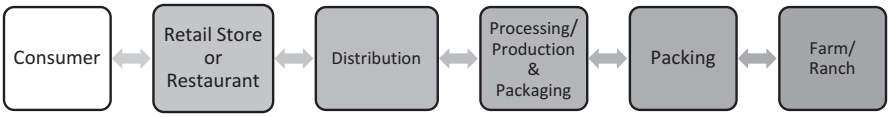

Fig. 9.1 Supply chain: The consumer

that supplies this food – from farm to table, we must consider consumers to be an integral link; understand their expectations and perceptions (right or wrong); and realize the impact of these on the demands of traceability (Fig. 9.1).

Today's consumers are more educated about the food they eat. They seek out information and have unprecedented access to information – and misinformation – through the virtually infinite expanses of the internet – the World Wide Web – and all the topics and trends therein. Because the internet and its social media options provide open, unrestricted, uncontrolled, and often anonymous, access to anyone who wishes to opine on anything, those who have anything to say – fact or fiction – have unprecedented access to a worldwide platform and a receptive audience.

There's an old saying that a person will tell of a bad experience to ten people who will tell ten people and so on, eventually reaching hundreds of people. In today's world with the ability of a single post to be liked, shared, tweeted, retweeted, discussed, snapchatted, etc., that saying is multiplied a hundredfold and more, with the ability of a single person's idea or opinion to become an overnight trend, which soon transitions to a consumer demand, and, more often than not, is developed as a retail standard or even federal regulation.

One simply need recall the impact of a mother's post on "pink slime" in 2012 to understand the impact. Although lean finely textured beef (LFTB) was approved by the USDA as safe and used by numerous ground beef retailers, its internet sensation had consumers in an uproar, and led to school-lunch bans, the closing of three of the company's four plants, and loss of hundreds of jobs. Ironically, barely a year later, economic concerns and the USDA's continued affirmation of the product's safety put the beef product back in schools and on consumers' tables – and even holds a place of prominence on its manufacturer's website.

Like the perception of the LFTB … many consumer trends have little or nothing to do with food safety – despite such misrepresentation and misinformation that is all too prominent on the Web.

And it is just such trends and misinformation that add transparency to the list of challenges the food industry faces in traceability. Consumers want safe food – which is the key reason for traceability, but they also want to be able to make informed purchasing decisions, and retailers want to provide the means for them to do so.

Thus, traceability has become more than a tracking of contaminants, adulterants, and unlabeled ingredients. It has become a means of fulfilling consumers' desire, and right, to know what is – and isn't – in their food; how their food is grown …

manufactured … stored … transported … served; what really happens behind the closed doors of the food supply chain.

Walmart: Dedication to Transparency
Oct. 6, 2014 – "In front of hundreds of associates, suppliers and nonprofit organizations at its Global Sustainability Milestone Meeting, Walmart today announced its commitment to create a more sustainable food system. The company will reach this goal through four key pillars: improving the affordability of food for both customers and the environment, increasing access to food, making healthier eating easier, and improving the safety and transparency of the food chain. … Walmart will work to provide more information and transparency about the products on its shelves so customers can see where an item came from, how it was made, and decode the ingredient label." [8]

May 22, 2015 – "Our customers want to know more about how their food is grown and raised, and where it comes from. As the nation's largest grocer, Walmart is committed to using our strengths to drive transparency and improvement across the supply chain," said [Senior Vice President of Sustainability Kathleen] McLaughlin. "We believe it's important to promote transparency in this process, helping to put our customers in charge of their food choices by providing clear, accurate information about food ingredients. We appreciate the leadership our suppliers have shown to help us accomplish these goals." [10]

Thus, traceability has taken on an expanded role in each link in the chain. Not only must retailers ensure that the produce in their bins is safe, that allergen-free food truly is allergen free, but the supplier who provides that retailer and foodservice company with food labeled as organic, natural, or GMO-free is being driven to follow supplier traceability standards and recordkeeping of such transparency. The same is true of such consumer demands for humane treatment of animals, antibiotic-free, pesticide-free, cage-free, etc.

Disregarding one's opinion on the truth or misrepresentation of any of these, consumer right to know has added a challenging dimension to traceability. It is a matter of brand protection of each link to ensure every ingredient in every product is traced back to its root source, with each and every label claim – regardless of food safety or quality applicability – validated each step of the way.

It's a matter of consumer confidence in and future purchase of a brand's products. As depicted by the results of the 2018 Food and Health Survey from the International Food Information Council Foundation, consumers continue to be concerned about foodborne illness, carcinogens and chemicals in foods, but confidence in the overall food supply has risen slightly with the increased regulation (Table 9.1).

Table 9.1 Consumer confidence in the food supply [1]

Confidence level	2014	2018
Very/somewhat	66%	68%
Not too/not at all	30%	28%

Even the regulatory aspects of the food supply chain are essentially driven by the consumer. One simply need look at the Food Safety Modernization Act (FSMA) to understand this. While the specific rules of FSMA are written and enforced by the U.S. Food and Drug Administration (FDA), the Act itself, which requires FDA publication of the rules, was written, passed and mandated by Congress – an elected body "of the people."

And according to the 2015 Harris Poll from Nielsen, "the people" believe such government oversight is critical. Of poll respondents:

- 86% say food recalls have them at least somewhat concerned (with 58% somewhat concerned and 28% seriously concerned).
- 73% believe there should be more government oversight in regard to food safety.

When all this is taken into consideration, it is fairly easy to see that consumers drive retailers; and in order to meet consumer demands and expectations, those retailers (grocery and foodservice) must not only drive their suppliers, driving those suppliers' suppliers and the suppliers' suppliers' supplier … back to the farm, they must have a traceability system that verifies and validates the food safety [5].

At Retail: A Dual Role of Grocery and Foodservice

One of the greatest challenges for those in the commercial marketplace – whether it be retail or restaurant – is its dual role. Not only is it constrained by its own consumer, regulatory, and corporate requirements, but because it has the most direct line to consumer purchase, it is the link which has the responsibility of removing unsafe or mislabeled products from consumer purchase (Fig. 9.2).

Additionally, it is generally the only link that has any potential for tracking such product *after* consumer purchase. With such increased accountability, those who sell direct to consumer have learned to take on a policing role in traceability.

As such, anything that is done at this level is done for (or to) everyone in the supply chain. A restaurant that decides to promote its "all-natural, additive-free" menu has an obligation to hold its suppliers, its suppliers' suppliers, etc., to that commitment as well.

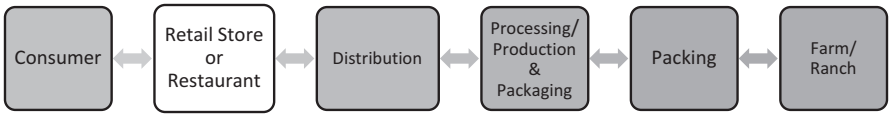

Fig. 9.2 Supply chain: Retail store and restaurant

Restaurant and Retail Impact

Every restaurant and retailer, large or small, impacts the food chain back to its source, even if only in its decision as to which products it will carry. But, there is no question that the larger and more prominent it is, the greater impact it will have. One of the best demonstrations of this is that of Walmart Inc.

With revenues of more than $500 million, Walmart was No. 1 on the 2018 Fortune 500 list [11]. Whether one has a positive or negative view of this corporate giant (and/or corporate giants as a whole), Walmart's prominence has enabled it to lead the food chain to increased food safety, transparency, and traceability.

As then-Vice President of Food Safety Frank Yiannas said in an interview with Quality Assurance & Food Safety (QA) magazine, "140 million customers walk through our stores in the U.S. in one week, and 200 million do globally … we have the ability to have a large impact on food safety and health." [9]

Those customers, Yiannas said, have an unspoken expectation that the products they buy will be safe. And ensuring that the expectation is fulfilled means requiring a culture of food safety throughout its stores, *and* throughout the company's entire supply chain.

While each step back in the supply chain has customer commitments for which it must make demands of its suppliers (e.g., an organic processor must ensure its suppliers provide only verified-organic ingredients, a peanut-free product manufacturer must ensure no cross-contact back to the farm, etc.), the consumer-facing company has the longest and most complex of chains to trace and the greatest obligation to quickly know of recalls, and stop sales of implicated product.

The Bioterrorism Act of 2002 recordkeeping requirements mandate that every link in the chain be able to trace products one step forward and one back, with lot number as the standard identifier. Although there are some retail and restaurant exemptions to the mandate, as well as new FSMA recordkeeping requirements, in today's litigious world, it behooves restaurants and retailers to consider themselves as much an integral link in the traceability chain as they are in the food chain itself.

It is, however, the very identification of implicated product that can be the greatest challenge in traceability for the grocer or foodservice provider, particularly when dealing with loose produce item, such as apples, onions or tomatoes.

In order to ensure a continuous and abundant supply of produce for customers throughout the day, items from varying lots will be commingled in the retail produce bins as stock is continually replenished, and/or product is separated for use in deli sandwiches or salads. While the produce is still trackable by lot, as required, this mixing and secondary use of products of multiple lots means that the recall of

a single lot of tomatoes could cause a store to have to pull every tomato in the store bins, deli prep, and prepared tomato sandwich and salad.

Thus, depending on the commodity, how much is out in the store at the time, and how the supplier defines its "lot," a recall of a produce item could mean a retailer pulls 20 or 200 pounds of product per store – which may or may not be of the lot recalled.

That said, retailers such as Walmart, require that every lot be traceable back through production and/or packing house (facility, date, time, line number, etc.) to the farm (field, date, time, etc.). The information need not all be listed on the lot coding, but it needs to be traceable … in case it needs to be traced. And the faster the retailer is informed of an issue, the better for everyone. Pulling an implicated product while still at the retailer's distribution center will be much more efficient and able to be lot specific.

Even non-produce items can be subject to such an "abundance of caution," as the definitions of packaged product lots can also be subjective, with products labeled to the case or pallet level. With such items, one may choose to pull or recall not only the implicated lot but also those of previous and successive lots as well. While the ability to label to the individual product exists, and would be of great benefit in waste reduction, the economic viability is questionable.

Additionally, few retailers would have the ability to accurately inform individual customers of an implicated product they purchased. And those that do keep track of their customers' purchases through store cards or other means may be wary of beginning such a notification process because of the liability of responsibility to inform that could go along with it.

Thus, while both retailers and restaurants seek to balance food safety and traceability/recall requirements with sustainability and environmentalism, the current standard tends to focus on an "abundance of caution."

Through Distribution: The Middleman

As the next-in-line upstream supplier to the grocery/foodservice provider, distributors are faced with responding to numerous challenges to meet the expectations of the end consumer as well as fall within the standards of the retailers to whom they distribute product. At the same time, they are continually being challenged by the range of capabilities, and the vast number, of suppliers that need to be managed (Fig. 9.3).

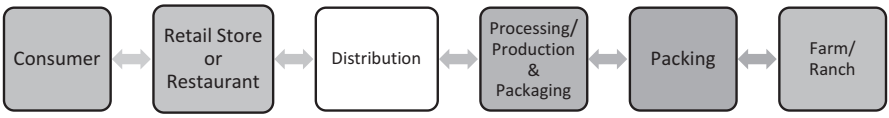

Fig. 9.3 Supply chain: distribution

As such, retailers and restaurants do not always have a true sense of the capabilities of distributors, the feasibility of certain expectations they have of this link in the chain, and/or the challenges of meeting expectations through a long-term solution rather than a short-term bandage.

Upstream Suppliers

To a great extent, the larger the distributor, the more in-depth – and more complex – its traceability program. With the need to manage more than 100,000 suppliers of varying types and sizes, a large distributor, such as US Foods or Sysco, has to be able to depend on complete and accurate information from its suppliers. However, there are as many reasons as there are suppliers that this isn't always the case.

A primary reason is the variation in lot coding. While food is required to be traceable through a lot coding system, there can be a great deal of variation between the systems and resulting lot codes of the products. For example, a produce supplier may define a lot by date and/or time, grower or field, or even buyer, and a co-packer doing small runs may simply break lots by brand – each of which would create a difference in coding. (To see the variation that exists between products, one simply need look at the array of lot codes on the boxes and cans of food in their pantry.)

Because of all this, product codes don't always align with the information needed by the distributor or that which is expected by the retailer. This may simply be due to the system the manufacturer chooses to use, or it may be a factor of the company's capabilities, with small and local suppliers often having more basic, even manual, systems. (The same can be true of distributors themselves, with smaller distributors not always having the resources or the technology of larger, multi-facility businesses.)

This, of course, in no way absolves a distributor from ensuring it can trace all product one forward and one back as required. Thus, most develop specific supplier requirements and systems to verify the supplied information. As discussed in a 2010 QA magazine profile on US Foods [3], for example, the company was tracking incoming supplies by pallet based on the receiving date and recording the issuance of pallets to customers. The specific case and lot numbers of product on each pallet were provided by the supplier on an Advance Shipping Notice or the purchase order. When shipments were received, they were spot checked for validation.

While it would be ideal for all in the supply chain to be able to apply technology that would scan every case and item in and out, the available technology is generally too expensive and time consuming for universal implementation. Thus systems still often focus on the pallet and can require significant manual input.

This is because, although electronic data capture systems are used in distribution, they are, for the most part, static. That is, general information can be pulled into the system (XYZ Beef case of beef patties, lot #150709435, etc.), but additional information that is needed from the supplier may not be able to automatically transfer to the next system, so that data, such as lot testing date, expiration date, etc., must be

added as transactional data instead. With technology accelerating at a rapid rate, new systems such as blockchain and those that utilize secure internet or "cloud" sites to provide data links are being developed and tested regularly. But down-to-the-item tracking is simply not – yet – feasible for all in the food chain, particularly for small and very small businesses, those bringing in supplies from a vast range of manufacturers, and those still tracking on paper or spreadsheets.

The recordkeeping and tracking get further complex when a distributor allows broken shipments, e.g., customer purchase of less than a full case. Because a product lot could be made up of only a few cases from a small supplier or thousands of items by a large manufacturer, a recall can mean identification and notification of a single customer or that of numerous recipients, and breaking a shipment by allowing purchase of a single bulk can or a few boxes of product by many would significantly increase the tracking and notification needed. Thus, some distributors no longer allow this practice, requiring minimums and full-case purchase.

Downstream Customers

As the previous example shows, the integration of traceability systems isn't just an upstream supplier issue, rather, as the middleman of the food supply chain, the distributor may have significant challenges in tracking downstream as well. A single box or can of food, for example, may travel a number of different ways/routes before reaching the end consumer. Additionally, retailers are not the only businesses to which distributors ship. Rather, some customers receive product for further processing, such as pizza, salads, etc. This means that a single item that is sold to a consumer may be an amalgamation of numerous products – with the burden placed on the distributor to capture and validate that information back to its source.

In many cases, a distributor is actually delivering to a retailer's distribution center (DC) – adding an additional link in the chain and, generally, additional requirements. Walmart, for example, receives product at more than 150 distribution centers, from which it ships product to its retail stores. The retailer requires not only that incoming goods be tracked back to the source, but that it be informed of any other recipients of the product from the same lot.

This is because the retailer may have purchased additional supplies of the product, say apples from a broker – to whom the distributor provided the product. So by having the information in a single record, the retailer would immediately know to pull that product as well, instead of having to wait for secondary contact from the broker. And when a Walmart DC is informed of a recall of product it received, the company will tell all its stores served by that center to pull the product from their shelves – regardless of lot number – out of an "abundance of caution." The retailer also has the ability to restrict the sale of an item at the cash register, so if any shoppers put the product in their carts before it got pulled, or a single package of the recalled product was missed, the cashier will not be able to ring it up/allow pur-

chase. Walmart doesn't lift the restriction until it is informed of and is comfortable with corrective action taken by the supplier – FDA acceptance is not always enough.

Whether a distributor is sending product to a customer's distribution center or directly to the retail site, it can face challenges of customer requests for delivery scans. In some cases (e.g., if the supplier follows GS1 standards and labeling practices), distribution information can be automated, but a requirement to scan every item at every stop would significantly increase the time and costs of distribution, increasing the overall cost of products. For example, if a distributor's delivery stop averages 25 min; scanning each item would add a minimum of 5 min to each stop. When calculated across the hours and number of stops in a business day, the impact would be a reduced ability in number of stops per driver, increasing the number of drivers and trucks needed. Because of transportation rules limiting the number of hours a driver can be on the road in a day, the company couldn't simply allow the driver to add the extra minutes, and resulting hours, to the day.

Such on-the-road rules also increased with the roll out of FSMA, which includes new rules for transportation of food product and defines distributor facilities as "food facilities," making them subject to food facility rules to which they were not previously held.

Consumer Expectations

Although the law only mandates tracing one step forward, a distributor is just as held to consumer expectations as is the retailer. For example, while a consumer request for "local" product does not increase traceability challenges – as this is listed on the label and the retailer/foodservice provider can select items by ingredients, it can become an issue when product runs low. For example, if a customer orders produce, the distributor can generally provide it from a number of sources, substituting one source for another when supply runs low. But if the customer requires local produce, and there is none available, the customer will have to make a choice, allowing produce from another region to be shipped or not receiving any. The distributor cannot simply substitute a comparable, non-local, product. The same is true of a request for natural, GMO-free, and other such consumer requests.

Stocking local product also provides other challenges, and costs, for distributors, as these have to be separately received and handled, specifically coded and segregated. Thus, while customers often perceive that local foods should cost less and be more environmental, the opposite is actually true. For example, rather than utilizing the efficiencies of large trucks that can haul a vast array of foods, local produce is more likely to be transported across the region in small amounts in pick-up trucks that have higher consumption of gas per pound of food. Thus, the environmental impact can be significantly higher for local foods – contrary to general belief.

The expectation of the distributor's customer is driven by the expectation of the retailer's customer – the end consumer. And those expectations continue to pass upstream to the manufacturer.

In Manufacturing

According to the 2013 CDC report, *Surveillance for Foodborne Disease Outbreaks – United States, 2009–2010*, "Among the 766 [foodborne illness] outbreaks with a known single setting where food was consumed, 48% were caused by food consumed in a restaurant or deli, and 21% were caused by food consumed in a private home" [7]. Despite this 59% downstream culpability, food processors and manufacturers are generally perceived as the greatest culprit in such outbreaks. This perception may be due to the likelihood of a manufactured product impacting more people across a greater geographic range; it may be because these recalls tend to get the greatest media and social media coverage; or it may simply be because this link in the chain is generally the least transparent, therefore the most suspect (Fig. 9.4).

Regardless of the reason, manufacturers frequently encounter consumer perception of "the buck stops here," making it all the more important that they have a thorough traceability program both up and down the supply chain, and even more critical, that they have verifiable and validated testing, sufficient test and hold, and specified "clean stop" programs by which to limit or disprove culpability in a recall and, when applicable, move the inspection upstream or downstream.

In fact, it is interesting to note that, despite the fact that it is not the most prominent cause of foodborne illness contamination, the manufacturing industry can be said to be the most tightly regulated (although FSMA rules are serving to spread the regulation and responsibility more equitably along more of the food chain).

While time is a significant element of traceability at all levels, its magnitude in the traceability at the manufacturing link may be the most critical aspect of a program. Thus, the manufacture should know its traceability process so innately as to be able to take immediate action if a product is implicated, whether by in-house testing, regulatory notification, consumer complaint – or any other reason.

One of the most common means of achieving this is the practice of holding mock recalls. In fact, while FDA is still in the process of developing FSMA's product tracing rules, the agency has published National Commodity-Specific Food Safety Guidelines, such as that for cantaloupes and netted melons, that recommend that "A trace-back and trace-forward exercise should be conducted at least annually and should achieve accurate traceability within four hours or as required by applicable regulations. The trace exercise should achieve an account of all product one step forward and one step back (100% reconciliation)." [4]

While noting that product tracing systems are not a preventive measure, the guidelines do state that they "are an important element of a comprehensive food safety program and should be verified periodically for effectiveness." With this in

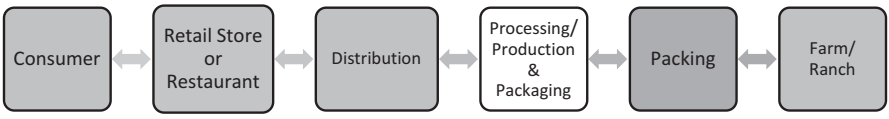

Fig. 9.4 Supply chain: manufacturing

mind, there is a certain likelihood that the FSMA rules on product tracing will incorporate similar recommendations – or mandates.

Although recall exercises are an important element of the food safety program, even more critical is having the alert system to notify the manufacturer of a potential contamination – i.e., product testing – and the retention of product until it is verified as safe – i.e., a test and hold program. This test and hold program should be set up so as to assume that every test will come back positive, and that a process be in place, that every person knows his or her responsibilities if and when it does, and that back-up personnel be assigned if the primary is unavailable. All of which are aspects of ensuring that the critical element of "time" be fulfilled and product be stopped from moving further into the supply chain should a contamination be detected.

Additionally, to halt sales of a product implicated after shipping, the manufacturer must have the ability to communicate with all downstream recipients at all times – from the designated contacts of the national grocery chain to the owner of the mom-and-pop market who may be camping in the wilderness on the Saturday night that the detection occurs, and/or any distributor or broker in between.

Downstream Customers

Such brand protection challenges also extend to the downstream handling and use of one's product. A key, nearly universal, aspect is ensuring that the product is transported and stored at the proper temperature. But there are also commodity and product-specific aspects, such as the beef producer ensuring that bagged beef intended to be sold whole, is not ground at retail – a use for which it hasn't been tested and found safe.

As technology continues to improve, the manufacturer is able to gain greater control over such downstream traceability. For example, there are sensors that can be placed with the product during transportation for remote monitoring. Not only can these monitor the temperature of the product, but with GPS tracking, the trucks can be monitored for location, speed, unscheduled breaks, etc. When drivers know they are being tracked, they may tend to be diligent, resulting in added protection for food safety and food defense as well.

This can be of particular benefit when high-value foods (such as baby food) are being transported, as these products are the most susceptible to theft and diversion. Along with the risk to the quality and integrity of the product, economic adulteration of stolen product takes such forms as product dilution and label recoding, with subsequent sales to small, local, or discount stores that may have less-sophisticated supply standards.

Despite the fact that recoded and/or diverted product is now likely to have been compromised – out of the hands and traceability of the manufacturer – it is still the manufacturer's name and brand that is at risk, along with the consumer. Additionally, it is virtually impossible for the manufacturer to know where the product has gone

or what may have been done to it unless and until a customer complains, and it is discovered the product came from a store to which the company never sold its product. At this point, the challenge will be to convince that store owner to trash the product and to only buy from certified/approved brokers in the future.

Upstream Suppliers

General upstream traceability can be just as much of a challenge for the manufacturers, particularly those that produce a great deal of product, a variety of product or multi-ingredient product – which can be said to be applicable of the vast majority of food manufacturers. In such cases, it is likely that lots will be commingled, requiring that every lot number of all ingredients in a product be recorded and tracked.

This is particularly essential when manufacturing specially labeled products, such as organic or kosher-certified, or those not listed as containing an allergen. In such cases the manufacturer must not only follow all correct protocols but must ensure against commingling with non-certified or non-allergen-free ingredients. If a shortage of a certified/allergen-free ingredient occurs, substitutions cannot be made to complete the order. While non-certified substitutions would not impact the *food safety* of organic- or kosher-certified foods, it is a consumer issue that can greatly impact the reputation of the manufacturer – as the consumer is paying for a specific characteristic, and there are consumer groups who will purchase such product off the retail shelf purely for the purpose of verifying its certification.

Similarly, the tracking of foreign ingredients back to the farm can be of significant challenge to the manufacturer, particularly when the ingredients are grown by, and only attainable from, small farmers. The confectionary industry faces such challenge with the purchase of cacao, which, because of these trees' need for specific amounts of warmth, sun, humidity, and shade can only be grown within 20 degrees of the equator, and because of the amount of attention and care required for their growth, are generally grown on small farms of less than 10 acres, and the beans commingled through exchanges before being roasted and processed [2].

While downstream, upstream, and international traceability pose challenges for manufacturers, the integration of their own internal systems can be just as demanding, as it can be difficult to have a single conjoined system that flows throughout all operations and departments of a plant. Because of this, a manufacturer often will have one system at receiving, manufacturing, and distribution – then link these with the others using third-party widespread systems. However, with the variation of data needed for each operation, and differences between plants themselves, third-party systems can still be cumbersome, expensive and difficult to configure to the user's need.

Add to all this the need to continually adapt to ever-increasing regulation, retail and restaurant requirements, global standards, and consumer needs that revolve around trends and perception as much as (or sometimes more than) food safety or

quality, and it becomes clear that the most successful manufacturer is likely to be the one with the most accurate crystal ball.

Through Packing/Co-packing: Integrated Separation

Packing, or co-packing, has an array of types and definitions and can be a step in the chain both before manufacturing and at the processing step. From the farm, it can be the sorting and packing of produce by type size and quality; it also can be the minimal process of cutting vegetables into individual portions or party trays (Fig. 9.5).

A packer may be a single brand that has a number of growers with whom it regularly works or individually contracts; it may be a co-packer that packages produce for various brands; or it may simply be the facility that sorts and packs bulk product to move it on to the next step.

As a processing step, as discussed in the previous section, co-packing can be a brand's use of a contracted processor for the manufacture or packaging of some its product. This practice is generally implemented for small or specialized runs, such as seasonal products, focused-marketing packaging, etc.

Thus while it is an essential link in the chain and may be a completely separate link, it is generally such an integral part of the previous or following step that this chapter discusses packing/co-packing as aspects of growing/processing rather than attempting to separate these out.

That said, as addressed in each of the two linked sections of this chapter, there are challenges unique to packing/co-packing, resulting primarily from the communication and integration of processes needed when two separate businesses must, essentially, operate as one.

Packing and repacking of produce can occur at many steps in the chain, from a single brand utilizing multiple growers (addressed in the next section) to co-ops and conglomerates that warehouse and pack multiple products from multiple growers, to repacking at a distribution center to sort out produce that may be going bad or to resort product for a particular use or customer.

While lots will be traceable upon receipt, once the commingling begins, the traceability challenges expand. And when produce is commingled multiple times – e.g., in the packing house, at the distribution center, then at retail to create a salad or fruit platter – the accuracy of the tracking information has multiple opportunities for errors.

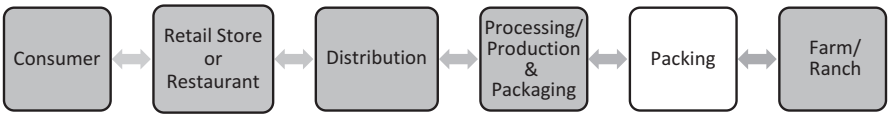

Fig. 9.5 Supply chain: packing

Co-packing can also add to the potential for purposeful economic adulteration. With co-packers identified simply by the code on the package, any alteration of a single number or letter in the code, or the application of a new label with false information, would completely nullify traceability and disassociate the actual packer.

Some of the greatest challenges of traceability in co-packing in manufacturing are that of labeling – ensuring the ability to integrate the co-packer's plant code into that required by the brand being co-produced. In such production, it is the commingling of ingredients that is most likely to introduce challenges. That is, because the runs are generally small, a very small amount of bulk product is likely to be used. Yet even in small amounts, this bulk product, such as rice from a silo, may have been commingled from different lots which can settle together as rice is fed from the silo into production.

From the Farm: Where It All Begins

It all starts at the farm. Thus, a single inaccuracy at this point – whether it be the accidental transposition of a number, the hurried "pencil-whipping" of field notations at the end of the day, or the inability to decipher a hand-written entry – will impact the traceability all the way through the system. This is the same whether it is the tracking of field produce or food animal (Fig. 9.6).

Thus, the greatest challenge at this level can be ensuring the accuracy of information that is passed forward throughout the chain. Although automation is increasing with pallets coded and tagged, systems still require that the user in the field enter the information (e.g., field, day, time, crew, etc.) in one form or another. There is a great deal of potential for the use of GPS devices that can automatically enter much of this information, but the industry, as a whole, is not yet at that level.

Additionally, there are some growers who do still rely on handwritten field tags. In such cases, there is a reliance on the integrity, literacy, and accuracy of the person recording the information; and the need for a dual step of manual entry into a recording system leaves opportunity for further error.

Not only can there be inadvertent mistakes of entry in the field, there can be purposeful mis-entry of information, e.g., if produce is being harvested from a different field than expected, etc. This could have an impact on traceability should a recall be required and be an issue if the produce were then mislabeled as organic or natural.

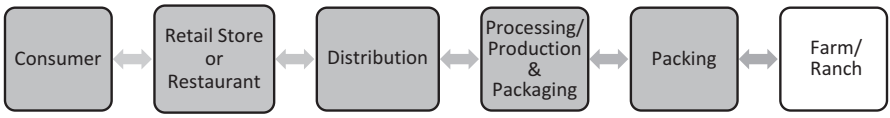

Fig. 9.6 Supply chain: farm

Probably the most organized system of traceability for produce is that of the Produce Traceability Initiative (PTI), launched in 2008, and now sponsored by Canadian Produce Marketing Association, GS1 US, Produce Marketing Association and United Fresh Produce Association, which provides for case-level electronic traceability of produce throughout the supply chain. The system uses a single code to follow the product through the chain all the way to retail and is described in more detail in Chap. 7.

While PTI has been largely adopted by the growing and packing communities and its use is continuing to grow, it has not been fully adopted downstream, primarily because it relies on use of the GS1 barcoding and the ability of the systems at each step of the chain to read and utilize the coding. Additionally, at present, not all distribution centers or retailers have the infrastructure to receive bar-coded information.

As with so many traceability aspects, it is most likely to be the large, resource-rich companies that are implementing and using PTI, while small and local businesses may continue to handwrite their records. This can then become a factor for all packers – large or small, because when produce is harvested and commingled from a number of fields, use of produce from a field that doesn't provide electronic product coding takes that traceability back down to the manual level.

The impacts on the produce industry of commingling of product from multiple growers and its use in complex products is clearly illustrated in numerous recalls. Once a foodborne illness outbreak is declared, and the investigation begins, the first step is determining exactly which ingredient is the culprit. And when a complex product with multiple ingredients is implicated (e.g., salad, salsa, etc.), the specific ingredient has to be determined. And the determination of that ingredient impacts all growers of the item – even if that determination is incorrectly made.

Take, for example, the *Salmonella* outbreak of 2008, in which FDA linked tomatoes to the outbreak and warned the public not to eat certain lots. While the warning was of specific growers and packers, consumers – who tend to be wary of all products/ingredients once implicated – began to avoid all tomatoes, and some retailers and foodservice providers stopped carrying tomatoes altogether. The issue was further exacerbated by the later decision that the source was actually raw peppers from Mexico, not tomatoes at all. Losses were estimated to run as high as hundreds of millions of dollars for tomato growers and packers.

The 2006 spinach recall provides another example of the impact of traceability challenges on an entire industry. Although spinach was correctly identified as the source of the *E. coli* outbreak, eventually leading to implication of Earthbound Farm on which former Chief Food Integrity Officer Will Daniels has frequently spoken, there was still the issue of commingling of the spinach from various fields, so that multiple growers were implicated. At that point it became a subjective call of the investigators as to where to put their focus.

Even prior to that, with the array of spinach uses in finished product, tracing had to be conducted both backward to the source and forward to the potential range of distribution – so the warning went out to consumers to not eat spinach. Period. Not

fresh, not frozen, not at all. At one point, it was even thought to potentially be a bioterrorism issue.

Interestingly, Daniels explained that one reason that Earthbound Farm became the primary focus was because the company knew that it could track recipients of its product, so it chose to conduct a voluntary recall. At that point, all attention was turned on it and others dropped out – even though multiple sites had been implicated.

While less commingling of product would have, at least somewhat, reduced the industry impact in both situations, it is not a feasible solution when considering the extent and speed of the market and the current limits of traceability. Additionally, even with the use of a GPS system, traceability remains at the case and/or field level, not the item level. Technology is continuing to improve, however, so that we are likely to see more traceability down to the square block, say 10'×10', rather than to Field X. This would enable tighter investigations with lesser amounts needing to be recalled, but would also require some redefining of a "lot."

Technological evolution is also dependent on the adoption by the food industry and the need for industry to continually challenge and improve its systems. For example, if a grower or packer codes and tests every pallet from a field, rather than considering all produce from a field as one, the definition of lot can be challenged. That is, if only one pallet of four from a field tests positive, the grower/packer can challenge the traditional practice of destroying all product from the field to destroying only that of a single pallet. So that if it were shown – through an accurate testing program of field lots and finished goods – to be simply a sporadic contamination, and a good test and hold program was implemented, the exposure and impact would be a great deal less severe – not only on the grower and packer, but also on everyone down the chain to the retailer and consumer.

That said, food safety as a whole is only as good as the continuum. Even when everything is done right in the field, an error, contamination, or other incident at receiving can cause the loss of the product tracing.

Food Animals

While there are obvious differences in the growing of produce and the breeding of animals for food, the commingling of product creates similar challenges for tracing meat back to the animal as for tracing produce back to the growing field.

Many food animals, such as swine and cattle, are marked with ear tags, to enable coding that follows them through the system. However, once the animal is moved through processing, it becomes more and more difficult to track. This is because once slaughtered, the meat from the animals will be separated by type and grade. The carcasses are generally not scanned at this point, and meat may be commingled from numerous feed yards, so it can be impossible for packaged meat to be linked back to the individual animal.

One significant difference on the farm is that of handling. While this is not so much a factor of traceback for food safety, humane treatment has become a significant factor of traceability for many brands and retailers who are focused on and/or market "ethical sourcing."

Long before ethical sourcing became an advocacy platform, animal handling has been an aspect of concern both for the welfare of the animals and the quality of the meat. As such, transparency on the farm and in processing are becoming ever more essential for consumer communication.

As noted by Temple Grandin, world-renowned animal science professor and livestock handling system designer, such transparency is critical not only to show what the industry is doing right but to counter the misinformation of the "hidden videos" of the internet [6].

It is also needed to take consumers back to the roots of meat production. The beef, pork, and chicken on our tables is – and can only be – produced through the slaughter of animals. In today's urban culture, it all too easy to "forget" that fact and think of meat as originating in its packaged, retail state – with the only ones focused on or publicizing the actual origination of meat being those who are against its use as food, thus wish to show as negative a picture as possible.

For industry's sake, traceability of animal products needs to go beyond that of food safety and communicate, to show and tell the ethical sourcing practices even in slaughter. As Grandin said, "these things need to be more commonplace and ordinary. I think we need to just show it and explain it… we need to show it to the point where it just becomes ordinary" [6].

Summary

When discussing the world's food supply, the word "chain" perfectly illustrates the linkage between the players. Each link of the chain is a unit unto itself with unique stressors and strains, but each has an integral charge to keep the chain intact, each must hold itself interconnected with the next, and a pull on any one link of the chain will impact every other link – forward and back.

Because each link – and each component that makes up the link – is unique, the specific challenges described in this chapter are not necessarily applicable to every farm, packer, processor, distributor, retailer, or even consumer; nor do they depict every traceability nuance of or challenge faced by these separate but integrated links of the food supply chain. But they do provide an overview and some industry perspective on today's traceability through the chain, how the food industry is improving and evolving to increase food safety and meet the needs and expectations of the consumer, and where improvements can and need to be made.

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