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The Sustainable Alliance for Food EcoSystems – Produce and Animal Protein Industries Working Together to Address Contamination in the Production Environment

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ABSTRACT

In agricultural communities across the United States, animal protein and produce production operations co-exist within organizations or as neighbors. Both the animal protein and produce production industries operate under government food safety regulations and are supported by government and academic food safety research. However, except for a few select studies evaluating pathogen transfer between animal protein and produce growing operations, the two agricultural communities have typically pursued their food safety research efforts independently. Recently the two industries have joined forces in a new effort, the Sustainable Alliance for Food EcoSystems, which held its inaugural meeting October 1 – 2, 2024, in Dallas, Texas. The meeting brought together industry and academic subject matter experts from U.S. agricultural companies, organizations, universities, and research centers in a think tank setting to focus on the challenges of zoonotic pathogen contamination stemming from the co-existence of produce and animal protein production operations. Following the concept of the One Health approach to food safety, SAFE's vision is to foster interdisciplinary collaboration to explore the interconnection of people, animals, and our environment with endeavors to find optimal outcomes, namely, the development of feasible mitigation strategies for reducing zoonotic pathogen contamination and/or transfer and preventing foodborne illnesses.

INTRODUCTION

The inaugural meeting of the newly formed think tank, Sustainable Alliance for Food EcoSystems (SAFE) was held October 1–2, 2024 in Dallas, Texas. SAFE was created to assemble subject matter experts from U.S. agricultural organizations and research centers to focus on the challenge of zoonotic pathogen contamination stemming from the co-existence of produce and animal protein production operations. The two-day meeting was sponsored by Western Growers, International Fresh Produce Association, Texas Tech University, National Cattlemen's Beef Association, National Association of State Departments of Agriculture, and Association of Food and Drug Officials. The meeting was attended by select representatives of the animal protein and fresh produce industry and academic communities.

The meeting began with opening remarks by the organizing team followed by introductory presentations of the current state-of-the-science by subject matter experts in the animal protein and produce industries. Mindy Brashears, Professor and Director of the International Center for Food Industry Excellence at Texas Tech University provided an overview of how the idea of a think tank was conceived. De Ann Davis, Senior Vice President of Science at Western Growers, reviewed the objectives of Healthy People 2030 and explained how the One Health approach to food safety, which recognizes the interconnection of people, animals, and our environment, and endeavors to find optimal outcomes through interdisciplinary collaboration, is foundational for the SAFE think tank *(28, 38)*. Meeting facilitator David Goldman of Groundswell Strategy charged participants with defining critical questions, objectives, and outcomes related to developing feasible mitigation strategies for reducing zoonotic pathogen contamination and preventing foodborne illnesses. Outcomes were categorized as research gaps, thought-leader talking points or requests, data-driven policy, and industry needs, which could manifest as research team formation, research funding sources, printed materials, or digital communications.

In their introductory "state-of-the-science" presentations, representatives of the industry and researchers from academia and government agencies presented overviews of scientific findings and data gaps related to the spread and the prevention of zoonotic pathogen contamination. Channah Rock, Professor and Water Quality Specialist

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at the University of Arizona Cooperative Extension gave an overview of a multi-year study carried out in the southwestern produce growing region. This longitudinal study, funded by the U.S. Food and Drug Administration's (FDA) Center for Food Safety and Applied Nutrition, was led by the University of Arizona with support from the Wellton-Mohawk Irrigation and Drainage District, local produce growers, and landowners *(41)*. The study focused on improving the understanding of the environment in and around the southwest growing region and included assessments of air/dust, surface water, canal sediment, and wildlife across a 54-mile study area. Samples were assessed for both pathogens as well as novel indicators to assess potential hazards and associated food safety risks. More than 5,000 analyses have been performed, and results have been shared at local industry meetings, working groups, food safety sessions and to the broader research community at the 2024 annual meeting of the International Association for Food Protection. In response to the initial findings, the Arizona Leafy Greens Marketing Agreement recently updated buffer distances from animal feeding operations of greater than 80,000 animals *(43)*. The research study has additional data forthcoming and is still considered an ongoing applied research project.

Tommy Wheeler with the U.S. Department of Agriculture's (USDA) Meat Animal Research Center and Angie Siemens, Vice President of Cargill Food Safety, Quality & Regulatory, gave overviews of the current state of animal agriculture research and industry practices, respectively. Research at the USDA's Agricultural Research Service (ARS) related to controlling STEC and *Salmonella* in livestock prior to harvest has focused on animal management including animal density, pen size, pen management, seasonality, feed types, feed ingredients, feed management, water management, and differences between animal agricultural practices (e.g., dairy vs. beef cattle) and between colonized and uncolonized animals *(4, 7, 44)*. Researchers have also studied pathogen contamination occurrence during transportation and lairage at the processing plant *(2, 3)*. At the beef industry level, since 1999 a "test to find" program was instituted in agreement with the USDA Food Safety and Inspection Service that has allowed the industry to correct contamination problems without heavy punitive regulatory repercussions *(33)*. The industry, for the most part, has determined that the contamination could not be solved pre-harvest because pathogen shedding events were transient and not understood well enough to institute pre-harvest control points. Rather contamination was better addressed at the plant during harvest where contamination can be more easily controlled.

From produce growers' perspectives, as presented by Michelle Danyluk, professor and extension specialist at the University of Florida and Trevor Suslow, professor emeritus at the University of California, Davis, contamination of the produce growing environment is a complex problem that could be better understood if it was more readily quantified. Currently, the produce industry is primarily focused on identifying microbial hazards and lacks a robust understanding of the contamination risk posed by the hazards that are identified in the surrounding production environment. For example, composting operations are a source of microbial hazards, and as air sampling in the longitudinal southwest study demonstrated, pathogens can be transmitted through the air *(41)*. But other routes of transmission such as shared roads, vermin, insects, and birds can also transfer pathogens from composting operations to nearby produce fields *(22)*. Planning studies (e.g., constructing the right research question/hypothesis) to assess the contamination risk from these complex multifactorial situations necessitates collaboration between produce and animal agricultural groups.

With extensive, consistent sampling and testing programs, contamination risks can be quantified; however, barriers to this approach include: 1) Such testing programs are prohibitively expensive and take extensive amounts of labor to execute; 2) because the hazards are understood but the likelihood of occurrence is not well understood, executional concerns such as when to test in a season, where to sample in a field, and other questions are unknown for each growing region; and lastly, 3) the practical concern that scientific knowledge and/or tools are insufficient to understand if findings of such testing can be and/or are adequately addressed without more extensive testing. Thus, applying extensive, consistent pathogen sampling and testing programs presents challenges in a produce growing field.

Following the introductory presentations, meeting attendees were broken into five groups by the meeting organizers and asked to address the following objectives: 1) the current situation of preventing the spread of zoonotic pathogens through the food supply as they perceived it, 2) the threats the current situation posed to the agricultural industry, 3) the data and information currently available to mitigate the contamination risks, 4) the data and research gaps, 5) a "big hairy audacious (5 and 10 year) goal" (BHAG) for fostering collaboration, acquiring data, funding research, and closing the data gaps, 6) strategies to connect with other stakeholders, and 7) next steps for the group to take moving forward. Following group breakout sessions over the course of two days, the five breakout groups reassembled and presented their ideas to the other meeting participants. This paper summarizes the key points (based on experiences, opinions, ideas, etc.) made by meeting participants in the five breakout groups during the discussion of the seven objectives over the course of the two-day meeting.

The current situation

In describing the current situation related to the risk of zoonotic pathogen transmission, groups discussed the need to move from identifying hazards to a risk-based focus in solving the problem of pathogen transmission from their sources to unharvested crops. Identifying hazards is relatively easy compared to quantifying the probability of finding said hazard in a particular place/space at a specific time, and sometimes the distinction of the two processes are not fully understood *(14)*. For both animal protein and produce producers, food safety hazards are well known, but knowing whether the hazard will cause contamination that results in consumer illness, in many cases, is less well understood. More research is needed for both industries to confirm or reveal preventive practices that support feasible, cost-effective mitigation strategies.

Several groups cited pervasive lack of trust in the current environment due to fears of punitive or retaliatory actions by regulators, customers, and/or consumers. This mistrust affects relationships among companies within the food industry as well as interactions between the produce and animal protein industries, the government and industry, and the public and industry. Distrust within the agricultural industry leads to an adversarial outlook where agricultural groups, at times, view each other as the problem and not as part of the solution. Because of their enforcement authority, government agencies are often viewed as adversarial by industry, which fears reprisal if they share information about their food safety problems and practices with regulators, especially as regards sampling plans and test results. However, government collaboration is vital to industry efforts, and the group deliberated over the appropriate timing in inviting regulators and public health officials to join the continuing work of this group.

Similar to the challenge of nurturing trust in relationships among industry stakeholders is incentives: when incentives differ among animal protein and produce industries, motivation to adopt or change practices for the sake of the other group is difficult *(1)*. If the beef industry adopts practices that effectively control pathogen contamination at the harvest step, the incentive to implement additional preventive measures during pre-harvest production is low even if it proves beneficial to a neighbor that grows row crops *(8, 9, 24)*. In comparison, the produce industry currently does not have and is unlikely to have an effective postharvest "kill step" that is appropriate for all produce commodities. Furthermore, the consuming public has been more skeptical of kill-step-type-methods and technologies such as irradiation when applied to fruits and vegetables.

The group discussed the difficulty in incentivizing a company to implement a new practice or change a current practice when preventing pathogen contamination is viewed as "not my problem". Companies are also disincentivized to be proactive if it leads to a disadvantage (e.g., higher costs without a guaranteed return on investment) or negative outcome (e.g., makes them a target for regulatory scrutiny). Even though it is often stated by the food industry that food safety is not a competitive issue, some companies view food safety practices as a competitive edge rather than a public benefit for which the industry-at-large should strive. Such a viewpoint runs completely contrary to implementing food safety practices that may benefit your neighbor's food production operation more than they benefit your operations. This viewpoint may be even more entrenched with companies that have never had a recall or been affected by a foodborne illness outbreak.

Overcoming the hesitancy to implement beneficial practices even when it doesn't necessarily directly benefit your product also applies to sharing information. All the breakout groups identified data sharing as key to finding solutions that effectively prevent or reduce zoonotic pathogen contamination. They also discussed the challenges and difficulties of data collection in the current business climate *(27)*. Recordkeeping and documentation practices vary greatly among industry members spanning the spectrum from paper records to sophisticated analytical software. Currently many individual companies in both industries are collecting a lot of data related to their agricultural practices and standard operating procedures but are not comfortable with sharing their data outside of their organizations. Fears of government reprisal and discovery under the Freedom of Information Act are difficult to dispel when efforts are made to collect private company data into a common repository for evaluation.

Those analyzing or otherwise using collective data are concerned about data quality and uniformity. Although meeting attendees agreed that data standardization would greatly increase the value of industry data for meta-analyses, many cautioned that waiting to collect data until standardization parameters are determined would come at the expense of using the data to monitor performance of current practices. For example, the beef industry tests products for pathogens during harvest and processing operations and uses it to inform a company's process performance and to evaluate industry performance in general.

Threats to industry

Economic impacts were a common theme in breakout groups' discussions of threats to agricultural industries. Producers face economic threats from increased costs incurred by legal liabilities from regulatory compliance and enforcement concerns and from recalls, market withdrawals, and foodborne illness outbreaks *(18, 19, 30, 42)*. When a contaminated product has already entered the marketplace resulting in a foodborne illness outbreak and/or a product recall, companies frequently face skyrocketing legal costs from litigation or mediation. Not only may they face legal action from the government, but they may also face lawsuits from consumers who became ill. Recalls and foodborne illness outbreaks severely, and in some cases irreparably, damage a company's brand or, for an unbranded commodity, the entire industry.

Liability concerns also affect companies' willingness to participate in research. Sharing company data with researchers carries the risk of discovery and liability when that data is made public *(27)*. For this reason, it is not uncommon for researchers to assist companies in data collection efforts (e.g., a root cause analysis) but not to publish or otherwise report the findings to the wider industry or public. This limits the usefulness of findings to the wider industry.

Other threats to the agricultural industry related to foodborne illness outbreaks involve government investigations. When conducting foodborne illness outbreak investigations, regulators and public health agencies frequently rush to causal conclusions. Regulators under pressure from government officials, the public, litigators, etc. may finalize investigations and draw incomplete or inaccurate conclusions based on insufficient data. To quickly find a conclusion, they may look for and find a plausible explanation to present as the "smoking gun" in a root cause analysis. In many instances, the producer may know the "smoking gun" is not the true cause, but faced with limited resources, they lose incentive to conduct their own root cause analysis, adding to a missed learning opportunity.

Another aspect of recall or outbreak investigations that threatens the industry is how the government attributes an outbreak to a food vehicle *(21)*. Investigations cost time and money for both the government and industry, and often they are too lengthy and do not match the scope of the incident. Sometimes recalls are too broad because industry lacks sufficient approaches to lot size determinations to limit the contamination event or regulatory agencies fail to understand or acknowledge a company's lot size determinations or production breaks that may limit contamination. Overly broad recalls also result in costly food waste from unnecessary product disposal when product repurposing is not an option *(16)*. The USDA's Food Safety Inspection Service's public health alerts were mentioned as a model method for a "pre-recall" approach for the FDA to consider adopting *(35)*. In recent outbreak investigations, the FDA has leaned too heavily on genomic analysis such as temporal clustering to determine attribution without waiting for the results of traditional traceback activities and epidemiological studies *(10)*. During traceback, the agency often does not take advantage of the industry's supply chain knowledge to more efficiently conduct the investigation but instead tries to assess the complex supply chain web without industry assistance.

New regulation(s) or new interpretation(s) of existing regulations by government agencies and/or customers adds uncertainty and increases costs for animal protein and produce businesses. Misguided and inappropriate policies and practices enforced by regulatory agencies and/or customers that are not science- or risk-based strain already limited resources and may result in unnecessary expenditures, further reducing profit margins *(6)*. An even worse economic threat is the devaluation of fertile productive land due to misguided food safety policies and requirements. In addition, if the risk, regulations, or buyer requirements become too great, producers may voluntarily take land out of production. Misguided practices may also come from vendors presenting food safety solutions that have not been validated or are inappropriately applied. Not only can a misguided practice result in a financial loss due to the cost of a product or service, but the "solutions" can even make things worse and amplify potential risk.

Available data and data gaps

A multidisciplinary approach to study design and data collection and sharing was a central theme in discussion points throughout the two-day meeting but especially in relation to data availability and data gaps. Collaborative multidisciplinary studies involving produce and animal protein will require agreement on common methods and terminology and on how economic and liability risk related to data collection will be shared. Lack of standardization in experimental design and data collection creates challenges to information accumulation, database building, comparison of results among studies, and trend analysis *(5, 17)*. Standardizing experimental design for studies in an outdoor environment is difficult because each study location has unique aspects. Research is primarily concentrated in areas that have had contamination events and in areas where research institutions are located. Currently, most research data in the public sphere comes from studies conducted on university farms, public land, or private land at undisclosed locations within a larger, named production region (e.g., farm X in the Salinas Valley). Because of the uniqueness of each production location, it is difficult to extrapolate study findings relating to transmission pathways between animal agriculture and produce from one location to another. Several groups identified the lack of understanding concerning pathogen amplification along a transmission pathway as a major data gap. Groups also noted the importance of identifying and understanding transmission pathways as essential for testing interventions.

All groups were in general agreement that risk assessors currently lack sufficient data to evaluate cumulative risk from farm to fork. Data relevant to assessing the risk of pathogen contamination in agricultural environments are available from publicly available datasets, most of which relate to weather conditions, soil, or public water systems (e.g., recreational water, drinking water, watershed, etc.). Quantitative microbial risk assessment helps researchers identify data gaps that can be targeted to reduce uncertainty and variability. Groups also noted the importance of sensitivity analysis so research can be focused on variables that have the most impact on outcomes.

In addition to risk assessment, many groups also discussed the need for metagenomic analysis and use of artificial intelligence such as machine learning to gain knowledge from existing data *(26, 31)*. Metagenomic profiling may be applicable in the identification of microbiomes associated with pathogen contaminated and uncontaminated animals and to ferret out variation and changes in pathogen prevalence in the environment or on produce (i.e., due to seasonality or location).

Most sources of publicly available data frequently cited by the breakout groups were relevant scientific literature and government databases. Several groups cited the need to better summarize existing data in the literature and to create a platform to catalogue pathogen isolates that are found in the animal protein and produce production environments along with the corresponding methods used to collect the data. The general consensus of all the groups was that much of the government's reference data (e.g., population level food consumption data used for epidemiology) are outdated and do not necessarily reflect current conditions. Outbreak investigations generally produce informative data about human pathogens in agricultural environments, but industry and academics typically do not have access to the raw data. The following publicly available datasets maintained by government agencies were referenced by breakout groups:

- Attribution analysis by commodity–Interagency Food Safety Analytics Collaboration *(21)*
- Genome Tracker – FDA *(40)*
- Genome sequences of human and food isolates, National Center for Biotechnology Information – National Institutes of Health *(25)*
- Estimates of foodborne illness – Center for Disease Control and Prevention *(12)*
- Epidemiological data – Center for Disease Control and Prevention *(11)*
- National Rivers and Streams Assessment – U.S. Environmental Protection Agency *(39)*

Although outbreak investigation findings may be informative to the industry, these datasets are minimal compared to the data owned by private companies that remain mostly unavailable for industry-wide research and analytical purposes. Private data is central to filling data gaps but concerns about data confidentiality is a major obstacle for companies. Because of producers' concerns about protecting their operations from legal action, researchers generally have limited ability to collect samples on private land and to make use of relevant data companies collect. Of particular interest is data representing "near misses" or situations where contamination is found prior to harvest or before product is released into the marketplace. This data remains mostly in the private sphere and is often closely guarded to protect the company. Researchers also discussed how to better use negative results where hazards were not detected, and in general, to better leverage what is known to improve food safety practices.

Groups cited the need to co-define the problem and goals and discuss/acknowledge financial impacts (i.e., gains and losses) to get industry buy-in for data collection and sharing. Producers are often hesitant to test for fear of discovering contamination, but most are comfortable using models that predict when pathogens are more likely to be present. Predictive models can assist producers in making risk-based adjustments to and decisions concerning practices and/or mitigation activities *(20, 32, 45)*. Application of the Hazard Analysis and Critical Control Point (HACCP) framework to testing (e.g., specificity, sensitivity, etc.) was recommended to ensure test methods meet predefined requirements. Testing to monitor production processes and quantify risk is a fundamental HACCP principle, which has previously been effectively implemented in animal agricultural industries (e.g., dairy) *(15)*. It was recommended that this HACCP framework for testing be applied in research related to quantifying risk of pathogen contamination in produce and animal protein production as a means to ensure data quality and uniformity *(23, 29)*.

Big ideas – "BHAG"

In envisioning big ideas for the next 5 to 10 years, group participants agreed that there needs to be a mechanism for removing or assuaging the industry's concerns about liability and punitive regulatory consequences. The most common recommendation was the use of a safe harbor approach consisting of a set time frame to implement and evaluate new practices without penalty and with the understanding that any new practice is nonbinding (i.e., returning to how things were before is an option). Safe harbors help industry act by alleviating the paralysis and fear surrounding making an investment and doing the right thing.

Another common BHAG idea was the establishment of a collaborative multidisciplinary entity focused on food safety research in animal protein and produce production. One group's depiction of a collaborative center is presented in *Figure 1*. The collaborative center would administer oversight and funding, coordinate and centralize communication and messaging, maintain a data repository, and establish best practices and publish guidance documents for preventing pathogen contamination. *Figure 2* depicts another group's idea of the different types of data that are needed to address food safety research questions in animal protein and produce production environments and how those data build on each other. With the formation of a collaborative center, research would be coordinated to ensure it is connected to larger goals. Meeting participants envisioned this to be orchestrated similarly to the USDA Agriculture Research Service's *Salmonella* Grand Challenge launched in 2023 *(36)*. The ARS initiative brings together scientists from across disciplines and integrates research to enhance understanding, to develop better tools for industry, and to identify trends, emerging threats, and novel mitigation strategies.

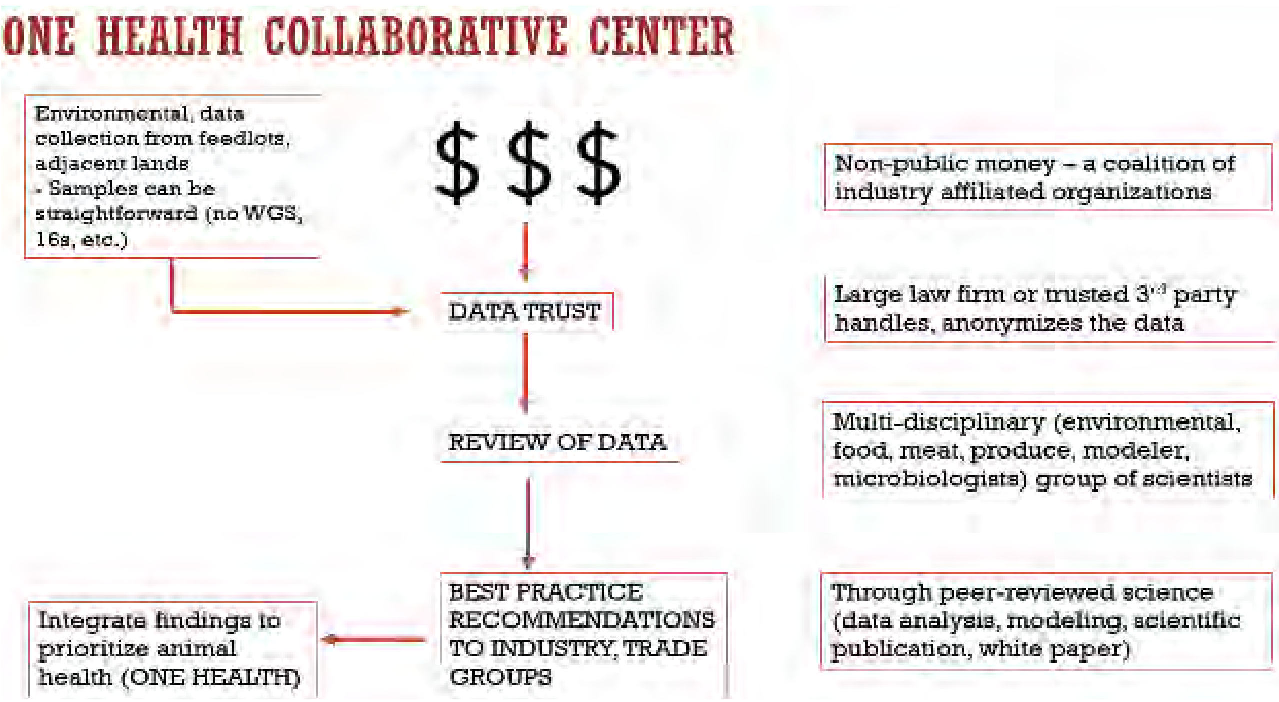

Figure 1. Schematic depicting a collaborative research center.

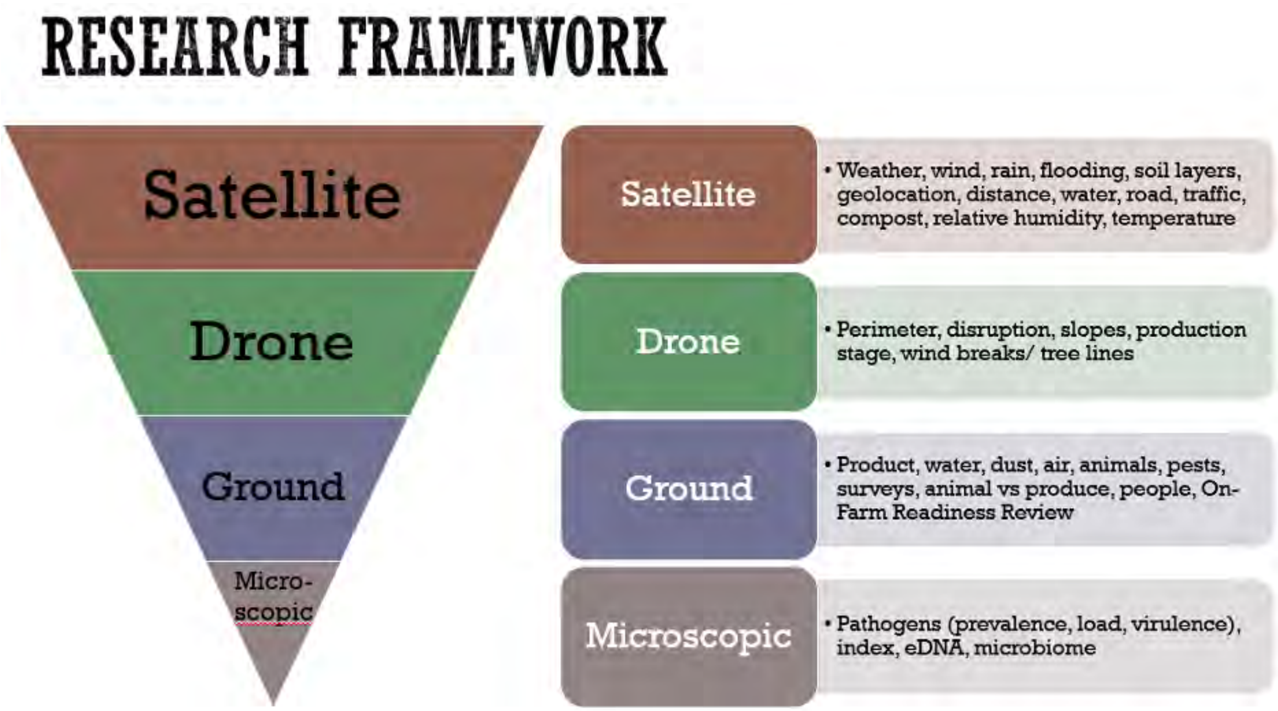

Figure 2. Research framework schematic.

Meeting participants discussed the never-ending search for funding sources. Most groups expressed dissatisfaction with the government's level of and process for funding food safety research. USDA's National Institute of Food and Agriculture was called out specifically for their funding of research that is not actionable or practical for the industry *(34)*. Since its inception in 2008, the Center for Produce Safety has provided leadership in determining and funding research that directly responds to the produce industry needs *(13)*. Diversification of funding among government and private sources was recommended as a hedge against changing sentiments in the congressional appropriations cycle. Another idea for funding involved the formation of checkoff programs in the produce industry, a practice that is more commonly employed in the animal protein industry. The beef industry's checkoff program assesses a cost per head on the sale of live domestic and imported cattle to fund research, promote beef sales and consumption, and manage industry issues *(37)*.

Connections

Breakout groups were tasked with considering other categories of people that should be invited to the table and strategies on how to reach out to these people. Participants were asked to consider government, academic, and industry groups whose participation would benefit the conversation. In thinking about strategies to bring others into the think tank, groups discussed commonalities in purpose and motivations for collaboration to address contamination problems in the animal protein and produce industries. Within agriculture, a fundamental belief in the American farm/ranch is a shared value – specifically the belief that sustainability and profitable agriculture is key to food security and national sovereignty. This belief is foundational to fostering "good neighbor" relationships within agricultural communities and with those groups who support the industry.

Meeting participants agreed that collaboration between the animal protein and produce industries and research communities is central to the goal of reducing crop contamination and preventing foodborne disease in consumers. To proactively work together as industries in reducing the contamination risk, companies must overcome several challenges beginning with building trust and implementing practices and procedures that enhance food safety beyond just the safety of their products. Both the animal protein and produce industries have the same goal of producing safe and nutritious food, but both industries also have significant variability within and between their industries. The produce industry varies primarily by commodities, environmental conditions of growing regions, and growing and harvesting practices. For example, agricultural practices in tree fruit operations will differ from row crop production within a U.S. growing region and tree fruit production in the Pacific Northwest will differ from tree fruit production in California and mid-Atlantic states. The same is true for animal protein operations, which also vary among and within each animal protein commodity. For example, practices in beef cattle operations vary based on the maturity of the animal (i.e., from cow-calf to finishing operations) and practices will vary between indoor and outdoor animal protein operations.

Ideas on expanding SAFE to other stakeholders included reaching out to other members of the farm-to-fork continuum, to government agencies, and to other support/advocacy groups. Meeting participants agreed that government should be included but in a timely manner that does not stifle or interfere with industry involvement. Other groups of people identified by meeting participants as potential additions to the SAFE think tank effort included:

- Retail and foodservice
- Other animal protein producers (e.g., poultry, swine, sheep)
- Dairy industry
- State-based trade associations
- Regional and local industry associations
- Consumer groups
- Regulators
- Veterinarians
- Irrigation and water management districts
- Controlled environment agriculture
- Nutritionists
- Economists

CONCLUSION: OUTCOMES AND FUTURE MEETINGS

In concluding the meeting, participants were charged with defining outcomes that could be communicated to the U.S. Congress, regulators, industry, and academia. Definitive outcomes from this meeting include writing a white paper about the meeting to inform industry, regulators, and academia and constructing talking points describing actions that the U.S. Congress could take to help move research and industry efforts forward. Other print materials noted to promote educational efforts include infographics and one-page briefs for different groups that describe various topics such as the think tank's goals and plans, policy recommendations and suggestions, guidance on discussing food safety issues with neighboring farms, etc.

Other desired outcomes include more funding for research at government agencies, academia, cooperative extensions, and state agricultural departments. Organizing team members will investigate grant opportunities at the state and federal level. In the near term, ideas to capitalize on the momentum of the two-day meeting centered around future meetings including virtual events and another in-person meeting in 2025. Meeting participants suggested routine virtual meetings to promote engagement and to report progress on funding and outreach efforts. Plans for a future field-trip meeting are underway for a research center/institute located in a major agricultural region. Meeting participants were surveyed to gather additional information for a future meeting time and location and to gather feedback on the Dallas inaugural meeting.

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