Food Microbiology and Food Safety

Practical Approaches

Series Editor:

Michael P. Doyle
Regents Professor of Food Microbiology (Retired)
Center for Food Safety
University of Georgia
Griffin, GA, USA

Food Microbiology and Food Safety Series

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John W. Spink

Food Fraud Prevention

Introduction, Implementation, and Management

Springer

John W. Spink
Michigan State University
Okemos, MI, USA

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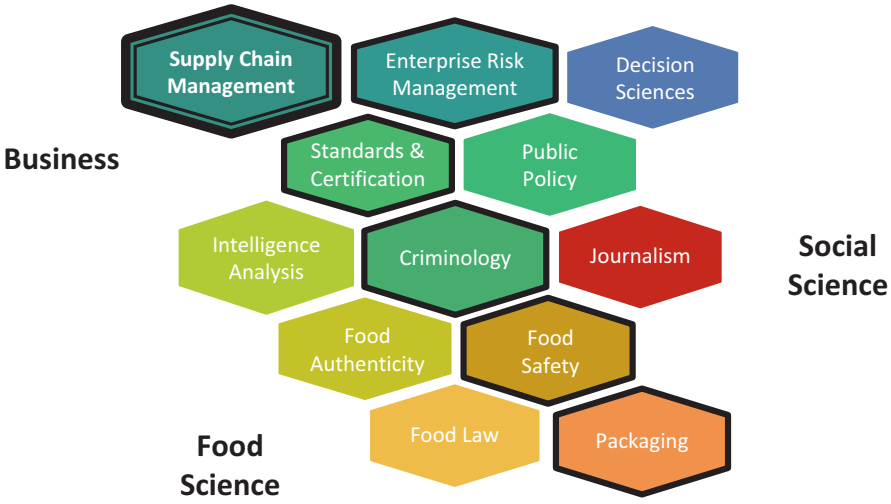
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Dedication

First, this is dedicated to my family who has been patient and supportive throughout the overall journey during the development of this book and also of my overall research path. Second, this is dedicated to the many colleagues I've worked with over the years. While this is a job that provides the finances for us to survive, I absolutely love the topic and working through the challenges of clarifying an implementation of the concepts and working with a wide range of colleagues from all over the world.

This book is also dedicated in remembrance of several key scholar mentors:

Ed Mather (1937–2010)

My first opportunity to return to academia was when in 2003, he asked me to develop an online graduate course for the Master of Science in Food Safety Program. Along the way, he helped me see the opportunity in academia and navigate through Michigan State University. His encouragement and guidance were critical to me, getting through my Ph.D. and providing a realistic perspective on what I could expect from my

appointments. He served as one of my Ph.D. committee members and my first supervisor in the MSU Master of Science in Food Safety Program. Previously, he was chair of the Department of Large Animal Clinical Sciences, associate dean for Research and Graduate Studies, director of the National Food Safety and Toxicology Center, and director of the Master of Science in Food Safety Program.

Don DeKieffer (1946–2011)

After meeting at an Anti-counterfeiting Conference, he was an early mentor that provided tremendous insight into the very first prevention strategies. A key point was "don't start with trying to stop all counterfeiting, get them to stop knocking you off!" His wide range of Washington experiences were especially insightful and valuable including having served on the professional staff of the US Senate Republican Policy Committee, as general counsel to the Office of the US Trade Representative, and then as a founding partner of deKieffer & Horgan law firm. In parallel, he led the EDDI, Inc., working on databases relating to counterfeiters and diverters.

Foreword

This book deals with a crucial matter regarding food. The problem of food fraud, unfortunately, has been with us as long as the history of food trade. The oldest recorded food laws attempt to deter it. In Babylon, you might be thrown into the Euphrates with a millstone around your neck for the adulteration of flour. In the fourth century BC, the Greek Theophrastus reported on the use of food adulterants for economic reasons in *Enquiry into Plants*. Pliny the Elder in *Natural History* provides evidence of widespread adulteration, such as bread adulterated with chalk to make it whiter and pepper adulterated with juniper berries in economic fraud.

John Spink brings an important perspective to this field. Food lawyers tend to look at food fraud from a legal liability viewpoint. Yet, reputational damage can far exceed the penalties in the laws. Food safety experts tend to approach the topic as health and safety risks. Yet, the clever fraudsters seek economic advantage and may present to health risk. Food scientists see the challenges in standards, detection, and testing. Yet, there can be adulterated food that contains no adulterant. Criminologists see motive and opportunity. Yet, the nature of supply chains can muddle such analysis. To deal with these seeming contradictions, John Spink brings a multidisciplinary approach to the topic.

The problem of food fraud is global in nature. Food fraud concerns public health but goes beyond to economic loss and harm to consumer confidence in individual companies and also loss of confidence in the integrity of the food supply. This has been with us since the beginning of food trade and will be with us as long as there is a trade in food. Knowledge is the key to food fraud prevention. And there has never been a better time for this book.

John Spink's footprints on the field of food fraud circle the globe. He is in such demand as a speaker; it can be hard to catch up with him even while working at the same university. Fortunately, we have his book.

Neal D. Fortin, J.D.
Director, Institute for Food Laws and Regulations (IFLR)
Professor, Food Science and Human Nutrition, College of Agriculture and Natural Resources
Michigan State University

Foreword

Food fraud has emerged as a serious food safety risk that ranks as one of the biggest concerns for both the food industry and government regulators. Food fraud, including economically motivated adulteration, is also a top concern with consumers. Food fraud is the intentional adulteration for economic gain, a food defense incident is intentional adulteration to cause harm, and a food safety incident is unintentional adulteration resulting in unintentional harm. However, in the case of food fraud, even though the motivation is economic gain, it can result in public health harm. The threat of food fraud is not addressed in conventional food safety and food defense management systems and need to be considered separately.

Dr. John Spink has been a leading researcher in the area of food fraud and has worked closely with the industry to develop vulnerability assessments. His work has helped the industry and governments to more effectively identify and manage the root cause of this criminal activity. There is a necessity to continue to address the core problem behind food fraud and develop a preventative system approach to combatting food fraud.

As the former Cargill Incorporated Vice President of Corporate Food Safety, Quality and Regulatory Affairs and the current Chairman of the Global Food Safety Initiative Board of Directors, I am keenly aware of the importance and challenges of dealing with food fraud. I lived through the melamine crisis as it impacted the industry in China and the United States. Food fraud undermines all of our efforts around food safety and food defense, and we must be able to impart trust in the integrity of our supply networks around the world.

This book focuses on tools that enable solutions to more effectively identify and manage the risks of food fraud. It covers all the activities focused on prevention starting with the criminal motivation through the responsibility of companies, from the boardroom to the factory floor to the farm. This groundbreaking textbook provides a full picture of food fraud and is filled with tools that companies can use to establish preventative systems and train employees to deal with this real threat to the integrity and safety of our food supply around the world.

Mike Robach
Chairman, Board of Directors, Global Food Safety Initiative (GFSI)
Former VP of Food Safety, Quality and Regulatory, Cargill Incorporated

Foreword

Food fraud is an extremely important and challenging problem for the food industry and for national administrations worldwide. It is an issue that has received particular focus in the European Union—following some high profile, high visibility, highly disruptive incidents—such as the presence of horse meat in internationally available, commercially recognizable meatballs.

While the horsemeat incident is often thought of as the first major international food fraud event, there have been an increasing series of concerns in recent years. There are a wide range of food fraud incidents that deceive the consumer and are injurious to public health. These can range from counterfeit alcoholic beverages, to species swapping and adulteration of meat products, and to counterfeit country of origin products. These pose many problems that not only have the potential to cause harm to consumers but may also result in reputational damage to a company or food sector, cause loss of profits and market share, lead to the fall or collapse of a share price, result in loss of market access, and can have political and economy-wide impacts.

In my regulatory role, over the past 35 years—more recently as Executive Chairman of the Sea Fisheries Protection Authority, and now in my current role as Director of Audit and Investigations with the Food Safety Authority of Ireland (FSAI)—I have witnessed the increasing sophistication and dangers of food fraud. The FSAI has recognized the need for multi-disciplinary multi-agency coordinated enforcement action in tackling food crime.

In order to lead the fight against fraudsters that operate within our food supply chains, we have engaged in many collaborative international networks such as the EU Food Integrity Project, the Interpol Intellectual Property Crime College (where I first met the author Dr. Spink at the 2013 conference in Dublin), INTERPOL/Europol Operation Opson, and in the EU Food Fraud Network. This broad set of experiences has led us to understand the complexity and challenge of not only detecting and deterring food fraud but also of preventing it from occurring.

This publication will be a benefit to and support for those involved as practitioners in the areas of food safety control, to the investigators of food fraud, and to the prosecutors of apparent wrongdoing. This book provides access to the concept and

breadth of what is defined as food fraud, and it applies its usefulness as a tool of insight as much to the seasoned practitioner as to the student of a number of codes.

Food fraud is not a new problem, but tackling it is a new discipline. This book makes it clear that it involves cooperation across a multitude of codes and professions, across industries, and across borders. As a concept which is evolved and understood, food fraud is given a solid foundation in this publication—this book uses a bedrock of established principles to guide us through the complex areas of understanding and strategy to tackle food fraud—for the danger, menace, and crime that it is.

Dr. Spink tells us that prevention is as important as the pursuit of the wrongdoers, when in pursuit the investigator needs to be as strategic as a chess player, and that targeting the reduction of opportunities for such fraud to exist is a paramount focus—with significant emphasis being placed by the author on the 'who is likely to commit it' pattern of thought, which investigators and lawmakers must focus on.

Traceability within and a transparency of the supply chain are deemed important and vital in the narrative of this book. In that regard, international relationships are deemed vital, as is a tailored risk assessment model for this area—rather than an imported model from other food control areas.

In recent years, food fraud has received increasing public and media attention and has been the focus of many academic articles and books. Dr. John Spink is a leading author in this field and has contributed enormously to the area of food fraud detection, management, and prevention. There is an increasing awareness of the need for a more wide-ranging and comprehensive consideration of the root causes of food fraud. This book examines the essential areas of food fraud prevention; demonstrates the need for advanced decision-making in the public and private sectors; addresses the need for industry to have processes in place to identify, assess, and control vulnerabilities, and discusses the application of criminological theory and the necessity to map and understand food supply chains.

The distinction is clearly made between the use of risk analysis in the management of food safety and the evaluation and control of vulnerabilities in the management of food fraud. All these areas are brought together in this book to provide an excellent text for understanding food fraud prevention and will act as a valuable resource for regulators, the food industry, the academic community, researchers, and students alike.

Over the years, Dr. Spink has been a leader and partner for a wide range of food fraud–related groups, and this textbook is the summary of those interactions and insights. This book advances food fraud prevention as a specific area of study and will support the development of a more strategic approach in the fight against food crime. This book provides useful tools for those wishing to reduce the food fraud opportunity and to protect consumer health and interests.

Peter Whelan
Director of Audit and Investigations, Food Safety Authority of Ireland (FSAI)
Irish Food Fraud Contact Point, Food Fraud Network, European Union
Irish Representative, Operation OPSON, INTERPOL/Europol
Advisory Board Member, EU Food Integrity Project
Advisory Board Member, EU Food Smartphone Project
FSAI lead for the Codex e-Working Group on Food Fraud
FSAI representative on the Food Industry Intelligence Network (FIIN)

Preface

Summary

This book is the culmination of a wide range of activities from outreach, research, and teaching. It provides a broad "education" foundation on the topics with practical application "training" to implement a practical Food Fraud Prevention Strategy, lays out an extremely interdisciplinary foundation to help address food fraud prevention, and presents a rational approach that applies sound science to evaluate the solution, understand how the countermeasures and control systems work, establish a first financial and accounting base in enterprise risk management, explore the efficiency of those activities, and then help decide on the course of action that best protects consumers. We've only just begun the journey to address food fraud prevention—we're only at the starting line—getting here was the easy part, and now the hard work begins. This book is one tool for understanding a holistic and all-encompassing perspective on the multidisciplinary Food Fraud Prevention Strategy.

Food Fraud Prevention Research Development

The research on food fraud has constantly been evolving, and until recently an interdisciplinary, holistic, and all-encompassing book—let alone a textbook—on the topic was not warranted since it would be out of date as soon as it was written. Over time, there has been enough research and publication on establishing a broad and theoretically sound foundation that a textbook is now appropriate. This book will cover the foundational principles and theories, not the current trends or hot topics. To be clear, our previous MSU research did *not* create the food fraud term or research area but did help formalize this as a holistic and all-encompassing discipline. When conducting various projects, our team found that there had not been research on defining the topic or publishing the details of the problem. Those findings provided the motivation for our 2011 journal article "Defining the Public

Health Threat of Food Fraud," which was the first research project and article focused on examining and publishing an explicit definition. While there were previously published uses of the food fraud term, critically reviewing the definition and scope was not the focus of a research project but were included as an assumption in the background or introduction section of a scholarly publication.

Our research and experience at the Food Fraud Initiative (FFI) at Michigan State University (MSU) has provided a unique opportunity to be involved in some of the very first food fraud prevention activities, such as with GFSI, ISO, Codex Alimentarius, FDA, INTERPOL, European Union, other Universities, associations, and others. Over time, our position as scientists "representing the discipline of Food Fraud Prevention" has enabled us to collaborate with many of the US and international thought leaders and committee or advisory group activities.

This MSU research began in 2005 with a focus on intellectual property rights product counterfeiting in my 2009 Ph.D. dissertation "Introducing the Counterfeit Product Risk Model (CPRM)" (see the Risk Assessment Application chapter) (Spink 2009). In parallel, I was teaching graduate courses in food safety starting in 2004. That early dissertation research—combined with graduate course development and teaching in the MSU Food Safety Program, MSU School of Packaging, and the MSU School of Criminal Justice—led to a focus on a wide range of products such as pharmaceuticals, consumer electronics, luxury goods, and food. Specific activities included developing and teaching graduate courses such as "Packaging for Food Safety" in 2005 and "Anti-Counterfeit and Product Protection" in 2008, which covers all products and intellectual property rights infringement. This wide range of activities brought to light an unmet need in prevention of "food counterfeiting" which evolved into "Food Fraud Prevention."

In 2013, there was an opportunity to shift the FFI activities from the School of Criminal Justice in the College of Social Science back to its original academic home of the Master of Science in Food Safety Program and the College of Veterinary Medicine (CVM), where we were able to focus completely on food fraud and prevention. During that transition, the MSUglobal team provided critical insight and support by supporting the development of the Massive Open Online Course (MOOC) concept, leading to the development of the www.FoodFraud.msu.edu website, and encouraging and supporting the blog posts. The shift back to CVM was an incredibly important opportunity since there were fewer distractions from commitments to address other products or industries. Also, in hindsight, this was also an important reposition to support the more holistic and all-encompassing implementation of the theories since the food industry is very coordinated and collaborative under food safety efforts. Food safety is truly *not* considered a competitive advantage among companies, and the relationships enabled the harmonized and coordinated focus on prevention.

In 2019, I was enabled to shift to the Department of Supply Chain Management (SCM) within the MSU Eli Broad College of Business (BUS). This move to within the business discipline was logical and efficient since, over time, the decision-making and problem assessment research kept narrowing to the COSO-based enterprise risk management practices. This research focus has included the monitoring and

control of both supply chains and operations and also specifically to procurement. While the ongoing research and activities continue, there is a new focus on how the general supply chain management threat of food fraud—and overall product fraud or related issues—would most optimally be assessed and managed. The opportunity in 2019 to shift to SCM has created a more intense focus on the basic business functions from within—rather than trying to influence from outside—business operations, logistics, and procurement.

Building the scholarly foundation helped create opportunities to collaborate with some of the key food fraud-related committee membership or project leadership activities including:

- **US FDA Open Meeting on Economically Motivated Adulteration**: Presented as the first nongovernmental presenter on the topic "Defining Food Fraud and the Chemistry of the Crime"
- **EU Food Integrity Project**: Researcher and former advisory board member
- **Queen's University Belfast:** Visiting researcher with professor Christopher Elliott, the lead researcher for the UK Defra Elliott Review of Food Crime
- **ISO Technical Committee 292 Security Management (TC292) and Work Group 4 on Product Fraud and Authenticity**: Founding chair of the US Technical Advisory Group
- **ISO Technical Committee 34 Food Products, Subcommittee 17 Management Systems for Food Safety, Work Group 8 Food Safety Management—Requirement (ISO TC34/SC17/WG8)—Management Systems for Food Safety (ISO 22000)**: Observer status
- **Grocery Manufacturers Association (GMA)—Work Group on Economic Adulteration as well as Various Brand Protection Advisory Groups:** Committee or share group member
- **Chinese National Center for Food Safety Risk Assessment (CFSA):** Foreign subject matter expert and researcher
- **US Pharmacopeia's Original Food Ingredient Intentional Adulteration Expert Pane**l: Volunteer member (2009–2018)
- **INFOSAN the WHO and FAO-UN Food Safety Information Sharing Network**: Presenter and researcher
- **Codex Alimentarius Electronic Work Group on Food Integrity and Food Authenticity**: Supporting the US delegation and also as a contributing scientist to the EWG
- **Global Food Safety Initiative (GFSI) Food Fraud Think Tank:** Member (Note: Due to the development and publication of certification requirements—combined with our continued engagement with a broad range of stakeholders—this is the most important and impactful activity.)
- **Canadian Food Fraud Work Group (FFWG):** Ex-officio member supporting the Canadian Food Inspection Agency (CFIA) with the goal of implementing steps to combat and prevent food fraud in Canada
- **ISLI Food Authenticity Project and Task Force:** Member
- **AOAC Presidential Taskforce on Food Authenticity:** Member.

These many research projects and engagements since 2005 are the foundation for this book. While the science of food fraud prevention is continuing to evolve, there is now a need to clearly understand the basic fundamental terms, concepts, theories, tools, methods, and processes. Even if the concepts are not yet universally known or implemented, the base concepts are published in peer-reviewed journals and, usually at least, outlined in standards, certifications, and common practice.

This book is the culmination of those activities.

Personal Insight: Developing Food Fraud

If anything, over time, the food fraud concepts have just become more ingrained and more formally recognized. If anything, they have matured from "what is it?" to "how to deal with it?" and on the way to "how much is enough?" On the GFSI Food Fraud Think Tank, this was referred to as "shifting from "what" to "how." We find that we have shifted from talking about "Defining Food Fraud and the Chemistry of the Crime" to "Food Fraud Prevention and Global Trends."

Our original 2011 research paper on "Defining the Public Health Threat of Food Fraud" was conceived during the FDA Public Meeting on EMA in May 2009. The conference was held near Washington, DC, at the FDA Center of Food Safety and Nutrition (CFSAN) in College Park, Maryland, which ended late on a Friday afternoon, and I decided not to hurry to the airport for a late flight. This allowed an opportunity for possible debriefs after the meeting. I decided to stay with friends who lived north of Baltimore and then fly back to Michigan on Saturday morning. I had some important time to decompress and allow time to reflect after the day of presentations. I had a long slow travel time driving through the rush hour that night then the drive and flight the next Saturday morning. I kept thinking about how we could do a better job of explaining the food fraud concepts. The base of that article was conceived during that trip.

The invitation to present at the FDA EMA meeting in 2009 came from David Acheson who was the FDA deputy commissioner for Food Protection. We had met earlier in 2007 at the Association of Food and Drug Officials (AFDO) annual conference and had started conversing about food fraud. (I will admit that I was new to these types of sessions and thought I had been invited to present to David and his team.) Fortunately, earlier in that week while at the Food Safety Summit, Gale Prince, the former vice president of Regulatory Affairs for Kroger, mentioned that he heard I was testifying later that week. "Testifying…?" I did a bit of research and figured out this was a formal public meeting that was on the record and would have a published transcript. I did quite a bit more preparation after hearing this. I am grateful to David for recommending me as a speaker and to Gale for giving me a heads-up to one of the most important events of my career.

After responding to all those insights, taking on an unsolicited project to define a new topic and area of study would seem like a bit of a bold activity since, technically, I was just a "grad student" and not even a "postdoc." Later that month, I

submitted my Michigan State University Packaging Dissertation, graduated, and, the next month, started at MSU as an assistant professor faculty member in the School of Criminal Justice. Academic publications are important, so I started thinking about how I would write this up to submit to a journal. I was excited about the topic and the opportunity to contribute to the innovation, so I didn't think about funding or a publication outlet—*yet*.

In July 2009, the National Center for Food Protection and Defense (NCFPD), housed at the University of Minnesota, had a call for projects. I remember hearing about this grant from my MSU SCJ colleague, assistant professor Dr. Robyn Mace, only a few days before it was due. I remember staying in the office late on a Friday to put this proposal together just before the deadline later that night.

I was fortunate in June 2009 to be awarded the grant just a month into my "soft money"-funded MSU fixed-term appointment that covered my annual salary—so this grant helped me get off to a running start. I was very fortunate to enlist a graduate student to help, the now Dr. Douglas C Moyer—and in 2014, now an assistant professor focusing on Public Health Administration and Counterfeit Medicines in the MSU Program in Public Health. He had 25 years of work experience with Ford Motor Company before coming back to MSU to pursue his Packaging Ph.D. and was focusing on operational management but was interested in collaborating on this food project.

We finished the deliverable for the NCFPD grant and then sought a publication outlet. We kept finding that food journals thought this was more of a criminology concept. The criminology journals thought it would be better suited in a food journal. The business and public health journals had not heard of the topic, and we did not yet have empirical research or a reputation that would encourage the defining of a new concept. All the while, both food and criminology journals said it was outside their aim and scope because they had never covered the concept before. There was still a general belief that this was more of a corporate crime or only a financial crime. Food fraud wasn't yet defined as a "thing," and it was not in the "aim and scope" of *any* discipline—yet.

Eventually, while Doug and I were talking out loud about this while having a beer during a chilly Fall evening around an outdoor fire pit at the 2010 NCFPD conference, a colleague mentioned interest in the article. Dr. Jennifer McEntire was the research director for the Institute of Food Technologists (IFT). We had presented on several panels for her IFT workshops. She chaired a USDA/FDA Public Meeting on food traceability where I submitted public comments on food fraud. She had seen the reaction from industry and understood this was an emerging and important topic. She asked us to forward the manuscript to the editor of the *Journal of Food Science* and to "cc" her. After several discussions, they took the article into the peer-reviewed process; then with quite a bit of effort to find reviewers—and some very challenging rounds of edits—finally our article was accepted. "Defining Food Fraud" was now a published topic. Food fraud was now a topic that had been defined in a scholarly journal. Food fraud was now a "thing."

Our NCFPD grant was funded from October 2009 to September 2010 with the final report published on April 30, 2011. At that time, we began working on the full

manuscript and then first submitted our journal article on November 10, 2010; had a review process for 9 months before it gets accepted on August 24, 2011; and finally published 3 months later on November 9, 2011. The formal research projects spanned 25 months from October 2009 to publication in November 2011. The process seems lengthy, but the peer-reviewed, refereed review process is important and critical to advance the science.

Over the years, patience and persistence have been critical because we often experienced extensive peer-reviewed comments that challenged the very essence of "food fraud" as a "thing." Fortunately, the intense feedback and lengthy review process was *not* a surprise—it was actually to be expected. Many of our senior mentors predicted the intense scrutiny and helped us to understand this was important. The intense feedback—and our active and thorough responses—was a vital insight into what was misunderstood and where we needed to address more of the basic foundation.

I have mentioned that many of our colleagues had been publishing on related concepts—the basics of food fraud were not the focus of those previous articles. We had now published a peer-reviewed, refereed article on the definition of food fraud and of the public health impact. Scholarly articles are influential because they do go through a peer-reviewed, refereed process. In a top journal, you can't get away with "junk science" or making "flippant" statements. This rigorous process is important and valuable. The final product stands the test of time. This article allowed future researchers—and us—to be able to reference this article rather than continue to argue about the definition of the term and of the threat. Over time, and through 2019, the definition published in 2011 is referenced as the foundation of almost every definition of food fraud.

Later, we realized that "no wonder" we were having so much trouble getting traction when talking about food fraud because it had not been defined and widely understood to be an actual "thing." While there have been publications about specific incidents or test methods, there was no scholarly publication citation that explained food fraud was really a problem. While here, in 2019, we're approaching 8 years since the article published, we're just starting to see grants soliciting work specifically in food fraud.

Personal Insight: Defining Food Fraud—Exploring a Foundation

Much of the foundation of the food fraud prevention research began earlier at the start of my 2005—2009 Ph.D. research on product counterfeiting risk modeling within the Michigan State University School of Packaging, College of Agriculture and Natural Resources. The Ph.D. dissertation was entitled "Analysis of Counterfeit Risks and Development of a Counterfeit Product Risk Model – CPRM" (Spink 2009). During that time, I was an adjunct graduate course instructor in the MSU

Master of Science in Food Safety Program (MSFS) within the College of Veterinary Medicines. The graduate classes created in 2006 and still taught include "Packaging for Food Safety" (co-listed in the School of Packaging (SOP), College of Agriculture and Natural Resources; VM/PKG 814) and modules in courses such as "Food Protection and Defense" (co-listed in the School of Criminal Justice (SCJ), College of Social Science; VM/CJ 821). Later in 2008, based on my Ph.D. dissertation and before joining the School of Criminal Justice, I developed and still teach "Anti-Counterfeiting and Product Protection" (co-listed in SCJ and SOP; VM/PKG/CJ 840). From the beginning, the broad scope of "all products" focus on intellectual property rights infringement combined with my food safety research applied to the concept of "food counterfeiting" to eventually adapt to policy and strategy issues for food fraud prevention.

As I was getting close to the end of my Ph.D. in early 2008, I approached SCJ director Dr. Edmund McGarrell to propose creating a new assistant professor position in the School of Criminal Justice. I helped develop that proposal and started in June 2009 reporting to him as a faculty member for 4 years before I was enabled to broaden my focus to all fraud while narrowing the scope to only food products. This refinement of focus enabled a much deeper immersion and engagement with a single industry. This immersion has been critical in building trust, increasing insight, and being afforded the time to not only research the topic but also to participate in a meaningful policy and strategy evolution.

Over time, while interacting with the food industry, around 2007, a leader said: "I'm not just worried about counterfeiting we've got a wider range of problems." Also, they stated, "I need to figure how to manage all these problems not just one at a time." During this period, around 2009, the US FDA defined economically motivated adulteration (EMA) as a "substance" for "economic gain" with a "hazard" (FDA 2009). We became aware of other related concerns such as in the pharmaceutical industry regarding regulations for stolen, diverted, and smuggled goods (RX-360.com, FDA 2004; WHO 2007). Our response was to combine the different intentional acts under a common topic that became "food fraud prevention." We did not create the food fraud term, but we provided a more rigorous definition and a peer-reviewed, scholarly journal citation.

In an effort to pursue related activities, since 2009, I was the founding chair of the US delegation to the International Organization for Standardization (ISO) Technical Committee 247 on Fraud Countermeasures and Controls (TC247; this shifted to under TC 292 Security Management and Resilience) (ISO 2010, 2017). It was interesting, and timely, to attend that first meeting. I remember talking to MSU colleagues that I could either wait for the results and write about them or actually attend the meeting. While at the meeting, I was approached and convinced to become the chair. This ISO activity was very important and had an influence on our research on the concept of product fraud, counterfeiting, and eventually food fraud. A key need was to define the terms, and eventually a "product fraud" definition was published in ISO standard 22380 Security and resilience—authenticity, integrity, and trust for products and documents—general principles for product fraud risk and

countermeasures (ISO 2018). This ISO standard codified our 2016 published Product Counterfeit Incident Clustering Tool (PCICT).

The evolution of the research continued when, in July 2012, the Global Food Safety Initiative (GFSI), under recommendation by then Chair Yves Rey of Danone and Co-Chair Frank Yiannas of Wal-Mart, convened a "Think Tank." The mission was to review the concept and consider the application under the GFSI Food Safety Management System. The group was originally entitled the "Economic Adulteration Think Tank," but based in part on the ISO precedence of referring to this as "product fraud," the name shifted to "Food Fraud Think Tank." A key for GFSI was that, although health hazards are the highest priority, companies needed a system to assess and manage all types of food risks. GFSI—and the base functionality of HACCP—is essentially a total quality management system, so it focuses not only on the highest risks but also on the underlying system variability that can lead to nonconformity. The GFSI-FFTT shifted a focus from risk to vulnerability and also first conceived the Vulnerability assessment and Critical Control Point plan (VACCP) content. VACCP was first formally presented at the 2013 GFSI Annual Conference in Barcelona.

Here in 2019, the GFSI food fraud requirement should not be a surprise for the industry since; in December 2014, the GFSI Board published their position paper on food fraud that stated the concept would be required in the next GFSI guidance document. The GFSI Issue 7 published in 2017 and implemented as of January 2018 includes requirements for the following: (1) a specific Food Fraud Vulnerability Assessment, (2) Food Fraud Prevention Strategy (Food Fraud Mitigation Plan), and (3) an emphasis on covering the "relevant GFSI scope" which is all types of fraud (e.g., from adulterant substances to stolen goods and counterfeits) and for all products (e.g., from raw materials through finished goods in the market) (GFSI 2014, 2017). In May 2018, the GFSI Board published a Food Fraud Technical Document that further clarified and refined what had been published back in the 2014 Position Paper and what was in the Guidance Document (GFSI 2018).

Over time, the "all types of fraud" and "all products" broad scope of food fraud has been widely adopted by the EC, UK, FSAI, China, INTERPOL-Europol, and others (ISO 2011; Spink and Moyer 2011; GFSI 2012; SSAFE 2012; CRS 2014; DEFRA 2014; EC 2014; CFSA 2015; CFSA 2015; Manning and Soon 2016; CODEX 2017; GFSI 2017; NFCU 2017; van Ruth, Huisman et al. 2017; CEN 2018). It is efficient that the food fraud term has a common definition because users or assessors can clearly state whether they are addressing all types or just a specific area such as adulterant substances.

Over time, food fraud has become a "thing" and is not only a requirement for compliance, but it is beginning to be understood to be a critical component of a competent Food Safety Management System—and just good business practice. The global food supply chain is safer—the global food security is improving.

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There have been so many incredibly important colleagues through the years during my return from industry to academia starting at MSU. Originally in 2003, Ed Mather, MSU CVM Associate Dean and Director of the Food Safety Program, was the first person to recruit me into academia as an adjunct instructor to develop the "Packaging for Food Safety" graduate course. Next, in 2008 Ed McGarrell, MSU SSC Director of the School of Criminal Justice, was the first person to offer me a full-time MSU faculty assistant professor appointment. Then another critical step was in 2013 when Chris Brown, MSU CVM Dean, recruited me to focus on food fraud research. The support of the College of Veterinary Medicine (CVM) allowed and encouraged us to follow wherever the unmet research needs led. It is very unique not only to collaborate across departments within the university but to move a faculty appointment between different departments and colleges is extremely rare. Further, we were wholeheartedly encouraged by CVM to publish in journals from outside our core veterinary medicine area even though it did not bring direct accolades to CVM. I am especially grateful to J. Ian Gray, MSU Vice President for Research and Graduate Studies, who worked with Provost June Youatt to secure a 5-year appointment in 2014. This appointment enabled the priority to shift to developing the research and scholarly foundation that included the top deliverable, which was this food fraud textbook. More recently, I am grateful for the research and coauthor collaboration with Dr. Cheri Speier-Pero, Chair of the Department of Supply Chain Management (SCM) within the MSU Eli Broad College of Business (BUS).

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I had an incredibly enlightening experience coauthoring a chapter on food fraud in the book *Food Safety in China: Past, Present, and Future* (Chinese). Drs. Junshi Chen and Joseph Jwu-shan Jen have been important mentors and editors for this book (Fig. 1).

Throughout my experiences working in China, Dr. Yongning Wu has been my primary contact and champion (Fig. 2). We first met in the USA during a US Pharmacopeia Expert Panel Meeting. I mentioned I was researching food fraud prevention and was going to be in Beijing a month later—he immediately extended an invitation to present at a conference, which I accepted. That conference in Beijing was important because I met my Moscow State University for Food Production colleagues and subsequently was invited to one of their conferences in Moscow.

Fig. 1 Dr. Spink with book editors Dr. Junshi Chen and Dr. Joseph Jwu-shan Jen

Fig. 2 Dr. Spink Presenting the Valued Partner award to Dr. Wu and CFSA

During my trips to China, I was hosted and guided by Dr. Miao Hong (Fig. 3). We originally met a year earlier at a food safety conference in Korea. She is a coauthor on our Food Chemistry article, and we have been constant collaborators on a number of projects. At CFSA, she is the deputy director of the Food Chemistry Laboratory. My other CFSA colleague is Dr. Zu Ru who hosted me during a large group presentation. She is the CFSA deputy director in the Division of Science, Education, and International Cooperation.

Fig. 3 Dr. Spink Presenting the Valued Partner award to Dr. Xu and Hong

Fig. 4 Dr. Spink Presenting the Valued Partner award to Dr. Quiding and China National Research Institute of Food and Fermentation Industries (CNRIFFI)

During my trips to China, and more often meeting at events around the world, Dr. Zhong Qiding has been providing important insight and support (Fig. 4).

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Fig. 5 GFSI China Focus Day Speakers (left to right): John Spink, MSU & Member of the GFSI Food Fraud Task Force; Petra Wissenburg, Director Danone & Chair of the GFSI Food Fraud Task Force; Mike Robach, VP Cargill & GFSI Chairperson; Yves Rey, Gen Manager Danone & GFSI Board Member; Zaotian Wan, VP COFCO (China) & GFSI Board Member; Anthony Hugget, VP Nestle & GFSI Board Member; Cindy Jiang, Sr Director McDonald's & GFSI Board Member; and John Carter, VP Metro Group & GFSI Board Member

Fig. 6 Dr. Spink with Frank Yiannas, VP of Food Safety at Wal-Mart, at the 2013 GFSI China Focus Day (Beijing)

About the Book

This section reviews the organization of the content in the book. The research is presented in a "cloverleaf" structure where several very different concepts will be reviewed in detail before the presentation down the narrow stem of the more specific application. This is different from the more traditional "keyhole" structure of academic research that is usually focused on a very specific small center of a concept explored in detail before the presentation of the broader application. In addition, the content of the book and within each chapter is based on a hierarchy of Key Learning Objectives (KLOs).

This book is organized by thematic areas which start with the core food fraud definitions and scope. Since this is an interdisciplinary and complex problem, then there is no logical, linear path of topics. The information is structured by Key Learning Objectives (KLOs) which are statements about what skills and knowledge are delivered and why. The hierarchy approach allows a review of what topics are important or critical to include, if they have been included, and to explain how the learning objective is to be successfully achieved. The KLO hierarchy includes the following: (1) book, (2) chapters, (3) three per chapter, and, finally, (4) three sub-objectives. Each chapter includes a statement of "What's In It for Me (WIIFM)" and discussion questions.

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Okemos, MI, USA John W. Spink

About the Author

Since 2013, Dr. John Spink (www.FoodFraudPrevention.com) has been the director of the Food Fraud Initiative (FFI) at Michigan State University (MSU). The Food Fraud Initiative is an interdisciplinary activity focused on detecting and deterring this public health and economic threat. The research focus is on policy and strategy starting with Criminology and through to the application of business decision-making and COSO/Enterprise Risk Management. His leadership positions include product fraud-related activities with "ISO 22000 Food Safety" and "TC292 Security Management/Fraud Countermeasures," WHO, FAO/UN, GFSI Food Fraud Think Tank, and US Pharmacopeia (USP). Global activities include engagements with the European Commission, INTERPOL/ Europol Operation Opson, New Zealand MPI, Codex Alimentarius, WHO/FAO, Food Safety Authority of Ireland (FSAI), Canadian Food Fraud Work Group, Trinidad and Tobago Parliamentary Inquiry on Food Fraud, and served as an advisor on food fraud to the Chinese National Center for Food Safety Risk Assessment (CFSA).

Dr. Spink has been focused on product fraud prevention since his 2005–2009 MSU School of Packaging Ph.D. research in the College of Agriculture and Natural Resources (CANR). This work was coordinated with his adjunct instructor activity within the Master of Science in Food Safety Program in the College of Veterinary Medicine (CVM). His Ph.D. dissertation research was focused on Anti-Counterfeit Strategy and risk assessment. Before he completed with his Packaging Dissertation, this research was the foundation for a CVM Food Safety administered graduate course on "Anti-Counterfeiting and Product Protection" (VM840 that was eventually accepted by the School of Packaging as PKG840 and also by the School of Criminal Justice as CJ840). This research formalized into a CVM-based initiative. From 2009 to 2013, he was an assistant professor in the School of Criminal Justice in the College of Social Science at MSU where his work research evolved from an Initiative to a Program. From 2013 to 2019, he was an assistant professor in the College of Veterinary Medicines where he founded the Food Fraud Initiative (FFI). This position was supported by a 5-year research appointment funded primarily by the MSU Provost. More recently, in 2019, he is an assistant professor in the

Department of Supply Chain Management in the Eli Broad College of Business at MSU.

While conducting his full-time faculty member requirements of research and outreach, he has had a full teaching load with graduate courses such as "Packaging for Food Safety," "Anti-Counterfeiting and Product Protection," and "Quantifying Food Risk." This program included a Graduate Certificate in Food Fraud Prevention. This research evolution to business decision-making and supply chain controls is supported by a focus on undergraduate student course development and teaching including "Introduction to Supply Chain Management" and "Procurement and Supply Chain Management."

He is widely published in leading academic journals with important works such as "Defining the Public Health Threat of Food Fraud," "Defining the Types of Counterfeiters, Counterfeiting, and Offender Organizations," "Introduction of the Food Fraud Initial Screening Method (FFIS)," and "Introducing the Food Fraud Prevention Cycle (FFPC)." Before returning to academia in 2009, he worked for over 11 years at Chevron Corporation, then at a high growth $100 million consumer products company, and 3 years in general management consulting. Outreach includes a series of food-related free, online courses presented in a MOOC (free, Massive Open Online Course) format. Please see www.FoodFraudPrevention.com

Disclosure

This book was created without any additional support other than within the key job responsibilities and commitment of personal time. The topic of food fraud—and especially the interdisciplinary criminology and business decision-making theories—is new, and since this was not a funded project, many other researchers and colleagues were interested but could not justify the time and effort to contribute. Hopefully, the innovative interdisciplinary approach, which is extremely practical and applied, will demonstrate the value of food fraud prevention and begin to support more extensive public and private funding.

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Note: This book specifically does not mention or address private or commercial products or services. There are many excellent options, but they will not be covered within.

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