Review

Not peer-reviewed version

Paradigms in Research on Food Science, Technology, and Engineering: Impact on Public Health

Rodrigo Alfredo Matos Chamorro *

Posted Date: 12 August 2025

doi: 10.20944/preprints202508.0807.v1

Keywords: paradigms; positivist; constructivist; socio-critical; pragmatic; food technology; food innovation

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 12 August 2025 doi:10.20944/preprints202508.0807.v1

Review

Paradigms in Research on Food Science, Technology, and Engineering: Impact on Public Health

Rodrigo Alfredo Matos Chamorro

Universidad Peruana Union, Peru; amatosch@upeu.edu.pe

Abstract

The aim of this article is to argue the importance of paradigms in the development of research in science, technology, engineering and food innovation to achieve a holistic understanding and effective solutions for public health. The positivist paradigm provides essential tools for quantifying, controlling, and ensuring fundamental aspects of food quality and safety, offering significant benefits for public health. The post-positivist approach addresses more complex aspects of food systems and their interactions with humans and the environment. The constructivist paradigm seeks meaningful impact on public health by focusing on meanings, lived experiences, cultural contexts, and the co-creation of knowledge, thereby complementing positivist and post-positivist perspectives. The socio-critical paradigm examines power dynamics and structures of inequality underlying many food and public health issues; it does not merely seek to describe or interpret but actively pursues transformation toward a fairer, more equitable, and sustainable food system. Finally, the pragmatic paradigm offers a flexible, action-oriented framework that, through its connection with public health, frees researchers from the constraints of a single approach, fosters creativity in research design, promotes interdisciplinary collaboration, and generates knowledge that can be directly applied to solve practical problems and improve the health and well-being of populations.

Keywords: paradigms; positivist; constructivist; socio-critical; pragmatic; food technology; food innovation

---

1. Introduction

Paradigms are the "worldviews" that guide science during a particular period. They form a complex structure of shared ideas, assumptions, values, and practices that define a scientific discipline—or any field of knowledge—for a certain time. According to Kuhn [1], problems that do not fit within the existing framework or persistent anomalies can eventually lead to a crisis and, ultimately, to a "scientific revolution" in which a new paradigm replaces the old one. This change is not gradual but revolutionary, often involving a redefinition of the problems, methods, and even the rules of scientific practice. Understanding this process shows that science is a dynamic and constantly evolving human activity, not merely a linear accumulation of facts.

Research in food science, technology, and engineering is a field of formidable complexity. It ranges from the inherent variability of biological raw materials to the complexities of large-scale processing and consumer interaction, with a direct and tangible impact on global public health. This complexity is not only an academic challenge but also the crucible in which solutions with profound and everyday impacts are forged. From ensuring the safety of food offered in the marketplace to optimizing its nutritional value to prevent disease and promote sustainable food systems, this area is a cornerstone of the health and well-being of populations around the world. Continuous investment and interdisciplinary collaboration are therefore essential to address current and future health and food challenges [2,3].

Transforming raw materials into safe, stable, nutritious, and appealing food products requires sophisticated engineering to optimize processes while maintaining food safety, including sensory quality, efficiency, cost, and environmental sustainability. It is crucial to understand that foods are

doi:10.20944/preprints202508.0807.v1

not inert or chemically pure substances, but rather complex, dynamic, and heterogeneous biological matrices in which multiple components interact, revealing their unstable nature. This makes process design require a deep understanding of heat, mass, and momentum transfer, as well as the kinetics of the chemical and biochemical reactions that occur during processing [4].

Furthermore, food science research does not occur in a vacuum; it is intrinsically linked to consumer perceptions, needs, and behavior, as well as regulatory and ethical frameworks. Sensory quality is a key factor in food selection and requires complex knowledge involving human physiology, psychology, and culture.

This complexity can be addressed from different paradigms that contribute to a deeper understanding of the phenomena. The purpose of this article is to argue the importance of research paradigms in the development of projects in food science, technology, and engineering to achieve a holistic understanding and effective solutions for public health.

2. Paradigms

In the field of philosophy of science and research (especially in the social sciences), "paradigms" are classified according to fundamental assumptions about the nature of reality and knowledge. These paradigms address three crucial philosophical issues that every researcher must confront, consciously or unconsciously. (Table 1) [5,6].

Ontology: What is the nature of reality? Is there a single, objective reality, or are there multiple realities socially constructed?

Epistemology: What is the relationship between the researcher and the object of study? Can researchers be objective and neutral observers, or are they part of what is being studied?

Methodology: How can knowledge of that reality be obtained? Which methods and procedures are valid?

Table 1. Summary of the main types of research paradigms.

Paradigm	**Criterion**			
	Ontology	**Epistemology**	**Methodology**	**Objective**
Positivist [7]	Single, objective reality	Objectivism, neutral researcher	Quantitative, experimental	Explain and predict
	Naïve realism			
Post-positivism [3]	Objective reality but imperfectly understood	Objectivity as an ideal; biases are acknowledged	Mainly quantitative, falsification, triangulation	Explain and approach truth
	Critical realism			
Constructivism [8]	Multiple socially constructed realities	Subjectivism, knowledge co-created	Qualitative, hermeneutic, dialectical	Understand and interpret
	Relativism			
Critical Paradigm [9]	Reality shaped by power structures	Subjectivism, value-oriented, seeks change	Dialogical, participatory, transformative	Critical y transformer
	Historical realism			
Pragmatic Paradigm [10]	Practical, pluralistic world	Transactional and experience-based	Flexible and context-appropriate	Action- and consequence-oriented
	Realism			

Approaching research in Science, Technology, Engineering, and Innovation (STEI) with a focus on public health from multiple paradigms is not only enriching but essential to achieving a holistic understanding and proposing effective solutions. Each paradigm offers a unique lens through which to identify problems, formulate questions, and design innovation strategies.

2.1. The Positivist Paradigm in Food Research and Its Impact on Public Health

Positivism, rooted in the thought of Comte and the Vienna Circle, holds that authentic knowledge comes exclusively from the scientific method through the positive affirmation of theories [7]. Its main characteristics applied to food science, technology, engineering, and innovation (STEI) are:

Realist Ontology: There is an objective and knowable reality. In food research, this translates into the idea that the physicochemical, microbiological, and nutritional properties of foods are quantitative measurements.

Objectivist/Dualist Epistemology: The researcher is an independent and neutral observer who does not influence the object of study.

Experimental/Manipulative and Quantitative Methodology: It focuses on hypothesis formulation, variable control, rigorous experimentation, precise measurement, and statistical analysis to establish cause-effect relationships and general laws.

Positivist Research Models in Food STEI

Below Are Some Examples of Positivist Research Approaches:

a. Chemical and Nutritional Analysis:

This allows for the precise determination of food composition (proteins, fats, carbohydrates, vitamins, minerals). This was crucial in establishing the first food composition tables and dietary reference intakes (DRI). These studies facilitate the identification of nutritional deficiencies in populations (e.g., scurvy, pellagra) and lay the foundation for food fortification (iodine in salt, vitamin D in milk), significantly improving public health [11].

b. Predictive Microbiology and Inactivation Studies:

This involves developing mathematical models to predict the growth, survival, or inactivation of microorganisms (pathogenic and non-pathogenic) under different processing and storage conditions (temperature, pH, water activity), as well as establishing parameters such as D and Z values. These studies are essential for designing safe preservation processes (pasteurization, sterilization) that prevent foodborne diseases, a major public health concern [12,13].

c. Optimized Process Engineering:

Focuses on the design and optimization of unit operations (drying, extrusion, grinding, etc.) to maximize efficiency, quality, and safety while minimizing nutrient loss, based on principles of thermodynamics, heat and mass transfer. These studies enable the large-scale production of safe and stable foods, facilitating their distribution and access to larger populations, as well as reducing exposure to contaminants generated by improper processing [14].

d. Shelf-Life Studies:

Involve quantitative assessments of physical, chemical, and microbiological changes to determine the period during which a food product maintains its quality and safety. These studies have helped reduce food waste and prevent the consumption of deteriorated products that could cause illness [15].

e. Kinetic Modeling of Chemical and Physical Transformations:

Uses mathematical principles to describe and predict the rate at which changes occur in foods during processing and storage. It goes beyond identifying what changes to also address how fast and under what conditions these changes occur. Applications include nutrient degradation (e.g., vitamins), formation of undesirable compounds (e.g., acrylamide, furans), or changes in texture and color [16,17].

f. Computational Fluid Dynamics (CFD) Simulation for Process Design:

 doi:10.20944/preprints202508.0807.v1

A highly quantitative engineering tool that uses numerical models and algorithms to simulate and analyze fluid flow (liquids or gases), heat transfer, and mass transfer within food processing equipment. CFD is critical for identifying "cold spots" in pasteurization or sterilization systems, ensuring that every food particle receives the lethal heat treatment necessary to inactivate pathogens such as *Listeria monocytogenes* or *Clostridium botulinum* [18,19].

2.2. The Post-Positivist Paradigm in Food Research and Its Impact on Public Health

Post-positivism emerges as a critique of positivism, recognizing the limitations of pure objectivity. While it still seeks objectivity, it acknowledges that all observations are fallible and influenced by theory, and that "truth" can only be approximated [7,20].

Critical Realist Ontology: There is an objective reality, but it can only be imperfectly and probabilistically apprehended. Complexities and interactions are acknowledged, which are not always linear or causally determined.

Modified Objectivist Epistemology: Objectivity remains an ideal, but the influence of the researcher is recognized. Triangulation and community critique are valued as tools to approach objectivity.

Methodology: Both quantitative and qualitative methods are used. Hypotheses are formulated and statistically analyzed for acceptance or rejection. Context, interpretation, and understanding of complex systems are emphasized.

Post-Positivist Research Models in Food STEI

a. Risk Assessment and Uncertainty Management:

Rather than assuming perfect control, risk assessment models (microbial, chemical) incorporate variability and uncertainty into the data and models (through simulations). These studies allow for more informed and realistic decisions regarding food safety, establishing acceptable risk levels and prioritizing interventions where the impact on public health is greatest [21].

b. Studies on Nutrient Bio accessibility and Bioavailability:

It goes beyond the mere quantification of nutrients (as in positivism) to investigate how food matrices and processing affect the release, absorption, and utilization of nutrients by the human body. The findings of these studies allow for the design of foods and diets that not only contain nutrients but also ensure their effective use, which is crucial for combating hidden hunger and optimizing nutritional status [22].

c. Sensory Science and Consumer Behavior Research:

Uses mixed methods (quantitative sensory tests, focus groups, qualitative interviews) to understand how consumers perceive food and make decisions, considering psychological, social, and cultural factors. Results from such studies are important for developing healthy foods that are accepted by the population, facilitating the adoption of more nutritious diets and successful product reformulations (e.g., reduced salt, sugar, fats) [4].

d. Life Cycle Assessment and Sustainability of Food Systems:

It assesses the environmental and social impacts of food products and systems "from cradle to grave," recognizing the interconnectedness of multiple factors. These studies promote more sustainable food systems that ensure long-term food availability while reducing negative environmental impacts that indirectly affect health (e.g., water pollution, climate change)[23].

e. Participatory Research and Co-Creation:

Involves various stakeholders (consumers, producers, policymakers) in the research and innovation process, recognizing that knowledge does not reside solely with experts. This interaction facilitates the development of food and public health policies better adapted to local needs and contexts, increasing their acceptability and effectiveness [24].

f. Systems Dynamics Modeling for Food Environments:

Rather than analyzing isolated variables (as in positivism), this approach models the food system as a complex, dynamic whole, with feedback loops, delays, and nonlinear relationships. It is used to simulate how changes in one part of the system (e.g., a subsidy policy, a technological innovation, a marketing campaign) may have unintended and long-term consequences in other areas, such as obesity rates or environmental sustainability [25].

g. Implementation Science:

This field focuses on systematically studying methods to promote the adoption and integration of evidence-based interventions (e.g., a new dietary guideline, a food fortification technology) into real-world practice. Post-positivism is evident here through the recognition that an intervention proven "effective" in a controlled trial (efficacy) does not guarantee it will "work" in a chaotic and diverse community setting (effectiveness) [26].

h. Dietary "Exposome" Research:

The exposome concept represents the totality of environmental exposures (including diet) to which an individual is subjected from conception to death. This model is inherently post-positivist because it moves away from the reductionist approach of studying a single nutrient or contaminant at a time. It encompasses the immense complexity of dietary exposures (thousands of compounds ingested simultaneously) and aims to capture a more holistic and realistic picture of how this complex mix interacts with our biology [27].

2.3. The Constructivist Paradigm in Food STEI Research and Its Relationship with Public Health

Unlike positivism and post-positivism, the constructivist paradigm is based on the premise that reality is not an objective, external entity waiting to be discovered, but rather is socially and individually constructed through experience and interaction with others in the world [7,10]. Knowledge is, therefore, an interpretation and a creation of meaning.

Key Principles of Constructivism:

Relativist Ontology: Realities are multiple, local, and specific, constructed by individuals and groups. There is no single, objective "truth."

Subjectivist/Transactional Epistemology: The researcher and the subject of study are interconnected. Knowledge is co-constructed through this interaction. Researchers' values influence the process.

Hermeneutic/Dialectical Methodology: Focuses on interpreting and deeply understanding meanings, experiences, and contexts. It primarily uses qualitative methods such as case studies, ethnography, phenomenology, in-depth interviews, focus groups, and content and discourse analysis to generate rich, detailed descriptions.

Development of Constructivist Research Models in Food STEI and Their Impact on Public Health

The constructivist paradigm introduces a radically different perspective in food STEI research, shifting the focus from intrinsic properties of food (though not ignored) toward how foods are perceived, valued, used, and integrated into people's and communities' lives.

a. Ethnographic and Cultural Food Practices Studies:

Researcher immersion in a community to observe and participate in daily and ritual food practices helps understand belief systems about food and how food knowledge is transmitted [28].

Applications:

- Investigating how indigenous communities use local plants with medicinal or nutritional properties, or how different ethnic groups interpret official dietary guidelines based on their culinary traditions.
- Studying how various population groups interpret and use nutrition labeling to make food choices, and how innovations in labeling could improve comprehension.

These studies help identify cultural barriers and facilitators to adopting healthy diets, aiding in the design of culturally sensitive and relevant public health interventions (e.g., nutrition programs), thereby increasing their acceptability and effectiveness [29]. They also help recognize beneficial traditional food practices or undervalued local knowledge.

 doi:10.20944/preprints202508.0807.v1

b. Research on Perception and Acceptance of Food Innovations (Technologies, New Products):

Focus groups, in-depth interviews, and case studies are used to explore how consumers construct meanings around new food technologies (e.g., genetically modified organisms, cultivated meat, nanotechnology) or reformulated products (e.g., low sodium/sugar)[30].

Applications:

- Analyzing consumer narratives and concerns regarding the "naturalness" of processed foods or perceived risks of additives.
- Understanding perceptions, beliefs, and cultural barriers and facilitators to adopting reformulated foods (e.g., low sodium), fortified foods, or alternative proteins (e.g., insects, cultured meat) [31].
- Exploring how individuals with specific conditions (e.g., celiac disease, type 2 diabetes mellitus) experience consuming specially designed foods, identifying daily challenges and improvement opportunities.

Understanding these aspects helps strengthen or modify interventions to enhance consumer acceptance—key to the success of any food innovation aimed at improving public health (e.g., fortified foods, healthier substitutes). Without acceptance, impact is null [30]. This approach supports food technologists and engineers in designing products that are not only safe and nutritious, but also desirable and trustworthy to the public, effectively communicating benefits and risks while addressing real concerns.

c. Participatory Action Research and Co-Design of Food and Nutritional Solutions:

Collaborative processes where researchers and community members work together to identify problems, investigate solutions, implement them, and evaluate outcomes. Knowledge is co-constructed, and action is a central goal [32].

Applications:

- Collaborating with a school community to design and implement a school garden and nutrition education program, involving students, teachers, and parents actively in all phases.
- Understanding how home cooking and preservation technologies affect the preparation of healthy meals and waste reduction.

Findings can empower communities to take control of their own health and food systems [33], generating more sustainable and contextually appropriate solutions and fostering ownership of public health interventions.

d. Studies on the Social Construction of Risk and Food Safety:

Investigates how different social groups (consumers, producers, regulators, scientists) define and perceive food risks and safety. Explores how these perceptions influence behavior and policy [12,34].

Applications:

- Analyzing why certain "food scares" have significant media and social impact even when scientific risk is low, or how communities build trust (or distrust) in the regulatory system.
- Designing food innovations that are not only biologically effective but also culturally appropriate, acceptable, and usable by the target population.

These studies help strengthen risk communication by public health authorities and support the design of policies with social legitimacy. Although risk perception may not always align with scientific assessment, it is a powerful driver of consumer behavior and public pressure on regulators [35].

e. Phenomenological Studies of Food Experience in Chronic Diseases:

Phenomenology seeks to understand the essence of lived experience from the perspective of those who experience it. In this context, research focuses on how people with diet-related chronic diseases (e.g., type 2 diabetes, celiac disease, severe food allergies, obesity) experience the world of food. It goes beyond measuring adherence to a diet and explores questions like: What does "eating" mean for someone with this condition? How do they navigate social situations (parties, restaurants)? How is identity shaped around dietary restrictions? [27,36].

f. Analysis of the Social Construction of "Healthy Eating":

This model investigates how the concept of "healthy eating" is constructed and negotiated by different social groups. It recognizes that there is no universal definition, but rather multiple "realities" influenced by the media, social media, food subcultures (e.g., veganism, the Paleolithic diet), the food industry, and public health institutions themselves [8,32].

g. Grounded Theory Studies on the Adoption of Dietary Behaviors:

Grounded Theory is a systematic method for generating a theory that explains a process or action based on data collected from participants. Rather than starting from pre-existing theories, the theory "emerges" from the analysis. It can be applied to understand how people decide to adopt a new dietary behavior (e.g., cooking at home, reducing meat consumption, trying a new healthy product) [28].

h. Case Studies on Intergenerational Transmission of Food Knowledge and Practices:

This model focuses on the family or community as a unit of analysis to understand how food knowledge, skills (e.g., cooking), and beliefs are built, maintained, and transformed across generations. It explores the role of grandparents, parents, and children in this dynamic process of constructing family "food culture" [37].

2.4. The Critical/Socio-Critical Paradigm in Food STEI Research and Its Relationship with Public Health

The critical or socio-critical paradigm goes beyond understanding (positivism, post-positivism) or interpreting (constructivism) reality. Its central aim is to critique and transform social, political, economic, and cultural structures that produce inequality, oppression, and injustice, with the goal of promoting emancipation and social change [7].

Key Principles of the Critical Paradigm:

Historical Realist Ontology: Reality is shaped by social, political, cultural, economic, ethnic, and gender factors that have crystallized over time into social structures. These structures are seen as real but also as historical products capable of transformation.

Transactional/Subjectivist Epistemology (with a focus on power): Knowledge is socially constructed, but this construction is mediated by power relations. The researcher is not neutral, but rather an agent of change seeking to expose underlying ideologies and power dynamics.

Dialogic/Dialectical and Action-Oriented Methodology: Aims at dialogue between the researcher and participants (especially marginalized groups) to foster critical awareness and stimulate collective action. It employs qualitative, participatory, and often historical methods such as participatory action research, critical ethnography, and critical discourse analysis.

Development of Critical Research Models in Food STEI and Their Impact on Public Health

The critical paradigm focuses research on how the food system (production, processing, distribution, consumption, innovation) contributes to the reproduction of social inequalities and how it can be transformed to achieve greater equity and social justice.

a. Critical Analysis of Food and Health Policies:

Examines food, agricultural, and public health policies to identify how they benefit certain groups (e.g., large agri-food corporations) at the expense of others (e.g., small farmers, low-income communities) [38]. It questions the ideological assumptions behind these policies.

Applications:

- Investigating how agricultural subsidies favor the production of commodities for ultra-processed foods rather than fresh fruits and vegetables, or how food safety regulations impose disproportionate burdens on small producers.

These studies can reveal how policies create or exacerbate diet-related health disparities (obesity, malnutrition). They advocate for policies that promote food sovereignty (the right of peoples to

 doi:10.20944/preprints202508.0807.v1

define their own food strategies) and equitable access to nutritious and culturally appropriate foods [39].

b. Research on Food Justice and Socioeconomic Inequalities:

Focuses on systemic injustices within the food system, such as the existence of "food deserts" (areas with limited access to healthy foods) and "food swamps" (areas flooded with unhealthy options), and how these correlate with race, class, and geography [40].

Applications:

- Analyzing the impact of gentrification on food access for low-income residents, or the working conditions of agricultural laborers (often migrants and racialized individuals).
- Examining how innovations in the supply chain (e.g., fortification, preservation technologies) differentially affect access to nutritious food in marginalized communities [41].

Findings directly link socioeconomic conditions and structural discrimination to poor health and chronic diseases in marginalized communities [40], driving policy efforts to ensure the right to food as a matter of social justice.

c. Analysis of critical discourse and food marketing:

It deconstructs how the language, images, and narratives used by the food industry, the media, and sometimes even public health institutions shape perceptions about food, nutrition, and health, frequently perpetuating myths or promoting corporate interests [42].

Applications:

- Investigating how ultra-processed foods are marketed to children and vulnerable populations, or how “personal responsibility” campaigns in health obscure structural determinants of poor diets.
- Critically analyzing marketing strategies of ultra-processed foods and their influence on dietary choices among vulnerable populations.
- Assessing the ethical, social, and power implications of emerging technologies (e.g., genetically modified foods, cultured meat) and who benefits or is harmed by them.

Findings expose how marketing strategies can undermine public health efforts and contribute to obesogenic environments. They also promote media and critical literacy among consumers so they can make more informed decisions.

d. Emancipatory Participatory Action Research (PAR):

Like constructivist PAR, but with the explicit goal of empowering oppressed groups to identify their own problems, analyze root causes, and develop collective actions for social change. The researcher acts as a facilitator and ally [9].

Applications:

- Working with low-income communities to establish food cooperatives or community gardens focused on food sovereignty.
- Co-developing local food processing and preservation technologies that strengthen traditional systems and empower small-scale producers.
- Promoting innovations that address structural causes of malnutrition and health inequities, fostering fairer, sustainable, and community-empowering food systems.

Results promote community empowerment as key social determinants of health and help create locally rooted and sustainable solutions.

e. Critical Studies on Food Technology and Innovation:

Questions who control the development and implementation of new food technologies (e.g., biotechnology, nanotechnology, precision agriculture), who benefits from them, and what their social, ethical, and environmental implications are particularly for the most vulnerable.

Applications:

- Analyzing the impact of seed patents on farmer autonomy or the unequal distribution of benefits from genetically modified foods.

- Designing, implementing, and evaluating school feeding programs using innovative, fortified local products, combining measurement of nutritional outcomes (quantitative) with understanding of acceptability (qualitative) [10].
- Developing new packaging technologies and assessing their economic and environmental impact and adoption by consumers and industry, using both quantitative and qualitative data.
- Evaluating different communication approaches (e.g., apps, labeling) to promote healthier food choices, measuring behavior change and understanding its motivations.

These findings help ensure that technological innovation does not deepen existing inequalities or create new risks, while promoting broader public debate and more democratic governance of food science and technology.

f. Political Economy Analysis of the Global Food System:

This approach investigates how the economic and political power of large transnational corporations and influential nation-states shapes global food production, distribution, and consumption. It focuses on issues such as market concentration, supply chain control, international trade agreements, and the influence of corporate lobbying on health and food safety regulations [43].

g. Critical Race Theory (CRT) Applied to Food Justice:

CRT is a theoretical framework that examines society and culture from the perspective of race, racism, and power. Applied to food systems, it analyzes how systemic and institutional racism has created and perpetuated profound inequalities in access to food. It goes beyond simple correlations between race and access to food to argue that the system itself is racially structured. It redefines "food deserts" as "food apartheid," shifting the language from mere lack of access to active and deliberate segregation resulting from historical and current policies [44].

h. Ecofeminist Perspective in Food and Agriculture:

Ecofeminism establishes a theoretical and political connection between the domination of women and the domination of nature, arguing that both arise from patriarchal power systems. In food research, she examines how the modern agro-industrial system devalues traditional women's knowledge about seeds and agriculture, exploits women's labor in the food chain, and degrades ecosystems essential to life [45].

2.5. The Pragmatic Paradigm in Food STEI Research and Its Relationship with Public Health

The pragmatic paradigm is distinguished by its focus on action, problem-solving, and practical consequences. Rather than being concerned with the nature of "truth" or "reality," pragmatists focus on "what works" to address specific problems in concrete situations [46].

Key Principles of the Pragmatic Paradigm:

Ontology: Reality is what works in practice to solve a problem. It does not commit to a single view of reality; multiple realities can be relevant. Reality is defined by what is useful and pertinent to the problem at hand.

Epistemology: Knowledge arises from action and problem-solving. The focus is on the practical consequences of research. It accepts the existence of both objective and subjective worlds.

Methodology: Naturally aligned with mixed-methods research (integration of quantitative and qualitative approaches), as it values using the most appropriate methods to comprehensively answer the research question.

Problem-Centered Focus: The research question is central and guides method selection, rather than having a prior philosophical commitment dictate the approach.

Orientation Toward Consequences and Utility: The value of research is judged by its practical utility, its ability to inform action, and its capacity to produce desirable outcomes.

Development of Pragmatic Research Models in Food STEI and Their Impact on Public Health

The pragmatic paradigm is particularly well-suited to food STEI research, an inherently applied field focused on solving complex problems.

a. Problem-Solving-Oriented Research on Food Safety and Nutrition:

A public health issue (e.g., high incidence of a foodborne illness, low intake of a key nutrient) is identified, and a combination of methods is used to understand it from multiple angles and develop effective solutions.

Application:

To address a high rate of campylobacteriosis associated with chicken, a pragmatic approach might combine:

- **Quantitative:** Epidemiological studies to identify risk factors, microbiological analysis at critical points in the production chain.
- **Qualitative:** Interviews with producers, workers, and consumers to understand practices, perceptions, and barriers.
- **Intervention:** Design and evaluation (quantitative and qualitative) of a multifaceted intervention (e.g., new technologies, training, education campaigns).

This study can provide actionable evidence and concrete solutions to pressing public health issues. It also facilitates the translation of scientific knowledge into effective policies and practices, closing the gap between research and action [47].

b. Development and Assessment of New Functional or Reformulated Food Products:

It focuses on developing products that meet technical criteria (safety, stability, nutritional profile) and that are simultaneously accepted by consumers and have a positive impact on health.

Application:

Developing fiber-enriched, low-sodium bread would involve:

- **Food Technology (Quantitative):** Consumer testing and focus groups to understand perceptions.
- **Sensory Evaluation (Quantitative/Qualitative):** Acceptance tests with consumers, focus groups to explore perceptions.
- **Intervention Studies (Quantitative):** Clinical trials to assess the impact of bread consumption on health markers (e.g., blood pressure, bowel regularity).

These studies lead to products that can genuinely improve population diet and health, as they consider both technical and acceptance-related aspects.

c. Evaluation of Nutritional Public Health Programs and Interventions:

Use a mixed-methods design to evaluate the effectiveness, implementation, efficiency, and sustainability of programs aimed at improving nutrition and food security (e.g., school feeding programs, nutrition education campaigns, front-of-package labeling policies).

Application: Evaluating a front-of-pack warning label program:

- **Quantitative:** Sales data analysis to track purchasing pattern changes; surveys to measure understanding and use of labels.
- **Qualitative:** Interviews with consumers to explore how they interpret and use labels; interviews with industry about reformulation challenges.

The findings provide a comprehensive understanding of “what works, for whom, under what circumstances, and why” in public health interventions, enabling improvements and scale-ups [48].

d. Translational Research in Food STEI:

Focuses on accelerating the process of translating basic and applied research findings ("from lab to table" or "from field to consumer") into practices, products, and policies that improve public health.

Application:

Identifying a promising new food preservation technology in the lab, a pragmatic approach would quickly move to:

- **Engineering:** Scale-up and optimization studies for industrial application.
- **Safety and Regulation:** Risk assessment and engagement with regulatory agencies.
- **Consumer Research:** Acceptance and willingness-to-pay studies.
- **Economic Analysis:** Commercial viability assessment.

Such studies reduce the delay between scientific discovery and public health benefit, ensuring innovations reach those who need them more efficiently.

e. Action Research to Reduce Food Waste in the Supply Chain:

This approach addresses the multifaceted problem of food waste not as a technical failure, but as a systemic problem involving technology, logistics, economics, and human behavior. The goal is to work collaboratively with supply chain actors (producers, processors, retailers) to identify critical points, co-design interventions, and evaluate them in real time [49,50].

f. Design and Evaluation of "Food Safety Culture" in Organizations:

Recognizes that food safety depends not only on following technical procedures (a positivist HACCP approach), but also on organizational culture: "what people do when no one is watching." The pragmatic aim is to measure this culture, identify weaknesses, and develop effective interventions to strengthen it [51].

g. Development of Usability-Based Customized Nutrition Services:

The goal is not just to create the most accurate nutritional algorithm (positive thinking), but to design a complete service (app, coaching, eating plan) that users find useful, easy to use, and can integrate into their daily lives for sustainable behavior change. The central question is: "How do we design a personalized nutrition solution that people actually use and that works in real life?"[52].

h. Community-Based Participatory Research for Co-Creating Healthy Urban Food Systems:

It addresses complex problems such as food deserts or food insecurity in urban neighborhoods. It recognizes that externally imposed solutions often fail. The pragmatic objective is to engage community residents as equal partners throughout the research process to develop community-based, sustainable, and context-appropriate solutions. This leads to interventions with a greater probability of success and durability because they respond to real needs and are managed by the community itself [49].

2.6. Final Considerations

Products developed by the food industry have a direct impact on public health. Therefore, research in food science, technology, engineering, and innovation must be approached from a multiparadigm perspective. Each paradigm, independently, makes its own contribution: positivism and post-positivism lay the foundations for effectiveness and safety; constructivism ensures that innovations are meaningful and accepted; the critical paradigm helps us consider equity and justice in our developments; and pragmatism integrates diverse knowledge to find solutions that work in complex contexts.

As food-related STEI researchers, recognizing the strengths and limitations of each paradigm allows us to formulate more comprehensive research questions and design more robust studies that are not only scientifically sound but also socially relevant and transformative for public health.

3. Conclusions

- In science, rigorous measurement and controlled experimentation are still valued, but there is growing recognition of the need to address uncertainty, context, subjectivity (from the consumer's perspective), and complex interactions.
- The integration of constructivist approaches enriches food-related STEI research, making it more relevant, contextualized, and ultimately capable of positively contributing to the complex relationship between food, technology, and human well-being.
- Critical research in food-related STEI is a powerful tool for defending public health as a fundamental right and promoting social justice within the food system.
- The pragmatic paradigm fosters creativity in research design, promotes interdisciplinary collaboration, and generates practical knowledge that can directly solve practical problems and improve the health and well-being of populations.

References

1. Kuhn TS. The structure of scientific revolutions. 2. ed., enlarged, 21. print. Chicago: Univ. of Chicago Press; 1994. 210 p. (International encyclopedia of unified science; vol. 2).
2. Morin E. La epistemología de la complejidad. Gazeta de Antropología. febrero de 2004;20(4):14. DOI: 10.30827/Digibug.7253
3. Popper R. Foresight: Processes and methods. Manchester Institute of Innovation Research; 2014; The University of Manchester.
4. Meiselman HL. Dimensions of the meal. J Foodservice. 2008;19(1):13-21. DOI: 10.1111/j.1745-4506.2008.00076.x
5. Marínez Marín A, Ríos Rosas F. Los Conceptos de Conocimiento, Epistemología y Paradigma, como Base Diferencial en la Orientación Metodológica del Trabajo de Grado. 2006;25:11.
6. Mora A. Filosofía y ciencia. Revista filosófica Universidad Costa Rica. 2008;XLVI(119):69-74.
7. Guba E, Lincoln Y. Paradigmas en competencia en la investigación cualitativa. En: Antología de métodos cualitativos en la investigación social. Sonora; 2002. p. 113-45.
8. Berger P, Luckmann T. The social construction of reality. Reprinted. England: Pinguin books; 1991. 250 p.
9. Freire P. Pedagogy of the oppressed. 30th anniversary edition. New York: The Continuum International Publishing Group; 2005. 183 p.
10. Creswell JW, Plano VL. Designing and conducting mixed methods research. Fourth edition. Los Angeles: SAGE; 2018.
11. Semba RD. The Discovery of the Vitamins. International Journal for Vitamin and Nutrition Research. 2012;82(5):310-5.
12. WHO. Towards stronger food safety systems and global cooperation. 2022. 56 p. (Draft WHO global strategy for food safety 2022-2030).
13. OPS. Evaluación de riesgos microbiológicos en alimentos: Guía Para Implementación En Los Países. S.l.: Panamerican Health Org; 2021. 1 p.
14. Singh RP, Heldman DR. Introducción a la ingeniería de los alimentos. 2a. ed. Zaragoza: Acribia; 2009.
15. Van Boekel MAJS. Kinetic Modeling of Food Quality: A Critical Review. Comp Rev Food Sci Food Safe. 2008;7(1):144-58.DOI: 10.1111/j.1541-4337.2007.00036.x
16. Penner MH. Review of Kinetic Modeling of Reactions in Foods. J Chem Educ. 2011;89(1):15. DOI: 10.1021/ed200760v
17. Van Boekel MA. Kinetic modeling of reactions in foods. Boca Raton: CRC Press; 2009. 1 p. (Food science and technology).
18. Park HW, Yoon WB. Computational Fluid Dynamics (CFD) Modelling and Application for Sterilization of Foods: A Review. Processes. 2018;6(6):62. DOI: 10.3390/pr6060062
19. Ennio B, Folco P, Lina R. Nudges in Sustainable Food Choices: Evidence from a Truth-Telling Incentivized Online Experiment. SSRN Electronic Journal [Internet]. 2025; Disponible en: https://ssrn.com/abstract=5261575 DOI: http://dx.doi.org/10.2139/ssrn.5261575
20. Popper KR. The Logic of scientific discovery. Reprinted. London: Routledge; 2005. 513 p. (Routledge classics).
21. FAO, WHO. Risk characterization of microbiological hazard in food [Internet]. Rome; 2009. 116 p. (Microbiological risk assessment). Disponible en: http://www.fao.org/ag/agn/agns
22. Etcheverry P, Grusak MA, Fleige LE. Application of in vitro bio accessibility and bioavailability methods for calcium, carotenoids, folate, iron, magnesium, polyphenols, zinc, and vitamins B6, B12, D, and E. Front Physio. 2012;3(317):22. DOI: 10.3389/fphys.2012.00317
23. Roy P, Nei D, Orikasa T, Xu Q, Okadome H, Nakamura N, et al. A review of life cycle assessment (LCA) on some food products. Journal of Food Engineering. 2009;90(1):1-10.
24. Piñuel Raigada JL. Epistemología, metodología y técnicas del análisis de contenido. SOLS. 2002;3(1):1-42. DOI: 10.1558/sols.v3i1.1
25. Chai J, Su H, Li X, Zhang Y, Xiao D, Kang J, et al. Computational fluid dynamics (CFD) modeling and application for cleaning of food-contact surfaces: A review. J Food Process Engineering. abril de 2024;47(4):1-10. DOI:10.1111/jfpe.14605

26. Glasgow RE, Lichtenstein E, Marcus AC. Why Don't We See More Translation of Health Promotion Research to Practice? Rethinking the Efficacy-to-Effectiveness Transition. Am J Public Health. 2003;93(8):1261-7. DOI: 10.2105/AJPH.93.8.1261
27. Wild CP. Complementing the Genome with an "Exposome": The Outstanding Challenge of Environmental Exposure Measurement in Molecular Epidemiology. Cancer Epidemiology, Biomarkers & Prevention. 2005;14(8):1847-50. DOI: 10.1158/1055-9965.EPI-05-0456
28. Fàbregues S, Paré MH. Charmaz, Kathy C. (2006). Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis. Revista de sociología. January 2008;86:5. DOI: 10.5565/rev/papers/v86n0.825
29. Pelto GH, Pelto PJ. Diet and Delocalization: Dietary Changes since 1750. Journal of Interdisciplinary History. 1983;14(2):507-28. DOI: 10.2307/203719
30. Frewer LJ, Van Der Lans IA, Fischer ARH, Reinders MJ, Menozzi D, Zhang X, et al. Public perceptions of agri-food applications of genetic modification – A systematic review and meta-analysis. Trends in Food Science & Technology. 2013;30(2):142-52. DOI: 10.1016/j.tifs.2013.01.003
31. Hartmann C, Siegrist M. Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. Trends in Food Science & Technology. 2017;61:11-25. DOI: 10.1016/j.tifs.2016.12.006
32. Blackford B. Nudging interventions on sustainable food consumption: a systematic review. JP&S. 2021;5(2):17-62. DOI: 10.3197/jps.2021.5.2.17
33. Chambers R. Whose Reality Counts?: Putting the first last [Internet]. Reprinted. Rugby, Warwickshire, United Kingdom: ITDG Publishing; 2005 [citado 1 de julio de 2025]. 20 p. Disponible en: https://www.developmentbookshelf.com/doi/book/10.3362/9781780440453
34. Gordillo G, Méndez O. Food security and sovereignty - Base document for discussion [Internet]. Rome: FAO; 2013. Disponible en: https://openknowledge.fao.org/server/api/core/bitstreams/61f3f359-669c-40ff-88c6-b39b48135f3a/content
35. Slovic P. Perception of Risk. Science. 1987;236(4799):280-5. DOI: 10.1126/science.3563507
36. Hultgren FH. Van Manen Max: Researching Lived Experience: Human Science for an Action Sensitive Pedagogy. pp. 1990;8:361-6. DOI: 10.29173/pandp15124
37. Hollweck T. Robert K. Yin. :Case Study Research Design and Methods. Canadian Journal of Program Evaluation. 2016;30(1):108-10. DOI: 10.3138/cjpe.30.1.108
38. Madsen RS. Alison Hope Alkon and Julian Agyeman (eds.): Cultivating food justice: race, class, and sustainability. Agric Hum Values. diciembre de 2014;31(4):685-6. DOI: 10.1007/s10460-014-9549-8
39. Patel R. Food sovereignty. The Journal of Peasant Studies. julio de 2009;36(3):663-706. DOI: 10.1080/03066150903143079
40. Clark JK. Book Review: Cultivating Food Justice: Race, Class and Sustainability. Journal of Planning Education and Research. diciembre de 2013;33(4):494-6. DOI: 10.1177/0739456X13509103
41. Torre P. Lang & Heasman: Food wars - the global battle for minds, mouths, and markets. Inter disciplina. 2022;10(265):341-4.
42. Mishyna M, Chen J, Benjamin O. Sensory attributes of edible insects and insect-based foods – Future outlooks for enhancing consumer appeal. Trends in Food Science & Technology. 2019;95:141-8. DOI: 10.1016/j.tifs.2019.11.016
43. Swinburn BA, Kraak VI, Allender S, Atkins VJ, Baker PI, Bogard JR, et al. The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. The Lancet. febrero de 2019;393(10173):791-846. DOI: 10.1016/S0140-6736(18)32822-8
44. Coplen AK. Julie Guthman Weighing in: obesity, food justice, and the limits of capitalism. Agric Hum Values. 2013;30(3):485-6. DOI: 10.1007/s10460-013-9455-5
45. Shiva V. Staying alive: women, ecology, and survival in India. New Delhi: Kali for Women; 1988. 224 p.
46. Patton MQ. Qualitative research & evaluation methods: integrating theory and practice. Fourth edition. Los Angeles London New Delhi Singapore Washington DC: SAGE; 2015. 806 p.
47. Green LW, Glasgow RE. Evaluating the Relevance, Generalization, and Applicability of Research: Issues in External Validation and Translation Methodology. Eval Health Prof. 2006;29(1):126-53. DOI: 10.1177/0163278705284445
48. Intrac. Realist evaluation. M&E Universe. 2017;

doi:10.20944/preprints202508.0807.v1

49. Israel BA, Schulz AJ, Parker EA, Becker AB. Review of community-based research: Assessing partnership approaches to improve public health. Annu Rev Public Health. 1998;19(1):173-202. DOI: 10.1146/annurev.publhealth.19.1.173
50. Parfitt J, Barthel M, Macnaughton S. Food waste within food supply chains: quantification and potential for change to 2050. Phil Trans R Soc B. 27 de septiembre de 2010;365(1554):3065-81. DOI: 10.1098/rstb.2010.0126
51. Yiannas F. Food Safety Culture: Creating a Behavior-Based Food Safety Management System [Internet]. New York, NY: Springer New York; 2009 [citado 4 de julio de 2025]. Disponible en: https://link.springer.com/10.1007/978-0-387-72867-4
52. Ordovas JM, Ferguson LR, Tai ES, Mathers JC. Personalised nutrition and health. BMJ. 13 de junio de 2018;bmj.k2173. DOI: 10.1136/bmj.k2173