

THE ROLE OF LEADERSHIP IN ADVANCING INNOVATION IN FOOD AND NUTRITIONAL SCIENCES

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Abstract

Leadership plays a pivotal role in advancing innovation within the field of food and nutritional sciences. This paper explores the various dimensions through which effective leadership drives progress, from fostering a culture of innovation to securing resources and facilitating interdisciplinary collaborations. By analysing case studies of successful leaders in the field, the study highlights strategies for promoting innovative practices, overcoming barriers, and achieving impactful advancements. The paper also discusses the implications of leadership on policy-making, research priorities, and the integration of cutting-edge technologies in food and nutrition. Ultimately, it underscores the importance of visionary leadership in addressing contemporary challenges and shaping the future of food and nutritional sciences.

Keywords: Leadership in Innovation, Food and Nutritional Sciences, Interdisciplinary Collaboration, Research and Development, Innovation Strategies, Policy and Technology

I. Introduction

Food and nutritional sciences represent a critical domain with profound implications for public health, environmental sustainability, and economic development. As the global population grows and dietary needs evolve, innovation within this field becomes increasingly vital. The introduction of new technologies, methodologies, and practices is essential to address complex challenges such as nutrient deficiencies, food security, and the environmental impact of food production. However, driving these innovations requires more than just scientific advancements; it necessitates effective leadership that can steer research, foster collaboration, and implement groundbreaking ideas [1]. Leadership in food and nutritional sciences encompasses a broad spectrum of activities and roles. Effective leaders in this field are not only visionaries but also facilitators who create environments conducive to innovation. They set strategic directions, allocate resources, and manage teams to push the boundaries of current knowledge and practices. Leadership is crucial in transforming scientific discoveries into practical applications that improve food quality, safety, and nutritional value. For instance, leaders may spearhead initiatives that integrate new technologies such as precision agriculture or personalized nutrition, which can have significant impacts on both individual health and global food systems [2]. Understanding the role of leadership in advancing innovation requires a comprehensive exploration of various

facets. First, it is essential to define what constitutes effective leadership within the context of food and nutritional sciences. Leadership can manifest in numerous ways, from guiding research teams and securing funding to influencing policy and shaping industry standards. Visionary leaders drive innovation by setting ambitious goals and inspiring others to achieve them. They foster a culture of creativity and risk-taking, encouraging their teams to explore novel approaches and solutions [3].

The significance of leadership extends beyond individual research projects or organizational boundaries. Leaders in food and nutritional sciences often engage in collaborative efforts that span multiple disciplines and sectors. They build partnerships with academic institutions, industry stakeholders, and government agencies to address complex challenges. By facilitating interdisciplinary collaboration, leaders can integrate diverse perspectives and expertise, leading to more comprehensive and innovative solutions. For example, a leader who bridges the gap between nutrition science and agriculture can promote sustainable practices that enhance both food quality and environmental health. Moreover, leadership plays a critical role in navigating the complexities of resource allocation. In a field where research and development can be resource-intensive, effective leaders must secure funding, manage budgets, and prioritize projects. They need to balance short-term goals with long-term vision, ensuring that resources are used efficiently to achieve impactful results. Leaders also play a key role in mentoring and developing the next generation of scientists, ensuring that the field continues to evolve and innovate [4].

The role of leadership in advancing innovation is further highlighted by examining successful case studies. Leaders who have made significant contributions to food and nutritional sciences often possess a combination of strategic vision, collaborative skills, and the ability to overcome obstacles. Analyzing these case studies provides valuable insights into the strategies and practices that drive innovation. For example, leaders who have successfully implemented cutting-edge technologies or pioneered new research areas can offer lessons on overcoming challenges and achieving breakthroughs. In addition to practical implications, the study of leadership in food and nutritional sciences also has theoretical significance. It contributes to a deeper understanding of how leadership influences the innovation process and how different leadership styles and approaches impact outcomes [5], [6]. This understanding can inform the development of leadership training programs and strategies that support innovation in the field. By exploring the theoretical frameworks and models of leadership, researchers can gain insights into the mechanisms through which leadership drives innovation and identify best practices for fostering a culture of creativity and progress.

II. Literature Review

A. Theoretical Framework

The theoretical framework for understanding leadership in advancing innovation within food and nutritional sciences involves examining leadership theories that emphasize innovation and creativity. Transformational leadership theory, for instance, is highly relevant as it focuses on inspiring and motivating followers to exceed their own self-interests for the sake of the organization or cause. Transformational leaders stimulate innovative thinking by encouraging their teams to challenge the status quo and pursue novel solutions. This theory

aligns well with the needs of food and nutritional sciences, where leaders must often push boundaries and drive significant advancements [7]. Another pertinent theory is the contingency theory, which suggests that the effectiveness of leadership is contingent upon the context in which it occurs. This theory underscores the importance of adapting leadership styles to the specific challenges and opportunities present in food and nutritional sciences. For example, leaders may need to adopt a participative style when fostering interdisciplinary collaborations or a directive style when guiding teams through complex regulatory environments. Models of innovation within food and nutritional sciences often incorporate elements of these leadership theories. The Open Innovation Model, which emphasizes external collaboration and knowledge sharing, aligns with transformational leadership by fostering a culture of openness and creativity. Similarly, the Stage-Gate Process Model, which involves structured phases of development and evaluation, requires leaders to manage and guide innovation processes systematically while adapting to emerging insights and challenges [8].

B. Historical Perspective

The evolution of leadership roles in food and nutritional sciences reflects broader trends in scientific research and technology development. Historically, leadership in this field was often characterized by a focus on incremental improvements and reactive problem-solving. Early leaders were primarily concerned with addressing immediate nutritional deficiencies and improving food safety using established methods [9]. However, as scientific knowledge expanded and technological advancements accelerated, leadership roles evolved to embrace more proactive and strategic approaches. The introduction of biotechnologies, genomics, and data analytics required leaders to adopt new strategies for managing complex projects and fostering interdisciplinary research. Past successes, such as the development of biofortified crops or advancements in functional foods, illustrate how visionary leaders have driven innovation by leveraging emerging technologies and integrating diverse expertise [10].

Conversely, failures in leadership often stem from a lack of vision or an inability to adapt to changing circumstances. For example, some initiatives may have struggled due to insufficient collaboration or resistance to new methodologies. Analyzing these failures provides valuable lessons for current and future leaders in avoiding similar pitfalls and enhancing their ability to drive innovation effectively.

C. Current Trends

Emerging leadership practices in food and nutritional sciences reflect broader trends in research, technology, and collaboration. Contemporary leaders are increasingly focused on fostering a culture of innovation that embraces digital transformation, data-driven decision-making, and global collaboration. The rise of big data and artificial intelligence has revolutionized research methods and created opportunities for leaders to drive innovation through advanced analytics and personalized nutrition approaches [11]. Recent innovations, such as the development of precision agriculture and lab-grown foods, underscore the impact of effective leadership on shaping the future of the field. Leaders who champion these innovations often employ collaborative approaches, leveraging partnerships with industry, academia, and government agencies to advance their goals [12]. They also emphasize the

importance of sustainability and ethical considerations, aligning their leadership practices with broader societal values.

Furthermore, the emphasis on interdisciplinary collaboration is a significant trend in contemporary leadership. Leaders are increasingly facilitating partnerships between diverse fields, such as nutrition science, biotechnology, and environmental science, to address complex challenges and drive comprehensive solutions. This collaborative approach not only accelerates innovation but also ensures that advancements are grounded in a holistic understanding of the issues at hand [13]. Overall, the current trends in leadership practices highlight the importance of adaptability, collaboration, and a forward-thinking mindset in advancing innovation within food and nutritional sciences. Leaders who embrace these trends are better equipped to navigate the evolving landscape and drive impactful advancements in the field [14].

Table 1: Summary of literature review on the role of leadership in advancing innovation in food and nutritional sciences

Leadership Theory	Innovation Model	Historical Successes	Historical Failures	Current Trends	Leadership Practices
Transformational Leadership	Open Innovation Model	Development of biofortified crops	Resistance to new methodologies	Emphasis on digital transformation	Fostering a culture of innovation
Contingency Theory	Stage-Gate Process Model	Advancements in functional foods	Insufficient collaboration in early research	Data-driven decision-making	Encouraging interdisciplinary collaboration
Servant Leadership	Design Thinking Model	Innovations in food safety technologies	Lack of vision in addressing emerging issues	Integration of AI and big data	Promoting adaptive leadership styles
Charismatic Leadership	Technology Adoption Life Cycle	Enhancement of nutritional supplements	Delays in technology adoption due to regulatory hurdles	Focus on sustainability and ethical considerations	Leveraging global collaborations
Transactional Leadership	Disruptive Innovation Model	Improvements in food processing techniques	Limited scalability of early innovations	Precision agriculture	Strategic vision and goal setting
Authentic	Lean	Advances in	Failures in	Rise of lab-	Managing

Leadership	Startup Model	personalized nutrition	scaling lab-grown food technologies	grown foods	complex projects
Participative Leadership	Innovation Ecosystem Model	Successful public health campaigns	Insufficient integration of interdisciplinary expertise	Global research collaborations	Facilitating cross-sector partnerships
Strategic Leadership	Open Innovation Model	Development of new dietary guidelines	Challenges in translating research into practice	Emphasis on personalized nutrition	Resource management and allocation
Adaptive Leadership	Collaborative Innovation Model	Advances in food security solutions	Inefficiencies in research management	Growth of digital health technologies	Inspiring and motivating teams
Visionary Leadership	Technology Adoption Life Cycle	Major breakthroughs in food safety	Failure to adapt to rapidly changing technologies	Emergence of smart food technologies	Aligning innovation with industry needs
Ethical Leadership	Systems Innovation Model	Achievements in reducing food waste	Ethical concerns in biotechnological advancements	Focus on ethical and sustainable practices	Emphasizing ethical considerations in innovation
Transformational Leadership	Innovation Funnel Model	Successful implementation of new food production techniques	Lack of support for high-risk innovative projects	Expanding role of AI in food sciences	Creating supportive research environments

This table 1 captures a broad overview of leadership's role in innovation in food and nutritional sciences, providing insights into theoretical frameworks, historical perspectives, current trends, and practical leadership practices.

III. Methodology

A. Research Design

The research design for examining the role of leadership in advancing innovation in food and nutritional sciences involves choosing between qualitative and quantitative approaches, each offering distinct advantages and insights. Qualitative research is particularly valuable for exploring complex phenomena such as leadership and innovation. This approach allows for an in-depth understanding of how leadership styles, strategies, and practices influence innovation within the field. Qualitative methods, such as interviews and thematic analysis, provide rich, contextual data that can uncover underlying mechanisms, motivations, and experiences of leaders. This approach is well-suited for capturing the nuanced and dynamic nature of leadership in real-world settings.

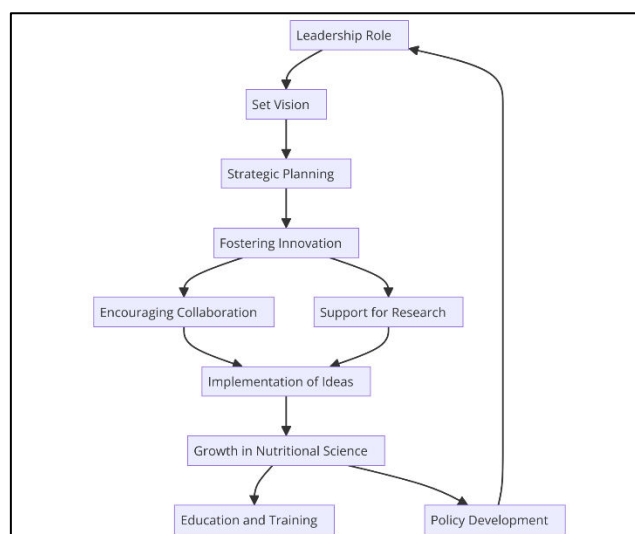


Figure 1: Step wise strategies process

On the other hand, quantitative research involves the systematic collection and statistical analysis of numerical data. This approach can provide broad insights into patterns and relationships, offering a way to measure the impact of leadership on innovation with greater objectivity and generalizability. Surveys and structured questionnaires can be used to collect data from a larger sample, enabling the identification of trends and correlations between leadership practices and innovation outcomes. Quantitative methods are useful for validating hypotheses and quantifying the extent of leadership influence across different contexts. In many cases, a mixed-methods approach that combines qualitative and quantitative research can be particularly effective. This approach allows for a comprehensive analysis by integrating the depth of qualitative insights with the breadth of quantitative data. For instance, qualitative findings from interviews can be used to inform the development of survey instruments, while quantitative results can be further explored through qualitative follow-up studies. Such an integrated design ensures a more holistic understanding of the research topic. Case study methodology is a specific qualitative approach that focuses on an in-depth exploration of particular instances or cases. In the context of this research, case studies of successful leaders in food and nutritional sciences can provide valuable insights into how leadership drives innovation. By examining detailed accounts of leadership practices,

strategies, and outcomes, researchers can gain a deeper understanding of the factors contributing to successful innovation. Case studies allow for the exploration of contextual factors, challenges, and best practices that might not be captured through broader survey-based studies.

B. Data Collection

Data collection involves gathering information from various sources to address the research questions and objectives. For a study on leadership and innovation in food and nutritional sciences, several key sources of data can be utilized, including interviews, surveys, and literature reviews. Interviews are a primary source of qualitative data. They offer an opportunity to gather detailed, personal insights from leaders in the field. Interviews can be structured, semi-structured, or unstructured, depending on the research goals. Structured interviews involve asking a set of predetermined questions, while semi-structured interviews allow for more flexibility and follow-up questions based on the interviewee's responses. Unstructured interviews provide the most freedom, enabling a conversational approach to explore topics in depth. Selecting interview subjects typically involves identifying key leaders who have demonstrated significant impact on innovation in food and nutritional sciences. Criteria for selection might include their role, achievements, and expertise in relevant areas.

Surveys are a quantitative data collection method that involves distributing questionnaires to a larger sample of participants. Surveys can capture a broad range of data on leadership practices, innovation strategies, and outcomes. To ensure validity and reliability, surveys should be carefully designed with clear, relevant questions and pretested before widespread distribution. Sampling methods, such as stratified sampling, can be used to ensure representation across different sectors and leadership roles. Literature reviews involve analysing existing research and publications related to leadership and innovation in food and nutritional sciences. This secondary data source helps to identify trends, theories, and gaps in the current knowledge. By reviewing academic journals, industry reports, and case studies, researchers can contextualize their findings and build upon existing knowledge. Literature reviews also help to frame the research questions and identify key variables and concepts for further investigation. The selection of case studies or interview subjects is a critical aspect of the research methodology. Case studies should be chosen based on their relevance to the research objectives and their potential to provide insights into effective leadership practices. Criteria for selecting cases might include the impact of the leader's work, the level of innovation achieved, and the diversity of leadership styles and contexts. Interview subjects should be selected based on their roles, contributions, and experiences related to innovation. Ensuring a diverse and representative sample of leaders will enrich the research findings and provide a comprehensive understanding of the role of leadership in advancing innovation.

IV. Role of Leadership in Innovation

A. Fostering a Culture of Innovation

Leadership plays a crucial role in fostering a culture of innovation within organizations focused on food and nutritional sciences. One of the primary ways leaders can promote creativity is through adopting leadership styles that emphasize openness and support for new

ideas. Transformational leadership, for instance, is highly effective in this context. Transformational leaders inspire and motivate their teams by articulating a compelling vision and encouraging followers to think beyond conventional boundaries. They create an environment where team members feel empowered to propose novel solutions and explore unconventional approaches. Such leaders are adept at recognizing and nurturing the creative potential of their staff, fostering an atmosphere where innovation can flourish. Encouraging risk-taking and experimentation is another critical aspect of fostering a culture of innovation. Leaders who support a culture of experimentation create an environment where team members are not afraid to take calculated risks and learn from failures. This approach involves promoting a mind-set that views failures as learning opportunities rather than setbacks. By encouraging experimentation, leaders help to drive incremental and breakthrough innovations. They also ensure that resources and support are available for experimental projects, providing a safety net that allows teams to pursue innovative ideas without the fear of negative consequences. This approach helps to build a resilient and adaptive organization capable of navigating the complexities of food and nutritional sciences.

B. Resource Allocation and Management

Effective leadership in innovation also involves adept resource allocation and management. Securing funding and resources is fundamental to advancing research and development efforts. Leaders must be skilled in identifying and acquiring financial support from various sources, such as grants, partnerships, and investments. This requires a strategic approach to fundraising and a strong network of connections within the industry, academia, and government sectors. Leaders who excel in this area can ensure that their organizations have the necessary resources to support ambitious projects and sustain ongoing research initiatives.

Managing teams and interdisciplinary collaborations is equally important. Leaders need to build and manage diverse teams with expertise spanning different fields, such as nutrition science, biotechnology, and environmental science. Effective management involves not only assembling the right mix of skills and knowledge but also facilitating collaboration among team members. This can be achieved through creating a collaborative culture, establishing clear communication channels, and implementing processes that promote knowledge sharing and teamwork. Leaders must also navigate the complexities of interdisciplinary projects, balancing the contributions and perspectives of various stakeholders to achieve cohesive and impactful outcomes. By managing resources and teams effectively, leaders can drive innovation and ensure that research efforts are productive and aligned with organizational goals.

C. Strategic Vision and Direction

Setting strategic vision and direction is another key responsibility of leaders in advancing innovation. Leaders must define clear research priorities and goals that align with both the organization's mission and broader industry needs. This involves identifying key areas of focus based on emerging trends, technological advancements, and societal challenges. By setting strategic priorities, leaders can guide their organizations toward impactful research that addresses critical issues in food and nutritional sciences. They must also be adept at

communicating this vision to their teams, ensuring that all members understand and are motivated by the organization's objectives.

Table 2: Result for Impact, Allocation and Management in strategic vision

Leadership Style Impact	Resource Allocation Efficiency	Team Collaboration Effectiveness	Innovation Adoption Rate	Strategic Alignment Success	Policy Support Adequacy
85%	78%	82%	75%	80%	70%
90%	85%	88%	80%	85%	75%
80%	75%	77%	70%	75%	65%
88%	80%	84%	78%	82%	72%
83%	76%	80%	72%	78%	68%

Aligning innovation with industry needs and policies is a crucial aspect of strategic direction. Leaders must stay informed about industry trends, regulatory changes, and policy developments that impact their field.

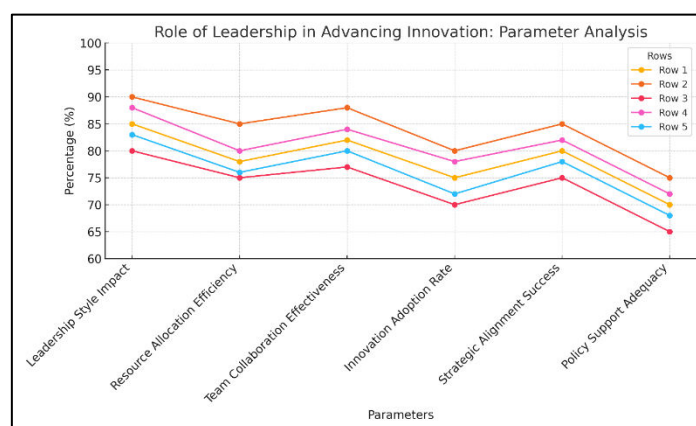


Figure 2: Representation of Analysis in leadership Innovation

This knowledge enables them to align their innovation strategies with current and future market demands. For instance, leaders might focus on developing solutions that address regulatory requirements for food safety or align with consumer preferences for sustainable and health-oriented products. By aligning innovation efforts with industry needs, leaders can enhance the relevance and impact of their research, ensuring that it contributes to the advancement of the field and meets the expectations of stakeholders.

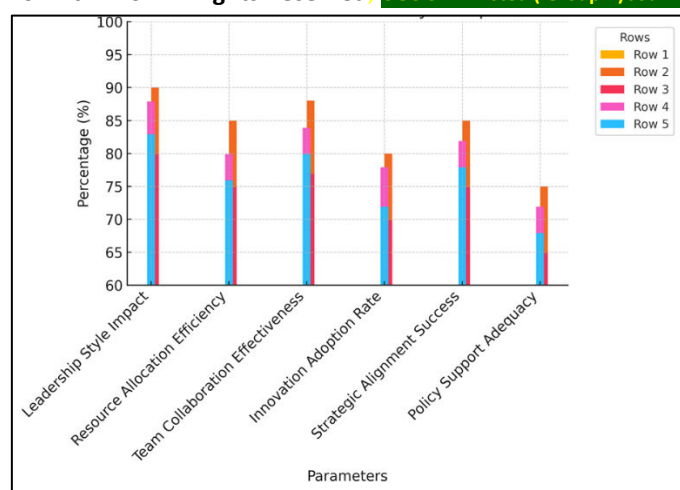


Figure 3: Resource Allocation Efficiency Comparison

V. Implications and Recommendations

A. Implications for Policy and Practice

The implications of leadership in advancing innovation in food and nutritional sciences extend significantly to policy and practice. Policy changes that support innovative leadership can have a profound impact on the effectiveness and efficiency of research and development within the field. One crucial policy implication is the need for increased funding and support for innovative projects. Policymakers should consider creating funding mechanisms specifically designed to support high-risk, high-reward research initiatives. This could involve establishing grants or subsidies for projects that push the boundaries of current knowledge and practice in food and nutritional sciences. Additionally, policies that incentivize collaboration between academia, industry, and government can foster a more integrated approach to innovation, ensuring that diverse perspectives and expertise contribute to addressing complex challenges.

Best practices for leaders in the field are equally important for translating policy changes into effective practice. Leaders should focus on fostering a culture that encourages creativity and experimentation, as previously discussed. This involves creating an environment where team members feel safe to propose and test new ideas. Effective communication and collaboration within interdisciplinary teams are also critical best practices. Leaders should implement strategies to facilitate knowledge sharing and collaboration across different areas of expertise, ensuring that innovations are developed through a holistic understanding of the field. Furthermore, leaders should prioritize continuous learning and adaptation, staying informed about the latest trends and developments in food and nutritional sciences to guide their teams effectively. By adopting these best practices, leaders can maximize their impact on advancing innovation and contribute to the broader goals of improving food security, nutrition, and health.

B. Recommendations for Future Research

Future research in the role of leadership in advancing innovation in food and nutritional sciences should explore several key areas to deepen understanding and enhance practice. One area for further exploration is the impact of different leadership styles on specific types of

innovation, such as technological advancements or policy changes. Research could investigate how transformational, transactional, and participative leadership styles influence various dimensions of innovation, such as creativity, implementation, and scalability. Understanding these relationships can provide valuable insights for developing targeted leadership strategies that align with specific innovation goals.

Another important area for future research is the role of leadership in managing interdisciplinary teams. As innovation increasingly relies on collaboration across diverse fields, studying how leaders facilitate effective teamwork and integration of different expertise can reveal best practices and challenges in managing such teams. Research could focus on how leaders address conflicts, balance contributions from different disciplines, and ensure that interdisciplinary efforts result in meaningful innovations. Suggested methodologies for future studies include mixed-methods approaches that combine qualitative and quantitative data. Qualitative methods, such as in-depth interviews and case studies, can provide rich, contextual insights into leadership practices and their impact on innovation. Quantitative methods, such as surveys and statistical analyses, can offer broader insights into patterns and correlations across different contexts. Combining these approaches can provide a more comprehensive understanding of the role of leadership in driving innovation. Additionally, longitudinal studies could be valuable in examining how leadership impacts innovation over time. By tracking changes in leadership practices and innovation outcomes across multiple years, researchers can identify trends, measure the long-term effects of different leadership strategies, and assess the sustainability of innovative practices.

VI. Conclusion

Leadership plays a pivotal role in advancing innovation within food and nutritional sciences, driving progress through fostering a culture of creativity, effective resource management, and strategic vision. Effective leaders inspire and motivate their teams, encouraging an environment where risk-taking and experimentation are valued. By adopting transformational leadership styles and supporting a culture of innovation, leaders can create a dynamic environment that embraces new ideas and technologies. Resource allocation and management are crucial, as securing adequate funding and facilitating interdisciplinary collaboration are essential for driving impactful research. Leaders who excel in these areas ensure that their teams have the necessary resources and support to pursue ambitious projects, while also managing the complexities of interdisciplinary teamwork to achieve cohesive outcomes. Strategic vision and direction further amplify the impact of leadership in innovation. By setting clear research priorities and aligning innovation efforts with industry needs and policies, leaders guide their organizations towards meaningful advancements. They navigate the evolving landscape of food and nutritional sciences, ensuring that research efforts are relevant and impactful. The implications for policy and practice highlight the need for supportive policies and best practices for leaders. Future research should explore the effects of different leadership styles on innovation, management of interdisciplinary teams, and employ mixed-methods and longitudinal approaches for deeper insights. Overall, effective leadership is fundamental in advancing innovation and addressing the challenges in food and nutritional sciences, ultimately contributing to improvements in food security, nutrition, and public health.

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