ORIGINAL ARTICLE

Role of Food Safety Management Systems in safe food production: A review

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Abstract

Food safety and quality has received attention in the agri-food sector and is basis of all initiatives taken on different activity levels starting from farm to enterprises as a whole on regional, national, and international levels. A hybrid of the ISO 9001, Quality Management System and Hazard Analysis and Critical Control Point (HACCP), ISO 22000 has been developed as an international solution for improving the food safety. Instead of applying good manufacturing practices, HACCP and ISO 9001:2000 separately, ISO 22000:2005 is implemented to observe the synergetic effect and to ensure food safety in food supply chain. ISO 22000 also known as Food Safety Management System (FSMS) is an international auditable standard. Standard ensures safe food supply throughout the chain and provide a framework of internationally harmonized system for the global approach. ISO 22000 incorporates critical control point and hazard analysis systems in more improved form to produce much effective auditable FSMS. This standard endorses conformity of services and products for international trading by assuring about reliability, food quality, and food safety.

Practical applications

The role exploration of Food Safety Management System (FSMS) in implementing food safety throughout the food production and supply chain is reviewed in this paper. The goal "once certified, accepted worldwide" of Globe Food Safety Initiative theme discussed to help industries and researchers. ISO 22000 along with its sister standards are auditable, reliable, and reasonable to ensure safe production, distribution, and consumption of food. During review of literature it is revealed that all technical aspects and requirements to implement the FSMS are not discussed on one place and thus leading to confusion. The aim of this review is to discuss different requirements, documentations, and systems in place for the certification of standards and the article will be helpful for the industries, technocrats, academicians, researchers, and policy framers.

1 | INTRODUCTION

Food processing sector, a link between agriculture and consumer, is proved to be quite important in overall development of economic system of a country (Panghal, Janghu, et al., 2018). Processing sectors has potential to diversify and commercialize farming, enhance farmer income, and create markets for agro foods along with generation of employment opportunities. Food and Agriculture Organization (FAO) of the United Nations advocate about food quality and safety for protection of consumer against food frauds. FAO also relates it to basic human rights as these have major economic and social implications for whole world. This is prime most right of human being to have ethically suitable and sensorial acceptable food for consumption. In continuation

with this World Food Summit, 2002 suggested about "the right of everyone to have access to safe and nutritious food," and is making continuous efforts to establish, implement, and upgrade the appropriate food safety and quality control systems for its member countries (Kondakci & Zhou, 2017). There is intense requirement of systematically managed safety in food supply chains for any organization to provide framework for internationally harmonized market. Food safety has become vital issue due to major credibility crisis and overwhelming public opinion about the food sector (Duan, Zhao, & Daeschel, 2011). An unhealthy and unhygienic condition has detrimental consequences on food quality, public health, and economics (Matthews, 2013). The public's confidence in regulatory system and agencies who are dealing with food and agricultural safety issues has declined due to severe

TABLE 1 ISO 22000 implementation and periodicals

Periodicals	Release date	Scope
ISO 22000: 2005 FSMS—Requirements for organization in food sector	September 2005	To ensure that there are no feeble links in food chain
ISO/TS 22002-1:2009 PRP on food safety-part 1: Food manufacturing	December 2009	Technical specifications specify requirements for establishing, implementing, and maintaining PRPs to assist in controlling food safety hazards
ISO/TS 22003:2007 FSMS—Requirements for bodies providing audit and certification of FSMS	February 2007	Technical specifications define the applicable rules for the audit of a FSMS and offer synchronized guidance for accreditation of certification bodies compliant with ISO 22000
ISO/TS 22004:2005 FSMS-Guidance on the application of ISO 22000:205	September 2005	It provide guidelines for implementation of ISO 22000 for food safety
ISO 2005:2007 Traceability in the feed and food chain—General principles and basic requirements for system design and implementation	July 2007	Standard gives the principles and specify the basic requirements for the design and implementation of a feed and food traceability system
ISO/TS 22002-3:2011 Specific prerequisites for farming	2011	
ISO/TS 22002-6:2016 PRP on food safety Part 6: Feed production	2016	Provides guidelines for implementation of ISO 22000 in feed production

food crisis in many countries (Ko, 2010). Increased consumer expectations and their concern about quality and food safety; requirement of diversified food chains; and profit-oriented food enterprises development has forced the manufactures to improve quality and food safety standards of their products by implementing management systems. Increased demand for safe food act as pushing force on development of new, improved standards along with regulations to achieve more and more safe food (Al-Busaidi, Jukes, & Bose, 2017). Many countries have taken a step forward to formulate some voluntary rules. Food safety systems are focused on safety, quality, efficiency, reliability, interchangeability, and environmental friendliness along with economic factors (Wentholt, Rowe, Konig, Marvin, & Frewer, 2009).

According to Codex Alimentarius Commission (CAC, 2017), food safety is to guarantee that food will not harm the consumer. To prevent food from being contaminated at any point of this "from stable to table, from plow to plate, from farm to fork, from boat to throat, from till to tooth and from spring to drink" continuum, the International Organization for Standardization (ISO) published a standard that describes the requirements for FSMS and involves quality management systems specially focused on safe and good quality food. Quality management systems suggested organizations to control and coordinate for quality by setting quality objectives and implementation of quality policy for food quality assurance with a system of continuous improvement.

In September 2005, ISO tailored the quality management system scheme into the ISO 22000 quality management system by incorporating proven Hazard Analysis and Critical Control Point (HACCP) principles for food safety. ISO 22000 which has integrated HACCP program in addition to quality management systems and prerequisite programs (PRPs) improved the quality and safety of the food chain in the industry. The standard includes specific methods applied as instructions, rules, definitions, or test procedures of different characteristics and technical specifications (Raspor & Ambrozic, 2012).

ISO technical committee named ISO/TC34 developed ISO 22000 family for food products and management systems subcommittee TC34/SC17 developed systems for food safety (ISO). The standard can be implemented by any party involved in the food chain business directly or indirectly (Table 1). ISO 22000 family includes all standards that reinforce implementation of this system in trustworthy and professional manner. The food chain covers all steps of production and manufacturing operations including consumption of processed and unprocessed food products. Food chain includes organizations that are not directly involved with food processing and come in contact with either food or food ingredients (Jung, Jang, & Matthews, 2014).

ISO 22000 specified FSMS that includes interactive communication among supplier, producers, and customers (Campbell-Platt, 2011). The standard characterize raw material and finished product quality characteristics, additives, cleaning agents, equipment and packaging material, raw material producers, food manufacturers, transport, and storage operators (Mourougan, 2015). ISO 22000 standard has great potential to partially fill this gap of international trade for developing countries by extending the approach of the quality management systems, ISO 9001:2000 standard which do not address safety specifically.

2 | OBJECTIVES OF ISO 22000 STANDARD

The ultimate objective of ISO 22000 is to deliver safe and quality food to the plates of the consumer.

TABLE 2 ISO 22000:2005 structure (Mourougan, 2015)

Clause title	Clause no.	Description of clause contents
Scope	Clause 1	Defines the scope of ISO 22000 and identifies certain limitations and exclusions.
Normative references	Clause 2	Refers to other publications that provide information or guidance.
Terms and definitions	Clause 3	Identification and definition of key terms that are of fundamental importance for FSMA and for using ISO 22000.
FSMS	Clause 4	It discusses about the general requirements, documentation requirements for ISO 22000 Standards.
Management responsibility	Clause 5	It discusses about the management responsibility, food safety policy, responsibility and authority, food safety team leader, communication, and management review.
Resource management	Clause 6	It details out the human resources, competence, awareness and training, infrastructure, and work environment.
Planning and realization of safe products	Clause 7	It describes the PRPs, preliminary steps to enable hazard analysis, product characteristics, flow diagrams, process steps and control measures, hazard analysis, establishment of OPRP, HACCP plan, verification plan and traceability, control of nonconformity.
Validation, verification, and improvement of FSMS	Clause 8	It discusses about validation, verification, and improvement of FSMS
Annex A		Cross references between ISO 22000:2005 and ISO 9001:2015.
Annex B		Cross references between HACCP and ISO 22000:2005.
Annex C		Codex references providing examples of control measures, including prerequisite programed and guidance for their selection and use.

2.1 | Food safety

ISO 22000 helps the organizations to plan, establish, and implement FSMS for organization. Principles and objectives of food safety proposed by CAC are very simple. This standard focuses on regulatory and statutory requirements applicable to food safety in an organization through FSMS of organization. There is tremendous need to give awareness throughout the world about food safety management requirements to trade within the food production, procurement, processing, and distribution chain (Matthews, Sapers, & Gerba, 2014). There is also need to provide a realistic approach to ensure eradication or reduction of safety hazards to provide safe food for consumption (Pan, Huang, & Wan, 2010). Food safety system is planned, operated, updated, and incorporated into the overall management activities within the framework of the structured management system and provides maximum benefit to organization and different parties linked to it. ISO 22000 aligned the organization to operate and maintain food safety and to update and improve FSMS of organization (Table 2). ISO 22000 provides directions for continuous improvement throughout food supply chain to ensure that FSMS is reviewed and updated. It also ensures sufficient control at all stages of food chain to prevent entry of food safety hazards and improve the internal processes to provide safe food consistently to consumer.

2.2 | Accessibility

FSMS helps the organization to ensure that their food products should not cause adverse health effects to consumers. It assures the access as this standard is transparent and universally accessible. The employees in organization can access the requirements of FSMS and can assess the status of safety systems at any point of time.

2.3 | Compliance

FSMS helps the organizations to ensure and demonstrate compliance with legal safety requirements and policy as well as consumer aspect. An objective of ISO 22000 is to demonstrate compliance to all interested parties with applicable statutory and regulatory food safety requirements and demonstration of all strategies to relevant interested parties.

2.4 | Evaluation

ISO 22000 helps the organization in evaluation of food safety requirements of customers and to provide safest products and services to satisfy customer. It helps in export of food products and trading in international markets. The certification agency can easily evaluate the organization as FSMS is scientific study-based systems and ensures proper documentation. FSMS also promotes continuous improvement and implementation in control systems for food safety.

2.5 | Communication

Communication is most important behavioral aspects of mankind. The communication should be both sided, that is, upstream and downstream in organization. Interactive and clear communication throughout the food chain is necessary to identify and to check all possible food safety hazards and their adequate control/reduction on each step of food chain. To meet customer and supplier requirements in terms of quality, need, and feasibility impact on the end product, the communication with suppliers and customers through systematic hazard analysis is helpful. There is immense need of developing assurance in safety and integrity of food supply for food handlers as well as consumers

(Wentholt et al., 2009). Business practices and policies for upstream and downstream communication and their implementation can help the organization to accomplish all management goals (Pardo et al., 2017). ISO 22000 also has management system to communicate safety issues with other relevant interested parties to resolve the issues. Effective communication regarding safety matters to their suppliers, customers, and all relevant components in the food chain in order to enhance customer satisfaction is the key to success in the organization.

2.6 | Confidence

ISO 22000 provides assurance to the food handling association and its management team regarding procedures. FSMS helps organization to ensure that their practices are in place and working effectively. It also assures to the customers and different stakeholders about ability of organization to control food safety of the products.

2.7 | Certification

Seeking certification or recognition after registration with FSMS from an external accreditation or certification body helps the organization to build confidence among its stakeholders and customers. ISO 22000 helps the organization to make a self-assessment or self-declaration of conformity to this standard. It also simplifies the work of the enterprise and in accreditation of certification body.

2.8 | Continuous improvement

ISO assures the continuous improvement in the whole food chain, including process, raw material, product, distribution chain, and management. It also includes machinery improvement, technology up gradation, manpower utilization, and product safety aspects (Psomas, Antony, & Bouranta, 2018). An ISO 22000-certified organization demonstrates the ability to provide safe products, in accordance with government requirements and regulations and consumer needs, promoting continuous improvement (Teixeira & Sampaio, 2013). Internal and external audit reports, status of corrective action plans, management recommendations are reviewed and finalized resulting in overall improvement from supplier to consumer.

3 | COMPONENTS OF ISO 22000 STANDARD

ISO 22000 (FSMS) became the first globally recognized and auditable standard for food safety. Food safety is the absence of any type of hazards in food which may cause food borne illness on consumption, which may enter at any stage of processing (Jevsnik, Hlebec, & Raspor, 2008). Food safety can be only achieved by the collective efforts of all the parties participating in the food chain. ISO 22000 standard directs the organization to meet all the applicable legal requirements in its management system and food safety policy. Organization commitment to provide hazard free food is reflected by its safety management systems and these systems clearly states company goal about food safety which will provide a base for international business too. ISO 22000

includes quality management systems, communications (external and in-house), responsibility designation, crisis management implementation, continuous improvement, and good health practices. With the help of ISO 22000 organizations can easily differentiates between critical control points (CCPs), operational PRP (OPRP) and PRP.

3.1 | Prerequisite program

PRPs are must to have conditions to be established in the entire food chain. ISO 22000 describes PRPs as "Basic conditions and activities that are necessary to maintain a hygienic environment throughout the food chain suitable for the production, handling and provision of safe end products". Examples of equivalent terms dependent on the segment in the food chain which are described by Raspor and Ambrozic (2012) are good agriculture practice, good laboratory practice, good hygienic practice (GHP), good manufacturing practice (GMP), good transport practice (GTP), good storage practice, good retail practice, good catering practice, good veterinarian practice, good housekeeping practice, good production practice, good distribution practice and good trading practice as basic good practices as per ISO 22000:2005.

PRPs must be implemented before implementing HACCP and are therefore referred to as prerequisites. PRPs apply horizontally across all food operations and have an impact on end product safety. Therefore, to ensure food safety, not only correctly applied HACCP, but also PRPs must be under control. These are the activities and practices which are performed to maintain streamlined and predefined condition. PRPs must be suitable and be capable of producing safe end products for consumption (Figure 1). Details of PRPs are outlined in ISO/TS 22002-1. Typical examples of PRPs (Allata, Valero, & Benhadja, 2017) provided by ISO 22000 (7.2.3) are:

1. Structure and layout of buildings and linked utilities;
2. Layout of premises, including workspace and employee facilities;
3. Supplies of air, water, energy and other utilities;
4. Supporting services, including waste and sewage disposal;
5. Equipment suitability and accessibility for easy cleaning, repairs and preventative maintenance;
6. Management of purchased materials (e.g., raw materials, ingredients, chemicals, and packaging), supplies (e.g., water, air, steam, and ice), disposals (e.g., waste and sewage), handling of rework and products (e.g., storage and transportation);
7. Measures for the prevention of cross-contamination;
8. Cleaning and sanitizing;
9. Pest control;
10. Personal hygiene;
11. Trainings;
12. Other aspects as appropriate.

The main objective here is to control all the basic activities and conditions which are must to maintain on permanent basis. PRPs ensure hygienic conditions throughout the food chain suitable for the
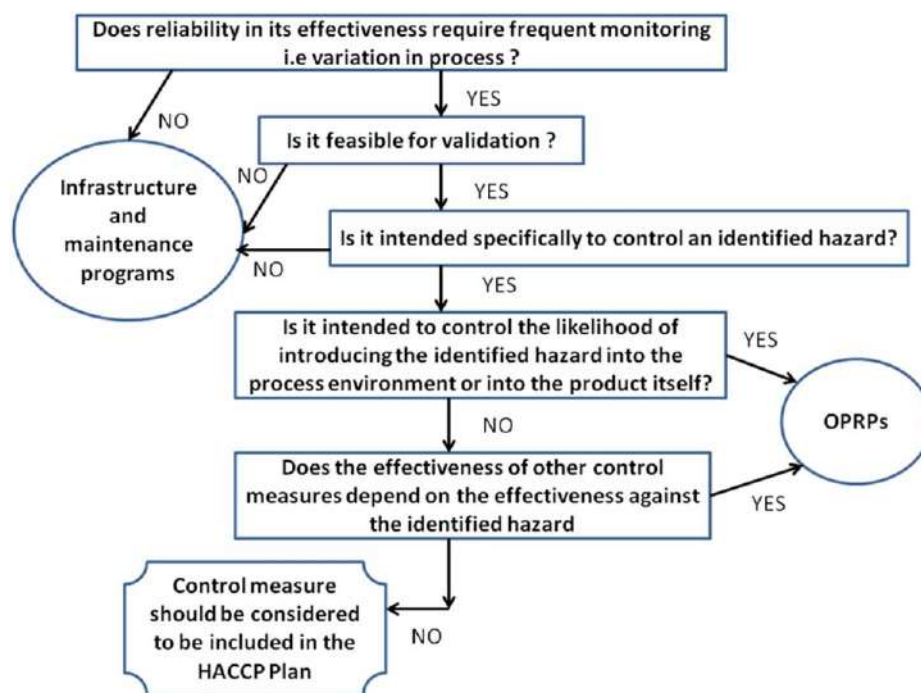
FIGURE 1 Decision tree approach to categorize PRPs

production, handling, provision of safe end products and safe food for human consumption.

The organization must identify the PRPs to be observed; implement effectively and assure the permanent implementation of its PRPs. These PRPs should be defined well in HACCP plan and should be well recognized, fully operational and verified. The type of organization, operating segments of food chains decides about particular PRP implementation.

Documentation of PRPs, ISO 22000 (7.2.3) requires documents to specify how activities included in the PRPs are managed; records of verifications and modifications shall be maintained. As a result, PRPs must be documented. HACCP documentation should be focused and recommendations from HACCP team should be documented in FSMS, not in the HACCP study. In the HACCP study only references should be made.

3.2 | Operational prerequisite program

OPRPs are PRPs identified by the hazard analysis as crucial in order to control the possibility of hazard entry in line and/or the contamination or proliferation of food safety hazards in the product(s) or in the processing environment. These are essential to control product-specific hazards that are not controlled through CCP.

In the hazard analysis, control measures are selected for each identified significant hazard. A categorization is made as to whether they are managed through OPRPs or through control measures at the CCPs. The categorization as to whether a control measure is linked to a CCP or is an OPRP depends very much on the product, process, and the hazard to be controlled.

ISO 22000 describes this in Chapter 7.4.4 "Selection and assessment of control measures" and it should be carried out using a logical approach that includes assessments with regard to the following points:

1. Effect on identified food safety hazards relative to the strictness applied

2. Feasibility for monitoring (e.g., ability to be monitored in a timely manner to enable immediate corrections)

3. Place within the system relative to other control measures

4. The likelihood of failure in the functioning of a control measure or significant processing variability

5. The severity of the consequence(s) in the case of failure in its functioning

6. Whether the control measure is specifically established and applied to eliminate or significantly reduce the level of hazard(s)

7. Synergistic effects (i.e., interaction that occurs between two or more measures resulting in their combined effect being higher than the sum of their individual effects)

ISO 22004 (the explanatory document for ISO 22000) states that the following may guide the organization in the categorization process:

1. Impact of a control measure on the hazard level or frequency of occurrence, the higher impact there is, the more likely the control measure belongs to the HACCP plan

2. Severity on consumer health of a hazard that the measure is selected to control, the more severe it is, the more likely it belongs to the HACCP plan
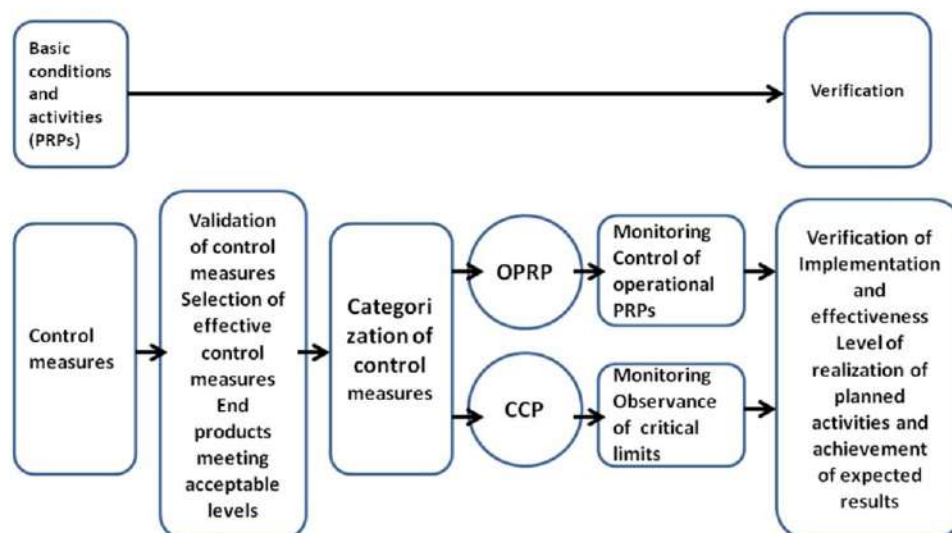
FIGURE 2   System approach to decide CCP and OPRPs and its verification

3. Need for monitoring, the more pressing the need, the more likely it belongs to the HACCP plan

So OPRPs can controls likelihood of introducing contamination and proliferation in comparison to PRP which ensures hygienic production environment. PRP, OPRP, and control measures at CCPs work alone or in combination together for food safety but the OPRPs are usually product-specific. As opposed to PRPs that are general for the whole factory; OPRPs and CCPs control product-specific significant hazards as identified in the hazard analysis. If the measure is absolute, it is a CCP; if it is not absolute then it is an OPRP (Figure 2).

3.3 | HACCP principle

Systematic and science-based HACCP system recognizes specific hazards and measures for their control to ensure food safety and focus on prevention instead of relying on end product testing only (Raspor & Ambrozic, 2012). Critical observation and control of biological, chemical, and physical hazards entry from raw material production, procurement and handling, production, storage, distribution, and consumption of finished product is necessary to achieve food safety (Montville & Matthews, 2007). Hence, HACCP is an effective and rational means of assuring food safety from harvest to consumption. Greater emphasis is given on the continuous improvement, with improved food safety performance derived through the establishment and achievement of tangible food safety objectives. The major components are:

1. Food safety policy: The policy should be well documented and communicated through the organization.

2. Emergency preparedness and response: This explains the risk management approach based on the risk of compromising the food during emergency incidents safety during implementation of FSMS.

3. Provision of resources: This is related to issues like work ethics and information distribution. The responsibility and authority of

any external expert involved in FSMS should be documented. Any issue concerned to food safety is clarified.

4. Traceability system: A traceability system is mandatory in ISO 22000, often as a result of legislation.

This standard requires that all hazards that may be reasonably expected to occur in the food chain, by the type of process and facilities used (Figure 3), are identified and assessed. This categorizes hazards on the degree of their severity and grades hazards on the basis of their need to eradicate/minimize (Oscar, 2017). During hazard analysis, the team involved in HACCP study determines the strategy to ensure hazard control by combining the PRPs, OPRPs, and the HACCP plan.

4 | IMPLEMENTATION OF ISO 22000

Customers are quite concerned about product manufacturing quality with sufficient confirmation of organization's ability to recognize and control safety hazards along with various conditions influencing food safety. The existing standard varies widely in content, level, and evaluation. HACCP ensures the food safety, whereas ISO 9001 system ensuring the quality. With the implementation of HACCP and ISO 9001 system through the entire food chain for safety and quality of food products, food organizations are assuring quality and safety at all levels and therefore are showing more competitiveness. HACCP with ISO 9001 quality management system, that is, ISO 22000 results in more effective food system than the application of either ISO 9001 or HACCP alone, leading to enhanced customer satisfaction and improving organizational effectiveness. The confusion created by number of national standards can be resolved by harmonizing the national standards at global level (Fernandez-Segovia, Perez-Llacer, Peidro, & Fuentes, 2014).

ISO 22000 has international foundation in global food market and is the first in a family of food safety standards that guarantees a globally safe food chain by using a network of internationally harmonized
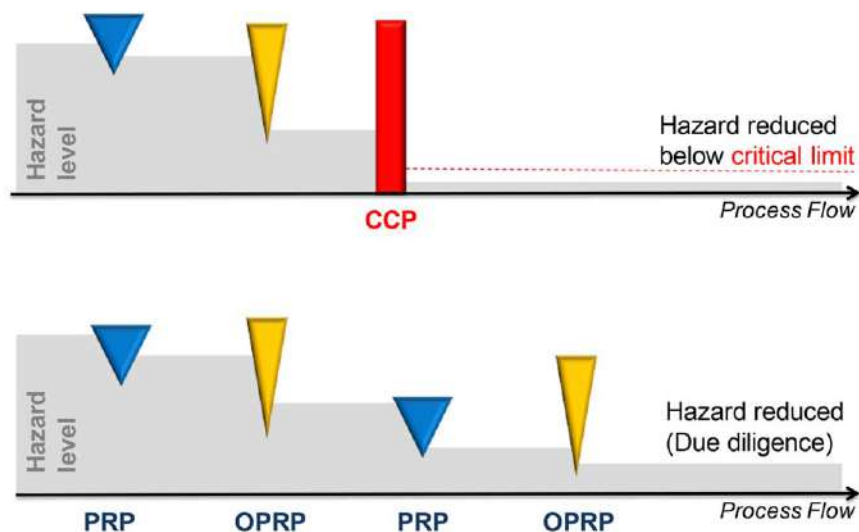
FIGURE 3 How PRP, OPRP, and control measures linked to CCP work together

systems. ISO 22000 makes it simpler and easier for organizations through the world to implement the Codex HACCP system for food hygiene in a harmonized manner and universally accepted.

ISO 22000 help companies to establish, update, and implement FSMS with continuous improvement of the system. Responsibilities of the FSMS are described by top management along with authorities. Organization personnel should be familiar with these responsibilities for effective operation and maintenance of the FSMS. Each personnel in organization have responsibility to report problems with FSMS to designated food safety team leader for maintenance and improvement of systems. The top management should be committed for development, implementations, and continuous improvement of FSMS (Allata et al., 2017). This is responsibility of higher management to appoint a food safety officer with good knowledge and expertise in this field (Soman & Raman, 2016). Responsibilities of food safety officer is to

1. Manage multidisciplinary team responsible for food safety team;

2. Trained the food safety team members for their work areas;

3. Ensure FSMS implementation, establishment, and continuous improvement in system;

4. Documentation and communication to top management on the suitability and effectiveness of FSMS.

The food safety team should be instantaneously informed about production systems and equipment; new products or products; ingredients, raw materials and services; surrounding environment; sanitation and cleaning programs, location of equipment, production premises; packaging, storage, and distribution system; responsibilities, authorizations, and personnel qualification levels; knowledge regarding food safety hazards and control; complaints indicating food safety hazards associated with the products; statutory and regulatory requirements; customer, sector and other requirements that the organization considers necessary; relevant enquiries from external interested parties; other conditions that have an impact on food safety (ISO 22000:2005, 2005) (Figure 4). The top management intentions and directions should be

clearly documented with the business objectives and communicated throughout the organization. Improvement in system will be carried out by meeting legislative, regulatory, and customer requirements, creating the food safety policy, performing management reviews, and ensuring the resources availability (ISO 22000:2005, 2005). Internal and external communication along the food chain should be maintained to confirm the identification of safety hazard and its adequate control. The organization should establish, implement, and maintain effective arrangements for better communication between supplier and contractors; customers or consumers; regulatory and statutory authorities; media; and stakeholders (ISO 22000:2005, 2005). This documented safety information regarding hazards entry and their control mechanism may be useful for the other organizations involved in the food chain.

5 | CERTIFICATION OF ORGANIZATIONS

The procedure for FSMS certification of organization is as follows:

1. Management system implementation: Management system must be in operation for minimum 3 months before being audited.

2. Top management internal review and internal audit: Before certification of management system, management must have completed at least one internal audit and must have completed one management review.

3. Certification body/Registrar selection: Selection of certification body is based on the choice of the organization.

4. Optional preassessment audit: A preaudit can be performed for an organization to check possibility of any gap between management system existing and the requirements of the standard for certification.

5. Audit Stage 1: A conformity review of the management system design. This is to verify that the management system is designed to meet all requirements of the FSMS and organizational
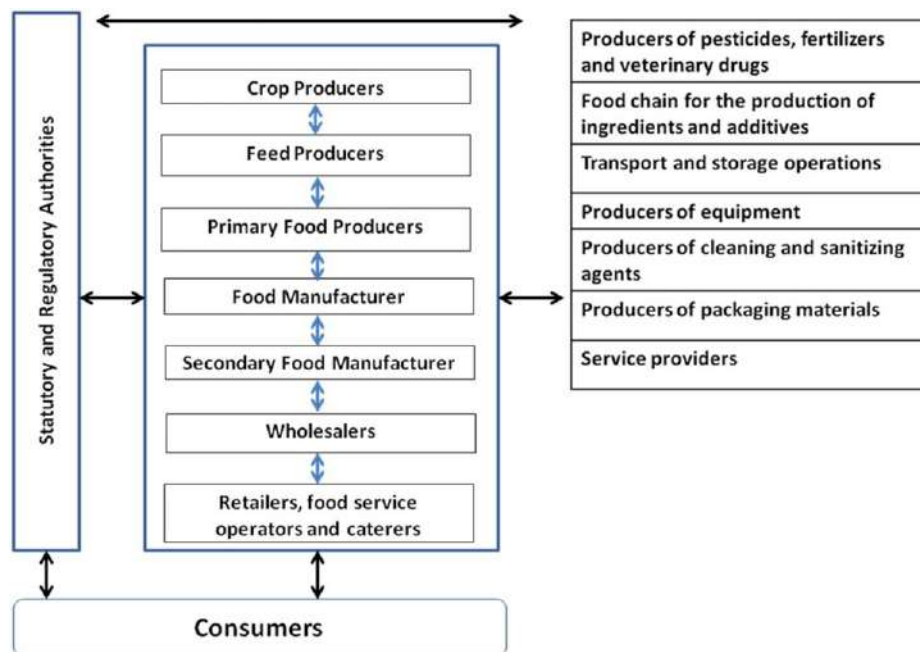
Crop Producers	Producers of pesticides, fertilizers and veterinary drugs
Feed Producers	Food chain for the production of ingredients and additives
Primary Food Producers	Transport and storage operations
Food Manufacturer	Producers of equipment
Secondary Food Manufacturer	Producers of cleaning and sanitizing agents
Wholesalers	Producers of packaging materials
Retailers, food service operators and caterers	Service providers

FIGURE 4 System approach for food safety

objectives. Some portion of Stage 1 audit should be performed at the organization's premises.

6. Audit Stage 2: Objective is to check the management system meets all requirements of the standard and are actually being implemented on-site in the organization. It is also confirmed that these systems can support the organization in achieving its objectives.

7. Follow-up audit: If the organization or auditor has nonconformities which require additional audit before being certified, the certification body has to perform a follow-up audit to validate the action plans linked to the nonconformities only. It is usually for 1 day on-site visit.

8. Confirmation of registration: If organization follow standard properly and is compliant with the conditions of the standard, the certification body or registrar publishes the certificate and confirms the registration.

9. Continuous improvement and surveillance: After registration, Certification Body conducts surveillance audits to ensure that management systems are complied with standards. This included on-site visits (at least 1/year), review, written request to follow-up and investigations following a complaint to verify the conformity of certified industry.

6 | BENEFITS OF ISO 22000

Safety standards covering each and every sector linked to food chain are not available (Sachdev & Mathur, 2017). Countries have developed their own national, voluntary standards as per their own requirements and related documents and are highly misleading for global business. The increasing cost of certification and accreditation also creates

economic burden on company profile. Simultaneously, these standards are not applicable to whole food chain and it becomes very difficult to assess safety performance of suppliers. By adopting uniform auditable standard makes the manufacturer competitive globally and improve safety systems, productivity, facilitates traceability. It boosts up the consumer satisfaction also (Jen & Chen, 2017). Standardization simplifies and speeds up the processes, ensures better planning and resource optimization as well as reduces cost, enhances efficiency, convenient, and wider applicability, and improves documentation.

The systematic and proactive approach of ISO 22000 for safety hazard identification, development, and implementation of control measures clearly defines individual responsibility of safety staff along with management, incorporates legal and regulatory requirements time to time, PRP's management and extends the two-way communication. This streamlined communication results in quick decisions about safety hazards with different parties involved in food supply chain. Simultaneously, this is beneficial for small organization to follow and implement a single international standard and also results in resource savings by avoiding overlapped system audits.

The Technical committee for the revision of ISO 22000 in 2017 has been constituted. The revised ISO 22000 encompasses two Plan-Do-Check-Act (PDCA) cycles; one PDCA cycle for the overall FSMS embracing clauses 4, 5, 6, 7, 9, and 10 of the standard, and another PDCA cycle within clause 8 for the planning, implementation, and maintenance of food safety control (Figure 5). The food safety PDCA cycle enables an organization to establish, implement, and maintain an updated food control program that consistently delivers safe end products. The revised ISO 22000 standard is continued to integrate the HACCP principles and application steps developed by Codex and attempted to adopt any changes that may foresee during the revision of the general principles for food hygiene.
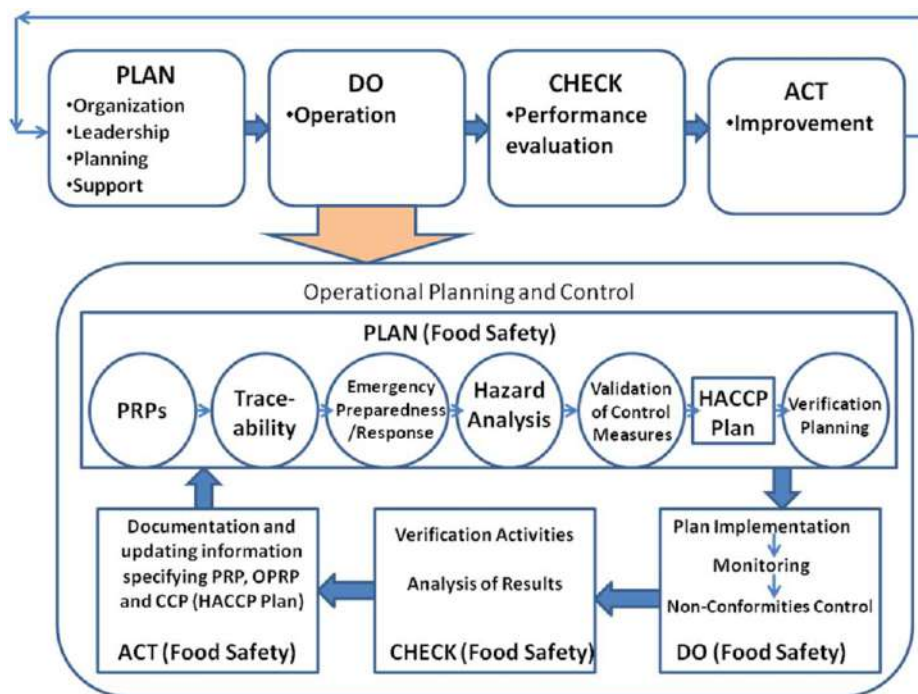
FIGURE 5 PDCA flow chart for ISO22000:2005

7 | WEAKNESSES IN ISO 22000:2005 STANDARD

ISO 22000 deals with uninterrupted improvement to ensure food safety; major disadvantage is in defining PRPs due to lack of adequate specifications. Proper explanation regarding PRP and OPRP to the industry personal by experts is requisite for this standard improvement. So, Globe Food Safety Initiative (GFSI) clearly described PRPs and other regulatory points in ISO 22000 series (Sansawat & Muliyil, 2012). Qijun and Batt (2016) stated that the standard address issues related to constituents of PRPs. However, ISO has resolved and revised the faults on ISO 22000:2005 in 2013 by introducing ISO 22002-1:2009. The standard is also lacking in specified supplier evaluation and mechanism in appropriate manner along with problems in traceability. All these requirements are introduced later on in other separate standard. The standard has set more than 568 minor and major requirements which are repeated in various places.

In view of above shortcomings reorganization of standard is must to streamline into a single set of instructions within a single standard document. Till now, consultants as well as auditors in the industry mainly following main standard ISO 22000:2005 and other sister standards worth to industry is very less. GFSI combined all applicable standards like PAS220, ISO 22005 extra as unit to comply with. The standard has been adopted and followed by more than 30,000 companies worldwide up to 2014 in its almost 10 years of existence (ISO, 2015). ISO is capable of providing way outs to the problems, but even after drawback identification and clarification by international experts, the revision took long time. The major concept for ISO 22000:2005 is harmonization of the prevailing safety standards (Motarjemi & Mortimore, 2005) but it increased number of available standards. In addition,

industries still have to get certified for various certificates to sell the products in market. So this is the reason ISO 22000 has somewhat diminished its perspective from the market. The goal "once certified, accepted worldwide" is also moved to GFSI theme.

8 | FUTURE NEEDS

Though FSMS assures food safety throughout food chain but to maintain the global prevalence of the ISO 22000 series, it is quite necessary to continually update the already published standards and develop new standards as well as technical specifications as per the need of commodity and market. There is immense need of subcommittee to handle the issues raised by the stakeholders at fast track with the help of expert team member knowledge. Technically standards should visualize implementation of sophisticated points and areas without any instrumental or human error. Updated and novel technical opportunities will also inspire new solicitations in expanded horizons of food supply chain (Raspor & Ambrozic, 2012). In future, climate change may be a threat for food supply chain and so the new standards (Semenza & Menne, 2009). Food processing is coming with emerging technologies like ohmic heating, pulse electric field, ultra sonication, and electrolyzed oxidation, etc., to maintain better nutritional and sensory qualities.

So there is need to revise and upgrade the criteria for food safety (Pan et al., 2010; Van Schothorst, Zwietering, Ross, Buchanan, & Cole, 2009). Recent studies highlight huge gap between food safety knowledge and implementation as consumer are doing regular violation at home which cannot be neglected (Jevsnik et al., 2008; Panghal, Yadav, et al., 2018; Raspor & Ambrozic, 2012). To ensure food safety for "Farm to Fork" and "Once Certified, Accepted Everywhere," working committees are continuously working on standard. ISO may improve multiple

platform initiative. ISO 22000 up gradation will cover all issues screened in last decade and GFSI may directly comply this for new problems or may accept independent verification by accredited auditing units. Virtual auditing and third party certification may reduce the issues and is highly valuable for manufacturer monitoring and improvement. However, current auditing systems are not 100% credible, so alternative updated ways and technologies will have an opportunity to develop in the future.

9 | CONCLUSION

The modernized farming system, mechanized food processing, and advanced marketing is not able to provide sufficient safeguards to the food safety and the prevalence of food borne disease highlight the actual concern of consumer regarding food safety. The major concern is about the unlabeled, patented, genetically engineered foods introduced in the market. Government policies, health implications, and need of globalization are the part of our food supply chain. Cumulative effort by consumer, industry, and government stakeholders in food chain can ensure food safety (Motarjemi & Mortimore, 2005). ISO 22000:2005 developed by clubbing GMP, HACCP along with comprehensive management system ISO 9001:2000. GMP was implemented through PRP specifications which are not satisfactory as additional guidelines are required to handle new issues. ISO 22000:2005 provided a more irrepressible platform for establishing and validating compliance of organization's FSMS with appropriate procedures and documentation. For quality assurance and better consumer reliability, legal requirements, norms and quality standards are monitored critically, continuously improved and developed in the food processing sector. This clearly states, need of FSMS, laws, and standard is also an integral component of advanced food processing industries. There is revolutionary change in food safety concept from stable to table, from plow to plate, from farm to fork, from boat to throat, from till to tooth, and from spring to drink. So we may expect new icons in food standards as we are transforming for newer healthy, convenient, and health-promoting food. At present, ISO 22000 along with its sister standard is reliable and reasonable to ensure safe production, distribution, and consumption of food.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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REFERENCES

Al-Busaidi, M. A., Jukes, D. J., & Bose, S. (2017). Hazard analysis and critical control point (HACCP) in seafood processing: An analysis of its application and use in regulation in the Sultanate of Oman. *Food Control*, *73*, 900–915.

Allata, S., Valero, A., & Benhadja, L. (2017). Implementation of traceability and food safety systems (HACCP) under the ISO 22000: 2005 standard in North Africa: The case study of an ice cream company in Algeria. *Food Control*, *79*, 239–253.

Campbell-Platt, G. (2011). *Food science and technology*. John Wiley & Sons.

Codex Alimentarius Commission 40th Session. (2017). *ISO communications*. Geneva, Switzerland: CICG, Food and Agricultural Organization of the United Nations.

Duan, J., Zhao, Y., & Daeschel, M. (2011). *Ensuring food safety in specialty foods production*. Corvallis, Or.: Extension Service, Oregon State University.

Fernandez-Segovia, I., Perez-Llacer, A., Peidro, B., & Fuentes, A. (2014). Implementation of a Food Safety Management System according to ISO 22000 in the food supplement industry: A case study. *Food Control*, *43*, 28–34.

ISO (2015). *ISO/TC 34/SC 17 Management systems for food safety*. Retrieved from https://www.iso.org/committee/583916.html

Jen, J. J. S., & Chen, J. (2017). *Food safety in China: Science, technology, management and regulation* (1st ed.). John Wiley & Sons.

Jevsnik, M., Hlebec, V., & Raspor, P. (2008). Food safety knowledge and practices among food handlers in Slovenia. *Food Control*, *19*(12), 1107–1118.

Jung, Y., Jang, H., & Matthews, K. R. (2014). Effect of the food production chain from farm practices to vegetable processing on outbreak incidence. *Microbial Biotechnology*, *7*, 517–527.

Ko, W. (2010). Evaluating food safety perceptions and practices for agricultural food handler. *Food Control*, *21*(4), 450–455.

Kondakci, T., & Zhou, W. (2017). Recent applications of advanced control techniques in food industry. *Food and Bioprocess Technology*, *10*(3), 522–542.

Matthews, K. R. (2013). Sources of enteric pathogen contamination of fruits and vegetables: Future directions of research, 1–5.

Matthews, K. R., Sapers, G. M., & Gerba, C. P. (Eds.) (2014). *The produce contamination problem: Causes and solutions*. San Diego, CA: Academic Press.

Montville, T. J., & Matthews, K. R. (2007). *Food microbiology: An introduction* (2nd ed.). Washington, DC: ASM Press.

Motarjemi, Y., & Mortimore, S. (2005). Industry's need and expectations to meet food safety. *Food Control*, *16*(6), 523–529.

Mourougan, S. (2015). Enhancing organisation performance for customer satisfaction and cost effectiveness through integrated management system. *IOSR Journal of Business and Management*, *17*(9), 50–65.

Oscar, T. (2017). Neural network models for growth of Salmonella serotypes in ground chicken subjected to temperature abuse during cold storage for application in HACCP and risk assessment. *International Journal of Food Science and Technology*, *52*(1), 214–221.

Pan, J., Huang, S., & Wan, Y. (2010). Identifying constraints, mechanisms, and resources in harmonized international food safety system between the Asia Pacific Region and U.S. *Agriculture and Agricultural Science Procedia*, *1*, 417–422.

Panghal, A., Janghu, S., Virkar, K., Gat, Y., Kumar, V., & Chhikara, N. (2018). Potential non-dairy probiotic products–a healthy approach. *Food Bioscience*, *21*, 80–89.

Panghal, A., Yadav, D. N., Khatkar, B. S., Sharma, H., Kumar, V., & Chhikara, N. (2018). Post-harvest malpractices in fresh fruits and

vegetables: Food safety and health issues in India. *Nutrition and Food Science*, 48(3).

Pardo, J. E., Zied, D. C., Alvarez-Orti, M., Penaranda, J. A., Gomez-Canto, C., & Pardo-Gimenez, A. (2017). Application of hazard analysis and critical control points (HACCP) to the processing of compost used in the cultivation of button mushroom. *International Journal of Recycling of Organic Waste in Agriculture*, 2(6), 179–188.

Psomas, E., Antony, J., & Bouranta, N. (2018). Assessing lean adoption in food SMEs: Evidence from Greece. *International Journal of Quality and Reliability Management*, 35(1), 64–81.

Qijun, J., & Batt, P. J. (2016). Barriers and benefits to the adoption of a third party certified Food Safety Management System in the food processing sector in Shanghai, China. *Food Control*, 62, 89–96.

Raspor, P., & Ambrozic, M. (2012). ISO 22000 food safety. In Da-Wen S. (Eds.) *Handbook of food safety engineering* (1st ed., pp. 786–816). Blackwell Publishing.

Sachdev, N., & Mathur, P. (2017). Evaluation of safety of street foods in Delhi using a HACCP approach. *International Journal of Current Microbiology and Applied Sciences*, 6(1), 948–955.

Sansawat, S., & Muliyil, V. (2012). Comparing global food safety initiative (GFSI) recognized standards. A discussion about the similarities and differences between the requirements of the GFSI benchmarked food safety standards. SGS.

Semenza, J. C., & Menne, B. (2009). Climate change and infectious diseases in Europe. *The Lancet Infectious Diseases*, 9(6), 365–375.

Soman, R., & Raman, M. (2016). HACCP system -hazard analysis and risk assessment, based on ISO 22000:2005 methodology. *Food Control*, 69, 191–195. https://doi.org/10.1016/j.foodcont.2016.05.001.

Teixeira, S., & Sampaio, P. (2013). Food Safety Management System implementation and certification: Survey results. *Total Quality Management and Business Excellence*, 24(3–4), 275–293.

Van Schothorst, M., Zwietering, M. H., Ross, T., Buchanan, R. L., & Cole, M. B. (2009). Relating microbiological criteria to food safety objectives and performance objectives. *Food Control*, 20, 967–979.

Wentholt, M. T. A., Rowe, G., Konig, A., Marvin, H. J. P., & Frewer, L. J. (2009). The views of key stakeholders on an evolving food risk governance framework: Results from a Delphi study. *Food Policy*, 34(6), 539–548.