

Food safety: System approach from farm to plate

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ABSTRACT: Food safety problems may arise at any stage from food production to consumption: on the farm, at the processing facility, at the retailer, or in the hands of consumers. Food and farming are interdependent however the cyclic nature of numerous factors like soil, irrigation, insecticide, pesticide, weedicides, farm implements, transport vehicles, harvesting yard, storage, etc., determines the safety of food from farm to plate. Farmers need to be aware of microbiological hazards that food can cause. Just as farmers, processors are expected to implement Good Manufacturing Practices (GMPs) that are designed to prevent or minimize contamination. Periodically, these practices need to be revisited to allow for consideration of newly emerging food safety issues. Clean markets are primary insurance to food safety. The retailer must keep in mind the shelf life of the food products and ensure sale of the products within the safe time period. Lesser the time lag from harvest to consumer, better is the quality of produce. Another approach to ensure food safety is organic farming in which reliance on external inputs whether chemical or organic is reduced as much as possible. The ill-effects of the conventional farming system are felt in India in terms of the unsustainability of agricultural production, environmental degradation, health and sanitation problems, etc. and thus, organic agriculture is gaining momentum as an alternative method to the modern system.

Key words: Consumer-Farmer, Fertilizers, Food safety, Organic farming, Processor- Retailer

INTRODUCTION

Between the farm and the dinner table, there are many opportunities for disease-causing organisms and other food safety hazards to enter our food supply. Keeping food safe as it travels that path is complicated, and as our food increasingly comes from all over the world, keeping food safe is becoming even more of a challenge. As the volume of international trade expands, so too, do the opportunities for transmitting pathogens or chemical contamination from one part of the world to another. Food safety problems may arise at any stage from food production to consumption: on the farm, at the processing facility, at the retailer, or in the hands of consumers (Buckley and Reid 2010). An outbreak of food borne illness in any pocket of world has enormous potential to make an effective newspaper headline whereas news of quality food production rarely receives public attention.

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to plate. Healthy and tasty food is the timely demand of people. Food safety is important for all because it concerns an individual but affects entire human and animal population (Sanders, T 1999). FAO is advocating a new approach to ensure that the food we eat is free from food-borne hazards - everything from pesticides and industrial chemicals, through to unwanted bacteria and contaminants - the "Food Chain Approach". The aim of the food chain approach, which incorporates these improved farming practices, is to ensure that the food chain becomes more transparent so national and global food crises can be prevented rather than treated. (FAO, 2003). In this paper, we are going to discuss the approaches that can lead to food safety at every point from farmers to consumers via processors and retailers, so that the resulting food-borne illnesses could be minimized.

Food safety

Traditionally, the food safety net has targeted the intermediary stages of the food chain - when food is processed from its raw state - rather than the initial or final stages of the food chain, where food is grown

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or consumed (Fig. 1). Food hazard is defined as “a biological (Microbes, rodents, insects and pests.), chemical (insecticides, pesticides etc.) or physical (Temperature, Humidity, inadequate harvesting instruments, storage facility etc.) agent or condition of food with the potential to cause an adverse health effect” (Sanders, T 1999).

A protective food safety system should be:

- systematic (i.e., from farm to table)
- risk-based (i.e., with set priorities and established risk management practices)
- transparent and participatory
- cost-effective
- Minimal disruptive trade among countries so that losses may be minimized.

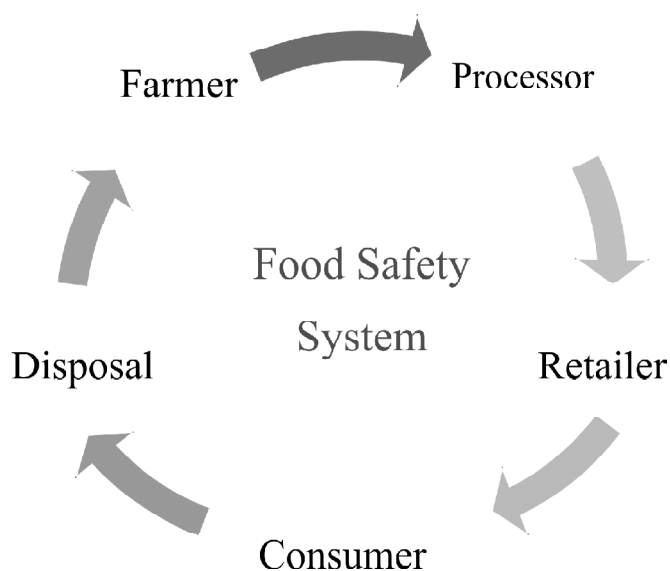


Figure 1: Food safety cycle

HACCP and Food safety

An important development in improving food safety has been the application of the hazard analysis critical control point concept (HACCP), which is a systematic approach to identifying, assessing, and controlling hazards, borrowed from the aerospace industry. It can be applied to all sectors of the food chain from primary production through food processing, manufacture, distribution, and retailing, to the point of consumption (Fig. 2). Its strength is that it focuses on identifying the main avenues of risk and tackling them (Sanders, T 1999)

Steps of HACCP

- Analyze potential hazards associated with a food and identify measures to control those hazards.

- Identify critical control points in the food chain at which the potential hazard can be controlled or eliminated.
- Establish preventive measures with critical limits for each control point.
- Establish procedures to monitor the critical control points.
- Establish corrective actions to be taken when monitoring shows that a critical limit has not been met.
- Establish procedures to verify that the system is working properly.
- Establish effective record keeping to document the HACCP system.

MANAGING FOOD SAFETY AT THE FARMER'S END

Microbial contamination of produce can occur at any point from farm to plate. Minimizing food safety risks starts before planting: Farmers need to be aware of microbiological hazards that food can cause (Hillborn *et al*, 1999). They should be committed to safe food production by conscience. Reinforcement through farm advisory, critical checks at market entry and ensuring appreciable returns for quality farm produce are necessary prerequisites. Public health as well as health of their families is the primary responsibility of farmer-producer (Bartz, 1999). There are 263 million agricultural workers in India out of a total population of 1210 millions (Table 1). Thus, the farmers have a lot of responsibility for the health of the general population and should keep in mind the following aspects:

Record Keeping: Food produced at farm is handled at many stages before it reaches to consumers. Good record keeping of manure use, water and soil test results, packaging materials, transport times will provide important information later that at which point contamination occurred.

Application of Manure: As manure is primarily animal faecal material the use of improperly composted or treated manure can increase microbial risk and contribute to food borne illness.

Pathogens such as *E. coli*, *Salmonella* and *Campylobacter* can be present in manure depending on temperature and soil condition. Composting in pit is ideal to ensure quality of manure (Stehmanet *al*, 1996).

Water used for irrigation: Water used in farming for various operations like watering, dipping, processing and irrigating may carry pathogens.

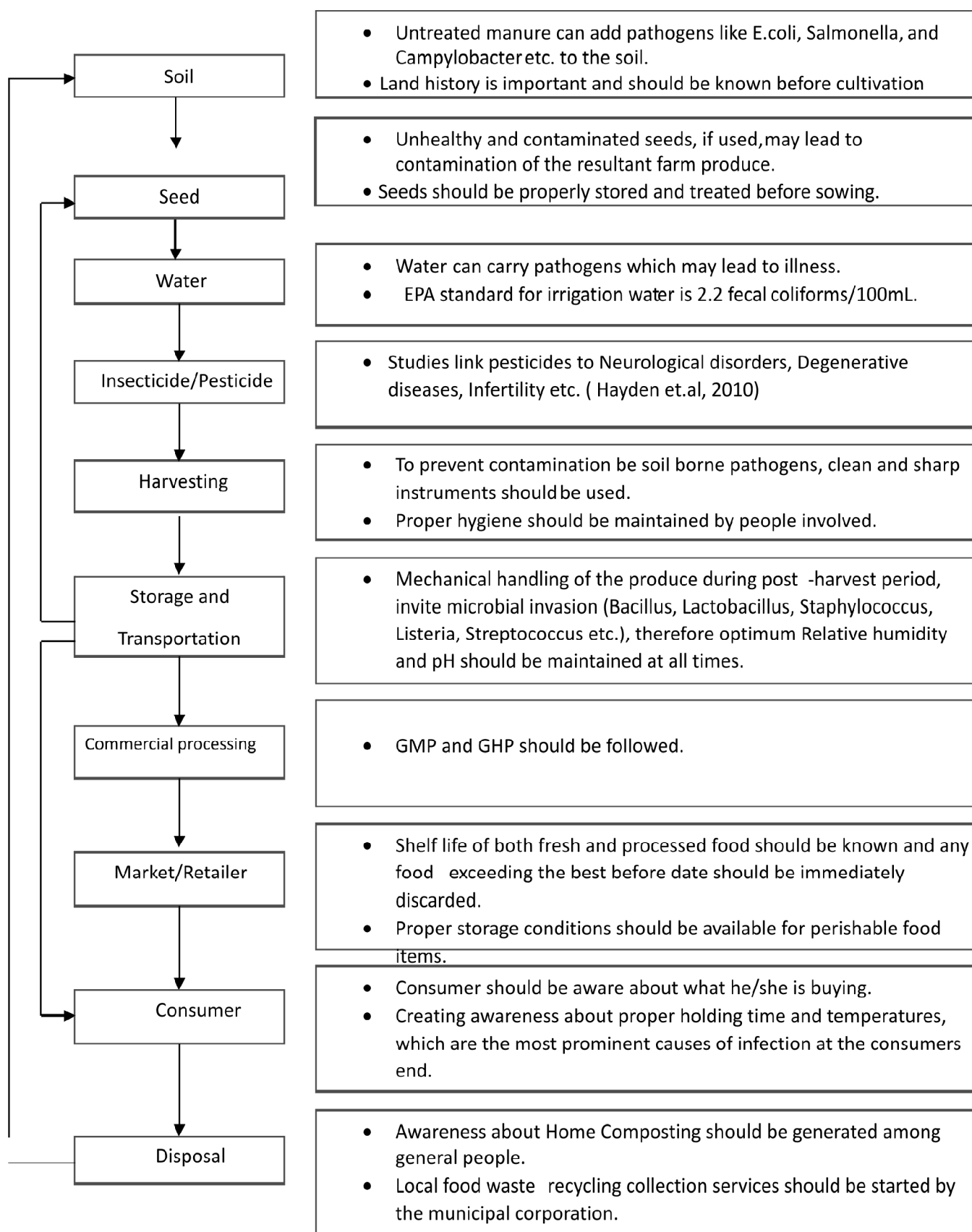


Figure 2: System's Approach to food safety

Workers' habits of personal hygiene are very important in food safety.

Table 1
Basic facts

Population of India (2011 Census)	1210 million
Agricultural workers	263 million
Total gross cropped area (2010-11)	199 million Ha
Net sown area	141.6 million Ha
Gross irrigated area	89.4 million Ha
Net irrigated area	63.6 million Ha

Hygiene, health and hand washing: Frequent and proper hand washing is an effective strategy for preventing food borne illness. Defecating in open is hazardous to food safety. Provisioning of toilets, soaps, potable water and single use towels go a long way in food safety.

Site for farming: Land identified for agricultural purpose should be cultivated only after determining the soil biota and the previous uses that the land has been put to. Land for fruit and vegetable crops should be selected based on the land history, previous manure applications and crop rotation. The produce fields should be kept away from animal housing and grazing lands. It should be ensured that contaminated water or livestock wastes does not enter a field via runoff or drift (Suslow, 1997).

Fertilizers/Pesticides/insecticides: Do not use beyond recommended doses of any of these chemicals as it directly causes hazards for producers and consumers. Never use banned pesticides. The use of fertilizers in India has shown a steady increase from past many years (Table 2) which is a point of major concern for food safety.

Table 2
Production, Imports and consumption of fertilizers
Fertilizers (Thousand tonnes of nutrients)

	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Production	15575	16095	14706.5	14334	16221	16380	16363	15735
Imports	5254	6080	7750.16	10221	9148	12364	13002	7308
Consumption	20340	21651	22570	24909	26486	28122	27790	25536

Harvest: Harvesting is the most critical point in farming where most of the contamination occurs because during this time the food comes in contact with the cutting equipment. If the equipment is not sharp enough or already contaminated, then it may lead to contamination of the food and also textural losses of the produce. The harvest bags, bins, threshers and transport vehicles all should be clean from farm to storage site.

Transportation: Vehicles used for transportation of the harvested crop should be clean and sanitized.

Storage facility and Sanitation: Sanitized storage facility helps to keep crops free from pathogen contamination and increase post-harvest shelf life of produce (Beuchat and Ryu, 1997).

MANAGING FOOD SAFETY AT THE PROCESSOR'S END

Processors are often reluctant to innovate or reform their practices. Aging facilities and poorly designed equipments are obstacles to processing food safely. Just as farmers have GAPs, producers are expected to implement Good Manufacturing Practices (GMPs) that are designed to prevent or minimize contamination. Like GAPs, these practices must be scientifically validated, documented, and

economically realistic. Periodically, these practices need to be revisited to allow for consideration of newly emerging food safety issues (Buckley and Reid 2010). Processors also need new technologies that might have immediate or near-immediate benefits, including:

- technologies to prevent re-contamination between processing and packaging,
- improved post-harvest lethality treatments,
- practical application of novel processing technologies (high pressure, industrial microwaves, pulsed electric field, etc.)
- more effective cleaning and sanitizing measures specifically addressed at the processing of low moisture foods,
- improved pathogen detection methods which are both more rapid and quantitative,
- real time methods of monitoring cleaning and sanitation to determine the presence of microbes, allergens, chemicals, and mycotoxins,
- mitigation technologies targeted specifically at contaminants that are difficult to control, including allergens, mycotoxins, and viruses,

- improved implementation of GMPs, and
- Small-scale technologies that do not require high throughput to be cost-effective.
- Wash, rinse and sanitize packing areas and floors at the end of each day. Exclude all birds and rodents from this area. Workers should not eat, smoke in this area.
- Vehicles used for transportation should be clean and sanitary.

MANAGING FOOD SAFETY AT THE RETAILER'S END

Market is very important for food safety as it is a transitional shift of food from farm to centralized area. Foods from all sources is centrally collected, inspected by buyers and then sold. The commitment of middlemen to maintain sanitation is important. Clean markets are primary insurance to food safety. The retailer must keep in mind the shelf life of the food products and ensure sale of the products within the safe time period. A detailed account of the perishable and non-perishable food products must be kept and regular monitoring of the food products must be ensured (USDA, 1998).

MANAGING FOOD AT THE CONSUMER'S END

The time lag between harvest at farm and selection by consumers determines food safety of produce. Lesser the time lag from harvest to consumer, better is the quality of produce (Beuchat & Ryu 1997). Largely, the legal responsibility of ensuring food safety lies on the manufacturers and processors. The consumers are often considered least responsible. The relative role of consumers in assuring food safety varies globally. In developed countries, consumers tend to assume that food is safe and do not recognize their own role in food safety—placing full responsibility for safety on producers, retailers and regulators. In developing countries, consumers have to assume responsibility for keeping their food safe because less quality assurance is expected from the private and public sectors. Also, many foods are produced locally and consumed quickly because of lack of refrigeration, possibly reducing risks due to processing, storage, and retail handling (USDA, 1998). Thus, awareness needs to be created among the consumers so that they are able to ensure the food they eat is safe.

Unsafe food and water kills an estimated 7,00,000 children in the WHO's South East Asia region every year. Access to safe foods remains a challenge in the

region. Whether as individuals, families, farmers, contributors to and handlers of the food chain or policy makers. We need to make food safety our priority (The Hindu 2015). The consumers also need to adopt safe food handling, hygiene and sanitation practices that include:

- Adequate washing of fruits and vegetables
- Frequent hand washing
- While using the kept and processed foods, reheat the foods for about 15 minutes to avoid any bacterial infection through kept foods.
- Prevent contaminating food with pathogens spreading from people, pets, and pests.
- Separate raw and cooked foods to prevent contaminating the cooked foods.
- Cook foods for the appropriate length of time and at the appropriate temperature to kill pathogens.
- Store food at the proper temperature.
- Do use safe water and raw materials.

FOOD SAFETY AND ORGANIC FOODS

The term 'organic' is best thought of referring not to the type of inputs used, but to the concept of the farm as an organism, in which all the components- the soil mineral, organic matter, microorganisms, animals, insects, plants and humans- interact to create coherent, self-regulating and stable whole. Reliance on external inputs whether chemical or organic is reduced as much as possible. Organic farming is a holistic production system (Lampkin *et al*, 1999).

Organic foods are more in demand partially because the consumers perceive that they are more nutritious. The results of meta-analyses of the extensive data set of 343 peer-reviewed publications indicated that organic crops and processed crop-based foods have a higher antioxidant activity and contain higher concentrations of a wide range of nutritionally desirable antioxidants/ polyphenolics, but lower concentrations of the potentially harmful toxic metal Cd (Marcin *et al*, 2014). Brandt *et al* (2011) conducted a similar study and concluded that there are significant composition differences between organic and conventional crops for a range of nutritionally relevant compounds.

It has been observed that the fertilizer consumption in relation to food grain production has also been on a steady rise in India over the past years (Table 3). The ill-effects of the conventional farming system are felt in India in terms of the unsustainability

of agricultural production, environmental degradation, health and sanitation problems, etc. and thus, organic agriculture is gaining momentum as an alternative method to the modern system.

Table 3
Fertilizer consumption in food grain production

	2008-09	2009-10	2010-11	2011-12	2012-13
Food grain production (in million MT)	2344.70	2181.10	2447.80	2592.90	2553.60
Fertilizer consumption in nutrients (in Lakhs MT)	249.09	264.86	281.22	277.90	255.36

The major constraints in large scale adoption of organic farming are-sustainable financial support, market development, lack of awareness, shortage of biomass, absence of an appropriate agricultural policy, high input costs, low yields and inability to meet export demands (Sharma Singh, 2004).

Safe food production or organic crop production standards prohibit the use of synthetic chemicals, crop protection products and certain mineral fertilizers (all N, KCl and super phosphate) to reduce environmental impacts (nitrate: NO₃) leaching and P runoff and pesticide contamination of ground water and the risk of pesticide residue being present in crop plants (Baranski *et al.*, 2014). The government policy seeks to promote technically sound, economically viable, environmentally non-degrading and socially acceptable use of natural resources in favour of organic agriculture. It actualizes the area and crop potential for strengthening rural economy, promoting value addition, accelerating growth of agro business and securing a fair standard of living for the farmers, and agriculture workers and their families (Bhattacharya & Chakraborty 2005).

CONCLUSION

Food and farming are interdependent. Consumption of safe food is cyclic chain from farm to plate, it is more a systems approach management. Food undergoes several disease causing opportunities from farm to consumer. Critical controls at seed, soil, manure, water, pesticide, disease control, cross weed control, harvesting, storage, transport market, consumer are forward linkages of food whereas systems approach demands that as in present times food under goes cross nation transportation it must be so labelled that it can be tracked back truly on backward linkage as well. This helps to check

contamination and hazard right at targeted terminal zone. The source of microbial or bacterial contamination can be precisely identified in case of outbreak of food borne illness by food systems approach.

India is country where 65% of population practices agriculture, contributing 14.5% to GDP. Organic farming is practiced in India since prehistoric times that still find validation in safe food production.

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