

The Health and Economic Threats of Global Food Recalls and the Growing National and International Efforts to Advance Food Safety

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Abstract

Many studies have been conducted to estimate the burden of foodborne diseases and the level of the potential health costs at national and international levels. Available data show that foodborne diseases are on the increase both in industrialized and developing countries because of the rapidly growing international trade in food and animal feed. An even greater challenge to food safety will come as new pathogens are identified from climate change and changes in ecological system, production methods, processes, practices and habits. As new pathogens and toxic agents are identified their health and economic impact will have global implications as witnessed by the biggest food recall incidents in the past few years. This study examines the global burden of foodborne diseases and the major food recall incidents in recent years that impacted the food industry as a threat to profitability and public health. Consumers attitude and response to food recalls and the stock market reactions to recalls are discussed. To meet the huge challenge of food safety in the contemporary world more effort is needed by national and international agencies to put into action new policies and strategies that focus on preventing food safety problems to make a big difference to public health and the economy.

Keywords: *Foodborne Diseases; Food Safety; Global Food Recalls*

Background

The global burden of foodborne disease and its impact on trade and development is currently unknown. The statistics on food safety incidents, their frequency, health, and economic consequences are grossly inadequate. Most food borne illnesses are not reported unless they occur in epidemic proportion. Of those reported many are never traced to a particular food nor the source and the causative agents identified. Available data show that foodborne diseases are on the increase both in industrialized and developing countries because of the huge international trade in food and animal feed causing pathogens to spread transnationally [1]. More foodborne pathogens can be expected because of changing production methods, processes, practices and habits. An even greater challenge to food safety will come from changes resulting from climate change, changes in microbial and other ecological systems, and the degradation of sanitation in the immediate environment where food is produced, processed, stored, distributed and consumed [2]. As new pathogens and toxic agents are identified their health and trade consequences in food will also have global implications.

The global recall of food is also increasing every year, contributing to the risk of spread of pathogens and other contaminant across national borders, thereby creating new challenges to national and international food safety regulators, food industries and food service establishments [3]. Big players in the meat, dairy, eggs, fish, poultry and bagged greens industries are impacted more by the financial loss caused by recall expenses and replacement of the contaminated product. The biggest food recall stories across the globe in the past few

years demonstrate the real harms, sickness and deaths that have resulted from product contamination and the severity of the financial loss. Consumers also lack knowledge of food recall and play limited role in keeping themselves safe [4]. Putting into action new policies and strategies that focus on preventing food safety problems and address new challenges will make a big difference to public health and the economy.

Aim of the Study

This study aims to examine the global burden of foodborne diseases and the major food recall incidents in recent years that impacted the food industry as a threat to profitability and public health. Consumers reaction to recall incidents and the stock markets respond to recalls are reviewed. Recognizing the public health and economic implications of food recall, the effort being made by national and international agencies to meet the huge challenge of food safety in the contemporary world is reviewed with particular reference to a few selected countries from developed and developing countries.

Methods

Data on the global burden of foodborne diseases, food recall and related health and economic costs were collected from multiple sources including news accounts, national and international reports, journals, web sites as part of literature review. The data were systematically analyzed to derive estimate of the financial cost of foodborne diseases and food recall. Consumers reaction to food recall was evaluated based on case study of selected countries. Stock market reaction to food recall was used as indicator of industry cost based on the study of Neal H. Hooker and Victoria Salis using partial event analysis technique. National and international response to the global food safety dilemma was evaluated based on measures undertaken to advance food safety in recent years.

Results

The global burden of foodborne diseases

The first ever estimate of the WHO global burden of food borne diseases caused by 31 agents-bacteria, viruses, parasites, toxins and chemicals states that each year as many as 600 million or almost 1 in 10 people in the world, fall ill after consuming contaminated food. Of these 420,000 people die including 125,000 children under the age of 5 years [5].

According to WHO diarrheal diseases are responsible for more than half of the global burden of foodborne diseases causing 550 million cases and 230,000 deaths every year. It is often caused by eating raw or undercooked meat, fish, eggs, fresh produce (raw vegetables) and dairy products contaminated by *Norovirus*, *Campylobacter* and non-typhoidal *Salmonella* and pathogenic *E. coli*. Other contributors to global burden of foodborne diseases are typhoid fever, hepatitis A, *Taenia solium* (tape worm) and aflatoxin produced by molds in grain that is stored inappropriately. *E. coli* are much more common to low income countries while *Campylobacter* is an important pathogen in high income countries [5]. The WHO estimate of foodborne disease burden is subject to several limitations due to un certainties of data collected from low-income countries where the burden is highest. Furthermore only limited list of pathogenic organisms microbes, parasites, and toxic chemicals are referred as the causative agent of foodborne illness.

On the other hand more reliable data on foodborne disease outbreaks are reported by the European countries, the United States, Canada, Australia and a few countries in Africa, Asia and Latin America that have surveillance programme for the control of foodborne infections and intoxications. In Europe, data on foodborne illnesses is collected and reported by members of the European Union to the European Food Safety Authority which has a Rapid Alert System used to notify all member countries when any country detects unsafe food products. The food product, the cause of the danger and the country of origin are reported [6]. In the United States the major sources of information on foodborne disease are the Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration (FDA). The CDC data are derived from reports of foodborne outbreaks submitted by State Health Departments. The FDA data come from CDC reports, City and State Department files, Public Health Service regional files, case histories and archival reports [7]. In Canada The

Canadian Food Inspection Agency and the Public Health Agency Government of Canada collect data on foodborne outbreaks and report annually including description of product, the cause of illness, country of origin and the number of incidents and cases. Many surveillance systems are used in Canada and each surveillance system plays a role in detecting and preventing foodborne illness and outbreaks [8]. The Australian Government Department of Health, Food Authority and Food Standards Australia New Zealand in collaboration with state and territory health departments, public health laboratories and Oz FoodNet epidemiologists monitor the incidence of foodborne illnesses to provide evidence for policy interventions and food safety regulation. OzFoodNET has been collaborating with Australia's State and Territorial health authorities to provide better understanding of the causes and the incidence of foodborne diseases since 2000 [9].

On the other hand the burden of foodborne disease is not well defined in many developing countries where the role of food as a vector and the pathogens causing foodborne disease outbreak are not well understood. A few countries in Asia and the Pacific, Africa and Latin America are making efforts to develop integrated laboratory based surveillance system for foodborne diseases. Although the Global Foodborne Infections Network (GFN) is committed to building capacity in Member States, to strengthen national and regional integrated surveillance to detect, control and prevent foodborne infections, success depends on obtaining political will backed by required financial support [10].

The Centre for Diseases Control and Prevention (CDC) estimates that 76 million cases of foodborne diseases occur each year in the United States resulting in 325,000 hospitalizations and 5000 deaths [11]. According to The European Food Safety Authority and the European Centre for Disease Prevention and Control, in 2015 a total of 4362 foodborne outbreaks including waterborne outbreaks were reported from 26 Member States. Overall these outbreaks caused 45874 cases of illness, 3892 hospitalization, and 17 deaths. This figure is low since the data does not include all European countries. Most of the outbreaks reported were caused by bacterial agents in particular *Salmonella* [12].

The Public Health Agency of Canada estimates that each year roughly one in eight Canadians nearly four million people get sick due to domestically acquired food-borne diseases. This estimate provides the most accurate picture yet of which foodborne bacteria, viruses, and parasites are causing the most illness in Canada, as well as estimating the number of foodborne illnesses without a known cause (unspecified agents) [8]. It is estimated that each year in the UK, around a million people suffer a foodborne illness, around 20,000 people receive hospital treatment due to foodborne illness and there are around 500 deaths caused by foodborne illness [13]. In Australia, there are an estimated 5.4 million cases of foodborne illness every year, causing 18,000 hospitalizations and 120 deaths [14]. Different surveillance systems are used in these countries to arrive at the above foodborne disease estimates. Therefore under-diagnosis and under reporting cannot be ruled out.

The food safety problem in Asia, Africa and Latin America is much bigger than Europe and the United States. While point source outbreaks with many victims are detected in the developing countries, identifying outbreaks that are widely distributed in time and space is rare due to lack of a well-developed laboratory based surveillance system. In China for example, a minority of patients with food poisoning seek formal medical care, informative tests are reported for only a fraction and insufficient analysis is done on the aggregate data. The most important recent advance in China's food safety system may be the development of a national human health surveillance system, which has required training epidemiologists in local health departments, equipping labs, and connecting them to share information quickly and respond assertively [15]. One of the products of this effort is PulseNet China which holds great promise.

A full analysis of the food safety control system in the developing countries would require a much lengthier and comprehensive study of the situation in the individual countries and would go beyond the size and limit of this paper. However in general there is positive development in several countries to improve food safety in coordinated and sustainable approach in realizing the major public health and economic benefits.

Major global food recalls in recent years and the health and economic impact

A food recall by definition is "any corrective action by a company needed to protect consumers from potentially adverse effects of a contaminated, adulterated or misbranded product [16]". Food recalls are rapidly becoming a common occurrence in the food and beverage

age industry. Most recalls result from operational mistakes, such as incorrect labeling, the presence of undeclared ingredients or contamination during the production process. While the biological causes such as the detection of *Listeria*, *Salmonella* and *E. coli* are also factors, a significant number of alerts are actually due to food fraud and corruption by suppliers in the supply chain.

The number of food recalls in the United States has shown a dramatic increase in the last few years jumping four-fold over the number just 5 years ago [17]. In the United States a total of 626 food recalls were tabulated for all of 2015. Most of the US recalls were linked to food allergens [18]. The Canadian Food Inspection Agency (CFIA) reported 388 Class I and Class II food and beverage recalls across Canada from 2011 through 2012. These were recalls that cause public harm. However recalls declined to 180 in 2014 and 124 in 2015 and the major causes were microbial contamination and undeclared allergen [19]. In the UK there has been an increase in the number of food alerts issued over the past 3 years rising from approximately 60 in 2014 to 150 per year in 2016 [20]. Food recall statistics from Australia show that there was 626 recalls between 1 January 2008 and 31 December 2017. For the last 10 years most recalls have been due to undeclared allergens and microbial contamination [21].

According to a review of the 2010 food recalls reported globally, *Salmonella* accounted for the majority cases of foodborne illness followed by undeclared allergens and intolerances, *E. coli* 0157:H7, *Listeria monocytogenes*, *Norovirus*, *Clostridium botulism*, *Hepatitis A*, evictious fish and toxic chemicals. The most exposed human food that were subject to recall were dairy and poultry products including eggs, meat; sea food; fruits and vegetables; prepared foods; nuts and raw agricultural commodities. Greater number of recalls were made by the United States, Canada, Australia and a number of European and Asian countries. Recalled foods originated from local producers and exporters of raw and processed food from China, Mexico, Canada, India, Turkey, Russia, South Africa, Kenya, Brazil, United Kingdom, USA and Vietnam [22].

Product recall costs are very high as it may include expenses for identifying the source of contamination, collecting and destruction of all recovered product, sanitizing production equipment and storage facilities, and retest for the presence of the contaminant. In addition manufacturers may be required to provide replacement product to customers and financial compensation to bodily injury or medical expenses, loss of work days and related third-party liability. The monetary losses incurred by business interruption due to product unavailability, decontamination down time, government action, brand damage, loss of contracts, crisis management consultant and legal fees significantly increase the cost of recall for large companies.

Many national and international companies in the food trade understand intuitively the risk of a product contamination, but fail for the most part to recognize the true financial severity ahead of time. Several studies show that food recall is a complicated and expensive event costing multi billion dollars in USA, United Kingdom, Canada and Australia where stringent food standards are applied. The more companies understand their financial risk, the earlier they make informed decision to protect their customers and maintain their profit. As international supply chains continue to expand in complexity, so do risk exposures, increasing the likelihood of a product contamination.

Numerous devastating outbreaks of foodborne diseases have occurred in recent years in both industrialized and developing countries resulting in recall incidents that had tremendous financial impact on large companies including loss of earnings and reputation. A few cases are highlighted below.

Recent major food recalls global perspective

- **China:** A number of high profile scandals involving tainted food products in China have shaken public confidence in the safety of domestic food supplies. The 2008 milk scandal was one of the largest food safety events in China involving the adulteration of milk and infant formula along with other food ingredients with the industrial chemical melamine. The melamine scandal took the lives of 6 babies due to kidney damage, horribly sickened 300,000 with kidney problem and an estimated 54,000 babies were hospitalized. The chemical appeared to have been added to milk to cause it to appear to have a higher protein content. An estimated 9000 tons of milk product had been recalled. The company was ordered to halt production and to destroy unsold and recalled products. The scandal provoked a nationwide panic among parents and damaged the reputation of Chinese food exports. At least 11 countries stopped all imports of Chinese dairy products for the time being. China is one of the world's largest market for baby food and infant formula representing around 23% of the \$41 billion global market according to a recent study published by Euro-monitor International, a research firm in London [23].

- **USA:** The United States has had some of the most stringent food production guidelines in the world but, it wasn't always so. Although the U.S still has some of the highest food safety standards in the world, but there have been alarming number of food recalls in recent years. In 2007, 21.7 million pounds of frozen ground beef patties was recalled because of an *E. coli* contamination. A class-action lawsuit was filed against the company and at the same time the company voluntarily complied with the order and ceased production. Nearly every employee was laid off. According to the report, the law suit and subsequent dismantling of the company caused significant economic problems for the government, the company and individuals. In 2008 the largest food recall happened when the USDA recalled 143 million pounds of beef resulting from the slaughtering of sick cows that were not inspected. The company agreed to a nearly \$500 million settlement which went to government agencies and animal welfare groups.

In 2010 more than 500 million eggs were recalled in USA from 26 states due to *Salmonella enterica* outbreaks that infected 1900 people, fortunately no one died. In response to public outrage that followed the USFDA updated their rules for egg safety to prevent *Salmonella* infection.

From 2007 to 2008 *Salmonella* contamination of over 3200 different peanut products prompted FDA to initiate a voluntary recall. The recall affected more than 1800 supermarkets. The tainted product killed nine people and sickened around 700 most of them children. The company lost an estimated \$1 billion as a result of the recall [24].

- **Canada:** *Listeriosis* outbreak in 2008 in Canada linked to a Maple Leaf Food Plant in Ontario resulted in 57 total confirmed cases and 23 deaths according to Canadian Food Inspection Agency. The law suits against the company were settled for \$ 27 million and the recall costed \$20 million for the entire plant cleaning up and disinfecting the entire equipment. About 250 employees were laid off while the plant was closed for cleaning [25]. Earlier in 2007 a Canadian firm reported that their large-scale recall in 2007 resulted in the loss of about \$ 42 million-just on recalled products. This was due to an adulterated ingredient purchased from an importer. This figure does not include ancillary costs related to recalls.
- **UK:** The Food Standard Agency (FSA) in UK recalled over 359 well known processed foods in 2005 after they were found contaminated by industrial dye called "Sudan 1" a red dye, used in soil which chilli growers found that it gave vegetables a lustrous red glow. "Sudan 1" came to the attention of the food industry in 2003 when France alerted member states to its presence in an Indian-sourced chilli powder. It was banned after it was discovered to be a carcinogen two years earlier and was probably used by mistake. While exact costs to the UK industry are unknown it is estimated that it could hit as much as 125 million British pounds [26]. The recall sparked an international alert as the chilli was reported to have been shipped to Canada, EU countries and China. It was thought to be a good idea to remove the substance from the food chain, but this was done simply as a precaution and not because there was an immediate impact on health as the risk of cancer was likely to be very low according to an expert in toxicology interviewed by BBC [27].
- **Ireland:** In 2008 pork contamination by dioxin and dioxin like PCBs in animal feed supplied by one Irish manufacturer to 37 beef and 9 pig farms across the Republic of Ireland and 8 beef farms and one dairy farm in Northern Ireland, led to the international recall of pork products produced between September and early December of that year. Within two days of the first announcement 1800 jobs have been lost in the Irish pig industry with further 6000 jobs said to be at risk by Irelands largest trade union. Processors halted the slaughtering of pigs until the Irish government provided them with financial repatriation [28]. The recall in Ireland was responsible for causing an estimated loss of 125 million British pounds (180 million Euros) to the European economy in extra spending to cover the cost of the meat recovery package [29].
- **Germany:** Major *E. coli* outbreak in Germany from May to July 2011 infected more than 4000 people, killed more than 50 and more than 765 of the patients developed the severe complication of hemolytic uremic syndrome (HUS) which frequently leads to kidney failure. The outbreak was caused by the rare strain of shiga toxin *E. coli* known as STEC 0104: H4. The outbreak was spread to 14 European countries, USA and Canada with more than 3900 infections in Germany. Consumers across Europe were shunning fruit and vegetables as the German authorities warned people from eating raw cucumber, tomatoes, lettuce and sprouts. EU farmers claimed to have lost up to US \$ 611 million a week as ripe vegetables produce rote in the fields and ware houses. In June 2011 the EU Commissioner made an offer of US \$ 306.2 million in compensation to farmers who lost money due to *E. coli* outbreak. The likely source was identified to be fenugreek sprout seeds imported from Egypt. The price tag for the German *E. coli* outbreak is estimated to be close to US \$ 3.5 billion as compensation for families, medical and hospitalization costs to the victims, pain and suffering and wage losses [30].

There was also dioxin scandal in Germany in 2011 where the German authorities shut down more than 4000 farms after it was discovered that a German company had sold 200,000 tones of dioxin tainted animal feed which had subsequently entered the food chain [31].

- **Africa:** In Africa where the gaps in food safety system raises concern and a national food safety alert or food product recall is rare, in 2004, an outbreak of acute aflatoxins from consumption of contaminated maize in Kenya resulted in 317 cases and 125 deaths. In 2009 Kenya destroyed US \$8 million worth of maize after it was found contaminated with aflatoxin. Aflatoxin contamination of peanuts poses a risk to human health and has been identified as a major constraint to trade in eastern Africa [32]. The World Bank estimates that the exaggerated aflatoxin tolerance level of Maximum Allowable Levels (MALs) of four parts per billion cost African countries \$670 million in annual export losses of cereals, dried fruits and nuts [33]. The failure of many African produced food products to meet international food safety and quality standards hampers the continent's effort to increase agricultural trade both intra-regionally and internationally, locking many farmers out of chance to improve their economic well-being.
- **Asia:** Threats to public health and international trade posed by potentially unsafe food in Asia and the Pacific is not uncommon and as a result disruption due to shortcomings in food quality have been on the increase. A ban on fish imports into the EU costed one Asian country \$335 million of lost export opportunities. The export of peanut meal by one Asian country to the European Union dropped by more than \$30 million per year since the EU introduced new mycotoxin regulation in the early 1980s [34]. Unacceptable pesticide residue levels in fruits and vegetables, chloramphenicol and other antibiotic residues in sea food and poultry, pathogens in sea food, and mycotoxins in crops and pea nuts have been the cause of rejection of food export from Asian region.
- **Australia:** Although a number of primary production and processing standards which aim to strengthen food safety and traceability throughout the food supply chain are being implemented, food recall is not much different from other comparable countries. According to the statistics the average number of recalls per year is 63. Recalls due to biotoxins occur periodically while recalls due to chemical and other contaminants are less common.

The recent *Listeria* outbreak in rock melons was linked to six fatal cases in March 2018. A class action involving Australians affected by the outbreak is likely to proceed according to a legal expert. Earlier in June 2018, there were two recalls linked to sprout contaminated with Salmonella and death linked to frozen pomegranate [35].

- **South America:** The entire region is composed of more than 30 countries, each with different levels of advancement in their food safety characteristics. According to the report of the World Trade Organization (WTO) South and Central America exported a combined U.S \$ 217 billion in agricultural products in 2013. South American countries export a wide variety of foods to the US, EU countries, Australia, Canada, India and a few African and Asian countries The exported products include coffee, beef, fresh fruits, corn, fish products among others. The US imported \$18.5 billion worth of agricultural and fish products from South America in 2014, according to U.S Census Bureau trade data compiled by the USDA. Since food safety efforts in South America have been devoted to protecting export crops actualization and implementation of new food legislation have been on the agenda of many countries [36].

On the down side there had been restricted access to markets of certain products owing to the presence of chemical residues and microbiological contamination that pose a risk to human health in food stuffs of animal and plant origin. The presence of areas with high prevalence of fruit flies causes loses of up to 40% in the production of fruits and vegetable. Strict food safety measures adopted by US and EU countries have resulted in detention and refusal of foods imported from Latin America and the Caribbean countries occasionally resulting in serious economic consequences. The products most commonly detained are fruits and vegetables, nuts, snacks and processed foods, fish and beef. Hence unless these countries make sustained effort to improve their food safety and quality standard they will continue to suffer from foodborne diseases and costly rejection of their products in the global market [37].

Stock market reaction to food recalls

There are several studies regarding the potential industry costs of food recalls, but studies that include analysis of the various elements of these costs are limited. Detailed information regarding the response of stock prices to recalls is useful because such data can be used to discuss potential firm and industry -level benefits of adopting particular food safety interventions. It also helps to compare the market reaction to different recalls to determine if the size and scope and severity in terms of the number of illnesses and death associated with the product prior to recall influence the magnitude of the reaction.

In 1999 Neal and Victoria of Texas A&M University, used a partial event analysis technique to demonstrate the unique impact of recalls on Stock Market by investigating the stock market reactions to four recalls as an indicator of industry cost. The result of their study suggests that financial market reacted in a limited way to certain food recalls. Although shareholders are negatively affected, negative repercussions did not last very long after the events, with only one lasting at least 40 days. Early indications suggest that though share price levels recoup initial losses reasonably quickly, a measure of price variability takes longer to recover. Based on the four recalls of differing scope and severity, there appear to be little or no relationship between the stock price reaction and the severity of the recall [37].

Another study in 2015, by Veronica and Ted of stock price reaction of meat and poultry recalls demonstrate the magnitude of stock price reactions representing the expected costs incurred by the implicated firms and used to assess the benefits of implementing new technologies or food safety protocols, including adoption of industry food management systems. Price reaction seemed to be persistent over time. However reducing product recall probabilities by designing and implementing mitigation strategies during the event has a positive impact on shareholders due to minimizing of losses. The factors driving the magnitude of impact that affect shareholders were the seriousness of the human health risk associated with the event; the size of the firm; firms recalling a large volume of product would be expected to be impacted more than those experiencing a small volume recall; the extent of media information accompanying a recall event which can decrease consumer demand for the implicated product; and the scale of the firm's operation and levels of diversification. Larger and more diversified firms are expected to be more able to weather a food safety recall than small companies. A firms past experience managing recall s can also influence the outcome from contamination incidents on the market value of firms [38]. That means firms undertaking an effective food safety crisis management strategy may be capable of minimizing stock market re action.

A thesis from the University of Guelph in Canada assessed the economic impact of a Canadian recall involving RTE meat products contaminated with *Listeria monocytogenes*, with the first seven trading days of the initial recall announced, the firm's stock price had dropped 27% [39]. This suggests that recalls have an adverse effect on current and future profitability of the food industry.

Consumers reaction to food recalls

Several studies show that the majority of consumers in advanced countries are unaware of some of the most significant food recalls in recent years. Most consumers significantly under estimate the frequency of recalls and display a general lack of awareness. This raises concern about the effectiveness of the communication system used by government and industry to inform consumers about food recall.

A recent survey by the Canadian Food Inspection Agency (CFIA) regarding where people are getting information about food recall, the majority of respondents said they receive recall information from traditional and social media. Only 8% of the respondents said they received recall information directly from the government. The U.S Food and Drug Administration (FDA) has dedicated social-media feeds for recalls and the Federal Government of Canada has created an app that sends out information on alerts on all types of product, including food [4]. Despite government and industry efforts our study shows that consumers don't seem to take adequate responsibility for food safety in general, either due to lack of knowledge or inadequate time for this purpose. Few consumers read the labels on the food they buy from grocery stores and in this case their interest is on 'best by' or 'use by' that shows the expiry date. Some countries provide standardized templates for consumer notification supported by guidance on where these should be displaced, in store or on line including guidance on proactively communicating recall notifications. According to a survey by U.K Food Standard Agency in 2007, few consumers 26% check or look for food recall notices on a regular basis or even occasional basis; 70% of consumers confirmed they had never or rarely looked for information, and 10 consumers mentioned the Agency's (FSA) web site as a source of this information [40]. Recall information does not always reach small retailers and even if it reaches the action taken will depend on the business ethics of the retailer. Those who still want to sell the recalled product they can do it without letting the consumers know about the recall to avoid financial loss. Consumers with any allergies or intolerances are more likely to look for information, although even among allergy sufferers only a minority claimed to take a proactive action and only 13% had visited a government web site, and only 8 % had signed up for allergy and

text alerts. In a Harris Interactive poll, consumers indicated that 55% would switch brands temporarily following a recall, and 15% said they would never purchase the recalled product, and 21% would avoid purchasing brand made by the recalled product. Similarly a telephone survey of 350 Hawaiian consumers found that one-third to one-half used the recalled food and drug products and the balance they threw them away or returned them to the store. A significant percentage, 16 - 33%, said they now buy less of the recalled products, and 11 - 32% stated that they switched brands due to these recalls [41]. On the other hand data collected from different groups and reported by The New York Time following spinach contamination in 2006 by *E. coli*, suggested that sales slumped for a few days but not for long indicating that consumers didn't stop purchasing recalled product for long. When it came to the biggest recall of beef in 2007 due to *E. coli* 0157 outbreak, the reaction at the meat counter was almost negligible [42]. There is limited information on the true consumers need to look beyond short-term reactions and try to reverse the underlying problems by raising their voices to identify the hazards that account for the largest portion of outbreaks. The majority of consumers don't feel they are also personally responsible for keeping themselves safe from hazardous food. Consequently they are not demanding for precautionary measures to be taken by producers and suppliers to ensure the safety of their products. In recent years consumer's confidence in food safety has declined in industrialized countries due to the rising dilemma of food recalls linked to contamination by pathogenic organisms, allergen, toxic chemicals, and foreign matter. A survey in 2010 found that the Chinese considered food safety the second greatest risk they faced in daily life after earthquakes due to some large food safety scandals that have come to light in recent years [15]. More than 70% of Americans are just as concerned about food safety as they are about the war on terror. The perceived health risks associated with adulterated food and failure to meet regulatory requirement by food producers diminishes the trustworthiness of producers by the consumers. Consumer's attitude to a food industry plays a very important role in consumers purchasing behavior. Therefore when product recall happens companies should take immediate action to keep consumers satisfied by providing access to a clear and accurate information consistently; explaining distinct set of roles and responsibilities of all stakeholders involved in the recall system; guidance for the appropriate way to fulfill the withdrawal of the recalled product from the system; and offering them a good compensation if there is damage and ensuring proactive preventive measures to avoid future risk. This is part of a good and effective recall strategy to reduce the negative perception and panic of consumers and change their attitude during food recall crisis. It is crucial that communication channels be established with the stakeholders immediately after a recall is identified and the root cause of the incidence be known to consumers. At the end of successful withdrawal of the product, the recall should be evaluated and experience shared for learning best practices to prevent similar incidents from occurring in the future. Creating public awareness of the food recall system including messaging to explain why a recall would be issued by giving the necessary information along with actions expected will help maintain public confidence on the safety of the food they purchase. Consumers concern and protection against frauds and contaminated food products in developing countries is inadequate due to lack of coherent national food safety management system. Food security is a major concern than food safety in this part of the world since a large percentage of the food supply is imported to supplement local production. The safety of imported food is not always assured due to lack of effective inspection. Only a few countries have active Consumers' Associations, Consumers Advocates, and organizations for Consumers Education. When consumers are quality and safety conscious they are able to complement the efforts of the food control agencies and this will encourage the food industry to comply with the food quality and safety standards. Therefore Governments of these countries should continue to facilitate the establishment of sustainable Consumer's Associations by creating awareness and educating them to be part of the food safety control system. Consumers need to raise issues related to food safety so that government and the concerned authorities take the necessary action to protect them from a large number of food fraud, contamination and the resulting infections.

National and international efforts to advance food safety

Over the last decades countless food safety conferences and workshops have been organized at national, regional and international level around the world to increase the availability of safe food and reduce the burden of foodborne diseases. As population, trade and migration increases, the risk of the spread of pathogenic microorganisms and other contaminants in food across borders gets high. It was

in recognition of the growing threat posed by foodborne diseases worldwide that over 50 developed and developing countries adopted the Beijing Declaration on Food Safety in 2007. The declaration urges all countries to base their food safety measures on sound scientific evidence and risk analysis.

In May 2010 the World Health Assembly in Geneva passed a resolution on food safety “Advancing Food Safety Initiative”, to assist member states to strengthen their food safety programmes [43]. Earlier in 2004 a joint FAO and WHO sponsored Regional Conference on Food Safety for Africa was held in Zimbabwe to find ways and means of strengthening existing food safety systems to ensure safer food for better health and agricultural trade opportunity [44].

In the European Region a five year action plan (2015 - 2020) on Food and Nutrition was developed to guide policy makers and health professionals on a wide range of action on food safety. The plan is aimed at significantly reducing the burden of preventable diet-related non-communicable diseases, obesity and all other forms of malnutrition still prevalent in the European Region of WHO [45]. The WHO/ Pan American Health Organization (PAHO) has developed Regional Strategy for Food Safety and Prevention of Foodborne Diseases (2013 - 2017) for the America. Market access throughout the world and brand protection have been the major drivers of food safety in South America. As a result formulation and implementation of new food legislation and the modernization of food safety inspection agencies to comply with international requirements have been on the agenda of most countries in the region.

In the African and Asian Regions a number of countries have moved to update and strengthen their food safety by establishing a national authority for food and drug, and harmonizing their food safety standard with Codex Alimentarius Commission. Africa has got chairs now, observer status, at The World Trade Organization (WTO) on its Sanitary and Phytosanitary (SPS) Committee where food safety and animal and plant health issues are decided [46]. The African Union has laid the ground work for African Food Safety Authority to set safety standards and monitor the African food supply, much like the European Food Safety Authority does for EU member states. The African Union believes that improving food safety particularly with international food standards, will not only reduce food losses and increase food availability in the continent, but also promote exports from the countries by taking advantage of international trade opportunities.

China has developed a plan to modernize the country’s food system to reduce the incidence of scandals that have continued emerging following the melamine scandal. Measures to be taken to reorganize regulatory agencies, to stream line standards and to toughen punishments for violators have been highlighted by the Chinese authorities [47]. However the effectiveness of these interventions need to be assessed based on the strength of monitoring and evaluation in the years to come.

In January 2011, the United States Congress Passed a hotly debated legislation called “The Food Safety Modernization Act”. The intention is to update and inject resources into the USA food safety system. It basically called for more inspection and gave government authority to mandate food recall. Under the new Act FDA will have new-prevention focused tools as well as a clear regulatory framework to make substantial improvement in the approach to food safety. However the inspection of meat, poultry and eggs remains under The Department of Agriculture. Funding limitation may limit the implementation of the new Act by FDA [48]. Facing the likelihood of ongoing budgetary constraints, the FDA will be hard pressed to carry out the full range of inspections mandated by the Food Safety Modernization Act.

In Canada several key strategic initiatives came to force including the publication of the Safe Food for Canadians Regulations (SFCR) which will come to force in January 2019. Canada is also creating a new International Affairs Branch to bring focus and accountability to international activities within CFIA and Agriculture and Agri-Food Canada (AAFC) in an effort to better advance the Government’s market access and trade agenda [49].

Despite the relative success in many advanced countries to improve the safety and quality of food produced for domestic consumption and export purpose, progress in advancing food safety in low income countries has been slow due to many reasons. The major constraints are the existence of multiple agencies with fragmented responsibilities combined with outdated legislation and lack of human and financial resources. Laboratory based food safety surveillance system does not exist in some of the countries to assess the burden of foodborne diseases and solicit political will to develop coherent national food safety policies and allocate adequate funds for food safety programme. Some of the countries are hard hit by food insecurity, political instability, natural disasters (floods, earth quakes, wild fire, storms) and other major public health and security concern. Amidst these crisis food safety remains low in the government agenda. Most of these countries use the Codex Standards in the absence of other national food safety legislation by applying the Hazard Analysis Critical Control Point System (HACCP) which has been advocated by WHO for many years. Food safety remains a challenge to the low income countries. There is a need for closer collaboration among countries to support measures in the implementation of the global food safety initiatives by creating a strong alliance to address the needs of the developing countries.

Discussion

Estimating the burden of foodborne diseases is a complicated task due to the fact that more than 250 different diseases have been described caused by a variety of bacteria, viruses, and parasites. Other diseases are poisonings, caused by hazardous toxins or chemicals that have contaminated the food. These different diseases have many different symptoms, so there is no one “syndrome” that is foodborne illness. The spectrum of foodborne diseases is also constantly changing as new microbes evolve due to environmental and ecological changes. The globalization of the food supply has contributed to the international public health problem creating the need to initiate and sustain efforts aimed at preventing foodborne disease at national and international levels.

Estimating the burden of foodborne disease is a good indicator of the magnitude of the problem. However very few illnesses can be definitively linked to food and the links are only made during outbreak situations. Nevertheless it is taken for granted that food does represent an important vehicle for pathogens causing acute gastroenteritis. For this reason studies determining the burden of acute gastroenteritis provide the basis for estimating the burdens due to specific pathogens commonly transmitted by food. Therefore in view of the complexity of this task, the data from The World Health Organization on global estimate of the burden of foodborne diseases and estimates provided by countries and regions that have laboratory based surveillance system should be used with caution.

With the recent increase in food recalls, human health in today’s complex global food trade remains an important challenge that need to be addressed. Even plants with the best controls are at risk of human error, mechanical breakdown or sampling failures that can happen at any time. A mistake can also originate with suppliers of ingredients or raw materials for which the manufacturer has no direct control. Therefore Increasing expenditures to prevent and control these risks to ensure product safety is by far a better investment than spending a large amount of money on recalls and repair of brand damage after an event. The challenge is to provide greater food safety without adding significant costs to the consumers.

The application of best practices, standards, regulations and scientific approaches to risk management such as “HACCP” and improved management are the major interventions to be pursued by industry, governments and other stake holders to reduce the risk of food safety. Ensuring best sanitary and hygiene practices in particular throughout the production and supply chain reduces the risk of microbial contamination which is the main cause for recalls that cost millions of dollar. Hence a review of the sanitary standard and hygiene compliance of the food processing industries will help to identify the current deficiencies and the action needed to better mitigate or eliminate the risk of contamination. This means increased effort is required for closer monitoring of the critical points in food processing particularly from the perspective of microbial contamination.

The potential risk factors of primary products are those risks associated with harvesting of crops, growing fruits and vegetables, slaughtering and milking cows on the farm, raising poultry, fishing in aquaculture, or catching from inland fresh water. The potential risks are contamination of farm products by chemicals used as pesticides, herbicides and fertilizers, microbes and environmental pollutants. The indiscriminate use of antibiotics in animal feed and to treat plant disease can also encourage the development of antibiotic resistant. Other factors associated with primary products are natural toxins produced by plants, fish and animals, food irradiation, food additives and growth hormones in farm animals which may find their way in the food we eat. Therefore industrial production of the primary products requires the application of risk based inspection aimed at reducing the likelihood of introducing a hazard which may adversely affect the safety of food or its suitability for consumption at later stage in the food chain.

The industrial countries have the resources needed to control the safety of primary products both for local consumption and export market. On the contrary in developing countries most fresh farm products are sold in local markets for domestic consumption and there are fewer processed and packaged foods. Perishable food is often prepared and consumed immediately with minimal left over for storage. As a result most of the foodborne outbreaks are caused by consumption of food in private households. Government inspection of food safety is carried out mainly in the cities and large urban areas where public health threats appear. Consequently most rural farmers are not aware of the health risks of their products and are not implementing Good Agricultural Practices.

On the positive side a good number of transnational corporations that are engaged in the food trade have started investing in various ways to improve the quality of food imported from developing countries including primary products. Such investment overseas by Governments and food industries from developed countries on farms, plants, institutional strengthening and application of science based approach to production and safety control is a challenge and opportunity to developing countries and is believed to bring positive outcome. The proof of success is that there has been significant decline in the number of rejection or withholding of food products imported from South America by U.S and EU countries. A good number of food exporters from this region have been accredited in various quality management and apply the "HACCP" system.

It is believed that reducing the burden of foodborne diseases and the number of food recalls by improving the quality of food produced for human consumption and animal feed has significant health and economic benefits. The cost of interventions is by far less than the cost of hospitalization and the cost for food recall. The global data indicates that the largest number of cases and deaths due to foodborne diseases is linked to food recall are caused by pathogenic organisms mainly *Salmonella*, *E. coli* 0157, *Campylobacter*, *Listeria monocytogenes* and a few viruses. These pathogens and the emerging new zoonoses issues should be targeted in the scientific research where there are gaps in our knowledge. There is also need to support research to further the evidence based intervention and evaluate the effectiveness of enforcing food hygiene legislation enacted to reduce foodborne diseases. Risk management programmes to control these pathogens should be implemented in coordinated approach in partnership with stake holders.

Consumer awareness and proactive engagement with food recalls should be enhanced by familiarizing them with the system for recalls and withdrawals to make sure that they have the most effective system in place, It is important that they understand that food alerts are issued for food safety reasons and action is required from them as well. This requires that existing methods of consumer notification should be expanded to include more public media. The information directed to consumers about food recalls should also be clear, consistent and accessible. Consumers should be educated how to prevent foodborne diseases so that they become part of the solutions and demand a safe food supply.

Developing countries taking part in global food trade are required to adhere to the increasing stringent quality standard of their trading partners in addition to ensuring safe food for domestic consumers. Without adequate regulatory food safety frameworks and enforcing capabilities the countries in Asia, Africa, Latin America will continue to suffer millions of cases of foodborne illnesses and their food

exports will continue to suffer from costly rejection. Hence there is a need to review their current operations including legislation, regulations, laboratory facilities and harmonize their standards with the Codex Alimentarius and the GAPs. However due to limited resources, the countries will not be able to address the current needs unless they receive technical and financial support from their trading partners, and international organizations. Measures to be taken include assuring safety throughout the food chain by enforcing science-based regulations, applying risk analysis focusing on those critical points in the food chain and improving coordination among food regulators, food producers and consumers.

Conclusions

The WHO estimate on the global burden of foodborne diseases and the data on foodborne illnesses reported by countries that have established laboratory based surveillance should be treated with caution to monitor trend. All studies on estimating the burden of foodborne diseases nationally and at international level confirm that available data are under reported.

The globalization of the food supply has increased the recall of products that cause public health risk at very high cost resulting in the loss of profit to the food industries. Therefore investing on preventive measures that impact on reducing foodborne diseases will have better health and economic benefits that spending millions of dollars on food recall and brand protection.

It is now well known that microbial contamination is the main cause for food recall and the specific pathogens are *Salmonella*, *E. coli* O157, *Campylobacter*, *Listeria*, *Clostridium Perfringens* and *Norovirus*. Working in partnership with the Government regulatory agencies, industries, research institutions and other stakeholders to review existing interventions available to reduce the risk of microbial contamination and develop a new strategy including research on emerging new zoonoses will provide a sound evidence base upon which risks and actions can be assessed.

Ensuring best sanitary and hygiene practices throughout the production and supply chain including the primary source where food is grown and cattle are raised has many benefits to the workers in the farms and plants, and to the industries in reducing levels of foodborne diseases. The application of "HACCP" principles should therefore receive active consideration to prevent or limit food contamination all the way from farm to table.

Several studies confirm that consumer's engagement in food recall and preventing foodborne diseases is low and the knowledge gap on foodborne illness between consumers in developed and developing countries is high. However foodborne disease is a common global health and economic problem whether it is produced on large or small scale for export or domestic consumption, whether it is purchased from the farm or major retailers, or whether cooked at home or prepared and eaten outside the home. Therefore raising public awareness and improving understanding of food recall and foodborne diseases through public education and hygiene campaign will help consumers to be part of the solution to prevent foodborne diseases.

The declarations and resolutions adopted at national and international level to advance food safety urge all countries to institute food safety measures based on sound and scientific evidence. However for low income countries, catching up with technically advanced countries in the application of advanced scientific investigation to confirm cases of foodborne diseases, and implement risk management outside the traditional method of food inspection is a challenging task. In view of the existing financial and manpower constraints the low income countries should aim at maintaining the basic sanitary measures and at the same time take full advantage of the support of the international organizations and their trading partners that import their products for better outcome.

A few simple hygiene practices such as hand washing; avoiding cross-contamination of one food with another; washing fresh fruits and vegetables in running water; cooking at the right temperature; refrigeration, freezing; sanitary disposal of human and other wastes, and targeting critical points in food processing with appropriate intervention can lead to preventive measures that reduce the risk of

food contamination by microorganisms. The application of these simple and affordable hygiene and sanitary practices from farm to the kitchen will save millions in health and recall costs. Countries that have achieved the minimum level of food hygiene standard can strive for a higher level of reducing foodborne diseases by implementing effective risk management system in partnership with government, industries and consumers in a concerted manner.

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