The Economics of Food Safety in Developing Countries

Spencer Henson

ESA Working Paper No. 03-19

December 2003

Agricultural and Development Economics Division

The Food and Agriculture Organization
of the United Nations

www.fao.org/es/esa

ESA Working Paper No. 03-19
www.fao.org/es/esa

The Economics of Food Safety in Developing Countries

December 2003

Spencer Henson
Department of Agricultural Economics & Business
University of Guelph
e-mail: shenson@uoguelph.ca

Abstract

This paper aims to provide an overview of issues associated with the economics of food safety in developing countries. It is intended to highlight the major questions and concerns associated with an economic analysis of food safety issues, both generally and specifically in a developing country context. Thus, it provides an overview of these issues and highlights key references for readers that wish to explore these issues in greater depth.

The paper provides a basic over view of what is meant by food safety, highlighting the main hazards potentially associated with food. It assesses the burden imposed on developing countries, both in terms of rates of human morbidity and premature mortality and the economic and social costs imposed on developing societies. In so doing, the paucity of data on the magnitude of food-borne illness in developing countries is highlighted. The ways in which markets may fail to provide for an appropriate level of food safety, and thus the case for government regulation, are than discussed. Much of the remainder of the paper than explores the key elements of food safety capacity and analysis attempts by developing country governments to enhance their capacity in strategic areas in some depth. It concludes by suggesting positive ways forward through which the capacity of developing countries to manage food safety, both for the protection of their domestic populations and promotion of trade in agricultural and food products, can be enhanced.

Key Words: Health, Economic Development, Agriculture

JEL: I18, 019, Q17, Q18

The Economics of Food Safety in Developing Countries

1. Introduction:

In recent years, there have been heightened concerns about food safety, not only amongst scientists with an interest in food toxicology or microbiology, for example, but also economists and other social scientists that focus on the wider socio-economic issues associated with the safety of a country's food supply. In part this reflects the real incidence of food-borne illnesses world-wide, and in part consumer concerns about the safety of the food they consume, particularly in industrialised countries, often fuelled by media attention. An added dimension is the impact of food safety regulations on global trade in agricultural and food products. In some ways there is a stark contrast between industrialised and developing countries, although in both contexts the incidence of food-borne diseases (in particular those associated with microbial pathogens) is acknowledged to be considerable. Whilst this paper will highlight these differences and similarities, its primary focus is on the economics of food safety, specifically in a developing country context.

In industrialised countries, whilst food supplies are generally considered to be safe, evidence suggests that food-borne illnesses are prevalent and that the incidence of certain food-borne pathogens is increasing. For example, more than 40 different food-borne pathogens are known to cause human illness (Buzby *et al.*, 2001). Significant incidents of contaminated meat, dairy products, salads and canned goods, although relatively infrequent, send signals to consumers that the food they purchase is not risk-free. In many cases only small groups of consumers are directly affected by the events, yet publicized food scares create an environment, through a process of 'social amplification', in which food safety is an increasingly widespread and pressing concern.

Whilst it is recognised that the prevelance of food-borne illness in developing countries is considerable, in most there is limited data through which the incidence of particular diseases and trends over time can be assessed. In many cases, high rates of food-borne illness are associated with low levels of general economic development and, more specifically, limited capacity to control the safety of the food supply. Further, there are close inter-relationships between food safety issues and other elements of environmental health, for example sanitation, water quality and housing conditions.

This paper aims to provide an overview of issues associated with the economics of food safety in developing countries. By necessity, many of these issues are not explored in the depth they deserve. However, it intends to highlight the major questions and concerns associated with an economic analysis of food safety issues, both generally and specifically in a developing country context. Thus, it provides an overview of these issues and highlights key references for readers that wish to explore these issues in greater depth.

The paper starts by discussing in very basic details what is meant by food safety, highlighting the main hazards potentially associated with food. The burden imposed on developing countries is then assessed, both in terms of rates of human morbidity and premature mortality and the economic and social costs imposed on developing societies. In so doing, the paucity of data on the magnitude of food-borne illness in developing countries is highlighted. The ways in which markets may fail to provide for an appropriate level of food safety, and thus the case for government regulation, are then discussed. Much of the remainder of the paper then explores the key elements of food safety capacity and analyses attempts by developing country governments to enhance their capacity in strategic areas in some depth. It concludes by suggesting positive ways forward through which the capacity of developing countries to manage food safety, both for the protection of their domestic populations and promotion of trade in agricultural and food products, can be enhanced.

2. What is food safety?

Food safety refers to the potential hazards associated with food that can cause ill-health in humans. Certain of these hazards are naturally-occurring (for example aflatoxins in groundnuts), whilst others occur through contamination (for example pesticide residues in fruit). The potential hazards associated with food include the following (Unnevehr and Hirschhorn, 2000; WHO, 2002a):

- **Microbial pathogens** are micro-organisms that occur naturally in humans, animals and/or the environment. Examples include *Salmonella*, *Campylobacter* and *E. coli*. Microbial pathogens are associated with diarrhoeal diseases.

- **Zoonotic diseases** are transmitted from animals to humans through food products, for example tuberculosis and brucellosis.

- **Parasitic organisms**, in particular intestinal worms, can be transmitted through contaminated food and water.

- **Physical contaminants and adulterants** can occur in food through normal modes of contamination or deliberate addition. Examples include glass, metal animal faeces etc.

- **Naturally-occurring toxicants** occur in food naturally or enter through normal biological processes. Many are virulent toxins associated with enhanced risk of chronic disease in humans and in certain cases acute ill-health. Examples include mycotoxins, alkaloids, lectins etc.

- **Agro-chemical and veterinary drug residues** can occur in food as a result of the purposeful use of these substances in agricultural production. Residues of some substances, for example pesticides, are associated with an elevated risk of cancer.

- **Prions** such as the agent causing bovine spongiform encephalopathy (BSE) are associated with human disease, for example new variant Creutzfeldt-Jakob (vCJD). Humans are exposed through consumption of meat from infected animals.

- **Persistent Organic Pollutants** are compounds that accumulate in the environment and the human body. Known examples are Dioxins and polychlorinated biphenyls (PCBs). These can contaminate food through pollution of air, water and soil. Dioxins are unwanted by-products of some industrial processes and waste incineration. Exposure to persistent organic pollutants is associated with a wide variety of adverse effects in humans, for example cancer.

- **Heavy metals** such as lead and mercury cause neurological damage in infants and children. Exposure to cadmium can also cause kidney damage, usually seen

in the elderly. These can contaminate food through pollution of air, water and soil.

- **Genetically-modified organisms** may contain allergens or toxins that are not found in conventional foods.

Some of these hazards cause acute illness, for example microbial pathogens. Others may increase the risk of chronic diseases such as cancer, for example pesticide residues. Across all of these hazards, the impact on an individual reflects a range of factors including age, prevailing health status, genetic constitution etc.

Perhaps of greatest interest in a developing country context is food-borne illness associated with microbial pathogens. The recorded incidence of food-borne illness is increasing world-wide for a variety of reasons including changes in eating patterns and food production and handling practices, the enhanced geographical movement of people, animals and plants, and emergence of new pathogenic organisms. Further, whilst less well documented, it is evident that the incidence of food-borne disease is greatest in developing countries due to the presence of a wide range of pathogens. Indeed, the high prevalence of diarrhoeal diseases in many developing countries suggests major underlying food safety problems.

Whilst the entire range of potential food-borne hazards are of concern world-wide, relative risk and perceived importance differs according to a range of factors including levels of economic development, climatic conditions, cultural and social norms, prevailing infrastructure etc. Thus, certain risks are greater in developing countries, for example because of poor sanitation and/or inadequate access to potable water (Unnevehr and Hirschhorn, 2000). For example, Cholera is a public health problem particular to developing countries that is the cause of significant levels of human morbidity and mortality and enormous economic losses. The disease is caused by the bacterium *Vibrio cholerae*. In addition to water, contaminated foods can be a major vehicle of infection. Different foods, including rice, vegetables, millet gruel and various types of seafood have been implicated in outbreaks of cholera. Likewise, mycotoxins are more prevalent in tropical and sub-tropical countries (Bhat and Vasanthi, 1999), as are certain parasites.

Food safety is a composite element of the wider concept of 'biosecurity' which the FAO Committee on Agriculture has defined as (FAO, 2002):

> "Biosecurity encompasses all policy and regulatory frameworks (including instruments and activities) to manage risks associated with food and agriculture (including relevant environmental risks). Biosecurity is composed of three sectors, namely food safety, plant life and health, and animal life and health. These sectors include food production in relation to food safety, the introduction of plants pests, animal pests and diseases, and zoonoses, the introduction and release of genetically-modified organisms (GMOs) and their products, and the introduction and safe management of invasive alien species and genotypes."
>
> "Biosecurity thus has direct relevance to food safety, the conservation of the environment (including biodiversity), and sustainability of agriculture."

This emphasises the similarities and complementarities between the control measures demanded by risks to food safety, plant and animal health. Further, certain hazards cut across these distinctions, for example the cattle diseases BSE and Tuberculosis are also associated with potentially significant food safety risks for humans.

Food safety is of particular concern in a developing country context not only because of the high prevalence of food-borne illness and other hazards associated with food, but also because of the considerable economic and social costs that, in turn, reflect prevailing levels of economic development. Thus, for example, a child that contracts diarrhoea from consuming contaminated food may not be able to gain access to the required medical care and may suffer more adverse consequences as a result. Further, the considerable and rapid economic and social changes associated with processes of development, for example urbanisation, changes in systems of food production and shifts in food consumption patterns can enhance risks and/or challenge prevailing systems of control.

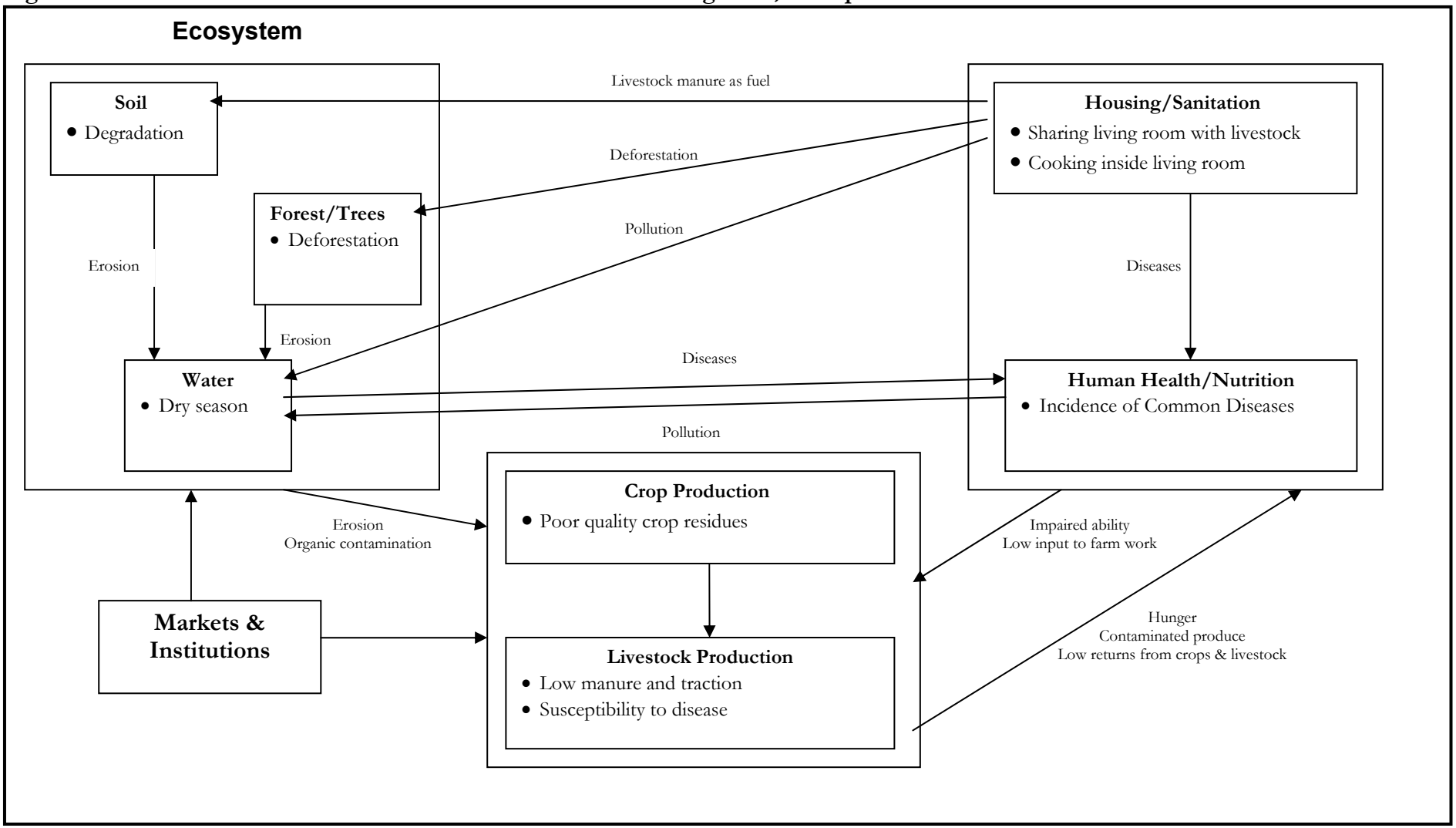
This emphasises the need to consider food safety within the wider context, for example as provided by the ecosystem approach to human health. This recognises the connections between disease and socio-economic factors such as poverty and malnutrition and the wider economic, social, physical and cultural environment in which people live (Forget and Lebel, 2001). For example, Figure 1 demonstrates the inter-relationships that determine the incidence of common diseases in rural Ethiopia (Lebel, 2003). Further, it emphasises that effective strategies to address food safety issues, particularly within a developing country context, require a holistic approach to be adopted that not only considers the risks associated with a particular food but the wider context in which they occur and the constraints on efforts for their control.

The importance of food safety as a global public health concern has been recognised internationally. For example, the Rome Declaration on World Food Security (1996) clearly stated that all people have the right to safe food whatever the level of their effective demand. At the international level, the promotion of food safety is the joint responsibility of both FAO and WHO. Food safety has long been a main-stream activity of FAO, including technical assistance program aimed at enhancing food safety control capacity. In the case of WHO, the 53rd World Health assembly requested that the Director-General give greater emphasis to food safety and establish a global strategy for surveillance of food-borne diseases and to initiate a range of other activities on food safety and health (WHO, 2000a; 2002b).

3. The burden of food-borne illness in developing countries:

Whilst the global incidence of food-borne disease is difficult to estimate, it is possible to sketch a general picture by way of introduction from the various and widespread information that is available. In the early 1990s, there were approximately 1.5 billion episodes of diarrhoea annually (Motarjemi *et al.*, 1993), of which around 70 percent were associated with contaminated food. Further, it is estimated that 2.1 million people died from diarrhoeal diseases in 2000 (WHO, 2000a). In industrialized countries, for which more data are available, the percentage of people suffering from food-borne diseases each year has been reported to be up to 30 percent. In the United States, for example,

Figure 1. Determinants of human health and nutrition in Yubdo-Lagabato, Ethiopia:



around 76 million cases of food-borne diseases are estimated to occur each year (Mead *et al.*, 1999). While most food-borne diseases are sporadic and often not reported, outbreaks can take on massive proportions. For example, in 1988 an outbreak of hepatitis A, resulting from the consumption of contaminated clams, affected some 300,000 individuals in China.

Data collected by surveillance systems are far from exhaustive and much of our understating of the epidemiology of food-borne diarrhoea has been derived from investigations of outbreaks. Data on sporadic cases is largely derived through passive surveillance systems, the quality of which varies greatly by country and disease. In addition, under-reporting of diarrhoea regarding both sporadic and outbreak cases is significant but varies by country. As a result, data on the incidence of food-borne illness in both industrialised and developing countries are very incomplete and under-state the extent of the problem. Data for developing countries are particularly weak, although it is recognised that a wide range of bacterial infections and intoxications are widespread (Table 1). Further, where incidence data are available, these are frequently out-dated. Some indicative examples are provided below.

Table 1. Estimated occurrence of bacterial infections and intoxications in selected regions:

Disease	Africa	Central & South America	South East Asia	Western Pacific[1]
Bacillus cereus gastroenteritis	+++	+++	+++	+++
Botulism	+	+	+	+
Brucellosis	+/++	++	+/++	+/++
Campylobacteriosis	+++	+++	+++	+++
Cholera	+/++	+/++	+	+
Clostridium perfringens enteritis	+++	+++	+++	+++
Escherichia coli disease	+++	+++	+++	+++
Listeriosis	+	+	+	+
Typhoid and paratyphoid fever	++	++	++	++
Salmonellosis	+++	+++	+++	+++
Shigellosis	+++	+++	+++	+++
Staphylococcus aureus intoxication	+++	+++	+++	+++
Vibrio parahaemolyticus enteritis			++	++
Vibrio vulnificus septicaemia				++

Note: -: absent; +: occasional or rare; ++: Frequent; +++: Very frequent.
Source: WHO.

There is little in the way of regular surveillance of food-borne disease in Africa, although there is awareness of the importance of diarrhoeal disease and a limited number of studies have been undertaken (Todd, 1997). For example, a survey of hygiene in households where diarrhoea had occurred was undertaken in Liberia by Molbak *et al.* (1989). This indicated that 40 to 80 percent of stored water samples and 19 to 32 percent of food samples contained significant numbers of enterobacteria. Levels of contamination were even greater in infant foods that were generally stored at room temperature. However, a case control study by Ekanem *et al.* (1991) suggests that diarrhoea in Liberian households was more related to improper disposal of faeces than poor food hygiene.

Occasionally, acute illnesses that are directly associated with a food are documented in African countries. For example, in 1992, a large outbreak of bloody diarrhoea caused by *E. coli* 0157 occurred in Swaziland. This was the first recorded outbreak of *E. coli* 0157 in Africa, and indeed in a developing country (Effler *et al.*, 2001). Over the period October to November 1992 there were 40,912 physician visits for diarrhoea in persons aged five years or older, 700% greater than in the same months during 1990-91. The outbreak was associated with consumption of beef and untreated water and more widespread amongst women. Droughts, carriage of E. coli 0157 by cattle and heavy rains with contamination of surface water were important factors contributing to the outbreak. Similarly, an outbreak of *E. coli* 0157 in Egypt during 1994 resulted in the death of three children and severe diarrhoea in six others. This resulted from consumption of contaminated hamburgers, *koshari* and dairy products. A follow-up survey of 175 foods from slaughterhouses, supermarkets and farmers' homes detected *E. coli* 0157 in six percent of unpasteurised milk, six percent of fresh retail beef, four percent of boneless chicken, and four percent of lamb meat samples.

Likewise, little surveillance of food-borne disease is routinely undertaken in Asia. Most information is derived from specific but limited investigations and studies (Todd, 1997). For example, in Vietnam, it is estimated that 30 to 57 percent of students in university hostels in Hanoi suffered from diarrhoea over the period 1984-88, mainly because food was poorly prepared and/or stored. Over the period 1983-88, 5,714 illnesses were documented, most associated with *Salmonella*, *E. coli* or *S. aureus*. Of these cases, 156 died.

In Thailand, there has been a particular focus on chemical poisonings, especially from insecticides, although these only accounted for 0.33 percent of the reported 207,580 cases of food-borne diseases over the period 1981-86 (Swaddiwuthipong *et al.*, 1988). Because of the widespread use of insecticides, some have accidentally contaminated desserts, beverages, fruit and other foods. Indeed, over the period 1981-87 insecticides accounted for 27.4 percent of food-borne disease outbreaks.

Over the period 1984-89, there were 721 food-borne outbreaks and 1,199 sporadic cases of food-borne disease were recorded in the cities of Hyderabad and Secunderabad, India (Shekhar *et al.*, 1992). The main vehicles of infection were 'stale' food, rice dishes, sweets and curry. 'Stale' food was most generally left over from a previous meal and stored at room temperature, usually overnight (Rao, 1989).

In Pakistan, sweet dishes have been found to be a major vehicle for *S. aureus* intoxication (Teufel *et al.*, 1992). In one outbreak, eight people were hospitalised after consuming *khoa*, a confection made from buffalo milk. Some samples of *khoa* obtained from manufacturers in a large city contained appreciable levels of *S.aureus*. *Salmonella* has also been found in *khoa* and cheese-based confectionery. Pulses, ground meat dishes and chick peas vended at bus and train stations in the same city contained high levels of *C. perfringens* when held at an inadequate temperature (Bryan *et al.*, 1992a). Home-prepared foods in small communities also contained pathogens such as *S.aureus*, *C. perfringen* and *B. cereus* (Bryan *et al.*, 1992b).

All countries in Latin America and the Caribbean have some form of notifiable disease system (See for example Table 2) (Todd, 1997). For example, diarrhoeal diseases account for 967 deaths per 100,000 of the population amongst children aged less than one year in Nicaragua. This compares with an incidence of 0.5 deaths per 100,000 of the population in Canada (PAHO, 1990). Typically, four to seven bouts of diarrhoea are experienced each year by children aged less than five years.

In Argentina, *Salmonella enteritidis* (Eiguer *et al.*, 1990) and *E.coli* 0157 (Lopez *et al.*, 1992) have been recorded as responsible for significant rates of food-borne illness. Between 1986 and 1990, there were 35 outbreaks of *S. enteritidis* affecting 3,500 people, largely through consumption of insufficiently cooked poultry or eggs used in mayonnaise. In

the province of Buenos Aires, *S. enteritidis* caused 23 percent of outbreaks, 44 percent were related to other bacteria and 27 percent to chemicals, whilst six percent were of unknown cause.

In 1991, *V. cholera* was found throughout Peru in water, sewage, finfish, molluscs and plankton (Tamplin and Pardodi, 1991). The disease was spread partly through consumption of street-vended foods and beverages containing ice (Ries *et al.*, 1992) and also undercooked or raw seafood (Finelli *et al.*, 1992).

A broader group of studies has examined levels of microbiological and/or chemical contamination of foods in developing countries without any attempt to relate to human disease. A major focus of much of this literature has been street foods and the products of the informal sector. For example, Gran *et al.* (2002a; 200b; 2003) investigate the occurrence of pathogenic bacteria in raw milk and fermented milk products in Zimbabwe. In certain cases high levels of contamination are identified that pose a significant health hazard to consumers. Bonfoh *et al.* (2003) present a similar study on the microbiological quality of milk in Bamako, Mali. Other recent studies, for example, examine levels of aflatoxin B1 in milk in Argentina (Lopez et al., 2003), Salmonella in raw vegetables in Malaysia (Salleh *et al.*, 2003) and polycyclic aromatic hydrocarbons (PAHs) in fruit and vegetable in Brazil (Camargo and Toledo, 2003).

In an attempt to bridge gaps in the available data, the WHO has developed a new approach to estimate the incidence of food-borne diarrhoea using a risk assessment-based approach (WHO, 2002c). This approach uses the estimated annual incidence of food-borne non-typhi and paratyphi *Salmonella* as an indicator of the overall incidence of food-borne diarrhoea. Further, it employs the transfer rate (TR) risk assessment approach based on the link between exposure to a micro-organism in food and a disease incidence.

For example, Tables 3 to 6 present the estimated incidence of food-borne salmonellosis in India, Egypt, Brazil and Zimbabwe. Eggs are the predominant vehicle of infection, accounting for more than 50 percent of cases in India, Egypt and Brazil. Poultry and fish and seafood are major vehicles in Zimbabwe and India respectively, reflecting local food

consumption patterns. In all countries, a very small proportion of cases are associated with fruit and vegetables.

Table 2. Data on food-borne disease in selected countries of Latin America:

Country	Years	Number of Outbreaks	Number of Cases per Year
Brazil	1985-89	42-90 per year	5,627-9758
Columbia	1983-88		5,281-8,668
Dominican Republic	1989-90 (6 months)	45	196
El Salvador	1989		509
Guatemala	1987-89	9	32
Mexico	1981-90	363	14,412
Venezuela	1989 1990	23 14	293 400
Argentina	1986-90	35	3,500
Buenos Aires	1988-90		522

Source: Todd (1997).

Table 3. Estimated incidence of food-borne salmonellosis in India:

Product	Minimum	Mean	Maximum
Poultry (Raw)	22,300	28,300	34,300
Eggs (Raw)	2,520,000	2,830,000	3,150,000
Beef (Raw)	273,000	405,000	535,000
Pork (Raw)	487,000	584,000	681,000
Milk & dairy products (Ready-to-eat)	0	241,000	561,000
Fish & seafood (Ready-to-eat)	0	1,410,000	3,520,000
Fruit & vegetables (Ready-to-eat)	0	12,600	50,500
TOTAL	**3,300,000**	**5,510,000**	**8,530,000**

Source: WHO.

Table 7 reports the estimated incidence rate for food-borne salmonellosis in a number of developing countries. Estimates range from 79.2 per 1,000 of the population in Thailand to 5.4 per 1,000 of the population in Ethiopia and India. However, there is considerable uncertainty associated with estimates for individual countries (as seen by the range around the mean) reflecting the paucity of existing incidence data and the assumptions associated with the estimation method. Further, differences in estimated incidence across these countries highlight the dangers of extrapolating the results from one geographical context to another and/or over-generalising to developing countries as a whole.

Table 4. Estimated incidence of food-borne salmonellosis in Egypt:

Product	Minimum	Mean	Maximum
Poultry (Raw)	11,700	14,800	17,900
Eggs (Raw)	508,000	572,000	636,000
Beef (Raw)	0	0	0
Pork (Raw)	168	201	235
Milk & dairy products (Ready-to-eat)	0	5,230	12,200
Fish & seafood (Ready-to-eat)	0	34,200	85,700
Fruit & vegetables (Ready-to-eat)	0	332	133
TOTAL	**520,000**	**627,000**	**753,000**

Source: WHO.

The United States probably has the most detailed data on the incidence of food-borne illness and, whilst recognising the problems of extrapolating to the wider context as discussed above, these can provide a more detailed picture of human illness associated with food. For example, Mead *et al.* (1999) estimate that food-borne disease causes approximately 76 million illnesses, 325,000 hospitalisations and 5,000 deaths each year. Of these, known pathogens account for an estimated 14 million illnesses, 60,000 hospitalisations and 1,800 deaths. Three pathogens – *Salmonella*, *Listeria* and *Toxoplasma* – account for 1,500 deaths each year accounting for 75 percent of fatalities from known pathogens. However, 62 million illnesses are related to unknown agents, 265,000 hospitalisations and 3,200 deaths.

Table 5. Estimated incidence of food-borne salmonellosis in Brazil:

Product	Minimum	Mean	Maximum
Poultry (Raw)	575,000	728,000	883,000
Eggs (Raw)	2,910,000	3,270,000	3,640,000
Beef (Raw)	173,000	256,000	339,000
Pork (Raw)	107,000	129,000	150,000
Milk & dairy products (Ready-to-eat)	0	51,000	119,000
Fish & seafood (Ready-to-eat)	0	135,000	339,000
Fruit & vegetables (Ready-to-eat)	0	1,240	4,960
TOTAL	**3,760,000**	**4,570,000**	**5,470,000**

Source: WHO.

Table 6. Estimated incidence of food-borne salmonellosis in Zimbabwe:

Product	Minimum	Mean	Maximum
Poultry (Raw)	38,900	49,300	59,600
Eggs (Raw)	47,100	53,100	59,000
Beef (Raw)	9,390	13,900	18,400
Pork (Raw)	0	0	0
Milk & dairy products (Ready-to-eat)	0	1,200	2,800
Fish & seafood (Ready-to-eat)	0	2,030	5,100
Fruit & vegetables (Ready-to-eat)	0	46	185
TOTAL	**95,400**	**120,000**	**145,000**

Source: WHO.

The Economic Research Service (ERS) of the US Department of Agriculture publishes detailed data on the incidence of food-borne illness in the United States (Table 8). It is estimated that 38.6 million cases of illness were associated with known food-borne pathogens in 1996. Of these, 23 million were associated with Norwalk-type viruses, 40 percent of which were transmitted by food. Bacterial pathogens accounted for 5.6

million cases of illness, of which *Campylobacter* and non-typhi *Salmonella* were the most prevalent. The vast majority of cases associated with bacterial pathogens were transmitted by food.

Table 7. Estimated incidence rate of food-borne salmonellosis in selected countries:

Country	Annual Incidence per 1,000 Inhabitants		
	Minimum	Mean	Maximum
Ethiopia	1.22	5.36	10.73
Zimbabwe	26.83	33.75	40.78
Cuba	11.45	19.00	28.82
Brazil	22.12	26.88	32.18
Mexico	66.00	79.20	95.00
Thailand	39.64	48.45	58.56
India	3.26	5.44	8.41
Malaysia	12.02	20.72	32.29
Tunisia	32.11	36.89	41.67
Egypt	8.39	10.11	12.15

Source: WHO.

Whilst there is a paucity of data on the incidence of food-borne illness in developing countries, there is even less information available on the associated burden in terms of human ill-health. One summary measure of the losses associated with premature mortality and morbidity associated with human disease is the Disability Adjusted Life Year (DALY). For any condition i:

$$DALY_i = YLL_i + YLD_i$$

Where:

$DALY_i$ = Loss of disability-adjusted life years associated with condition i.

YLL_i = Years of life lost associated with condition i.

YLD_i = Years lived with disability associated with condition i.

The YLL is a measure of the loss of life due to premature mortality, calculated using standard expected years of life lost and an appropriate discount factor. The YLD is time lived in health states worse than perfect health, weighted by a preference factor for each health state. Time lived with disability is also age-weighted and discounted in the same manner as YLLs.

It is estimated that 99.6 million DALYs were lost world-wide due to diarrhoeal disease in 1990, accounting for 7.3 percent of the loss from all causes (Table 9). Of the total loss due to diarrhoeal disease, 32 percent was in Sub-Saharan Africa and 30 percent in India. In these regions, diarrhoeal disease accounted for between ten and 11 percent of the loss from all causes.

There have been very few studies of the economic costs associated with food-borne illness in developing countries, although detailed data are available for a number of industrialised countries, most notably the United States. One exception is Sudhakar *et al.*, (1988) which provides an analysis of an outbreak of *S. aureus* in India during the 1980s. Overall, 41 percent of the associated costs were borne by the affected individuals including loss of wages or productivity losses and other expenses. The economic burden on the affected people was estimated to be greater, as a percentage of per capita income, than in similar outbreaks in the United States.

The ERS also publish detailed estimates of the economic costs associated with food-borne illness in the United States (Table 10). These provide some indication of the magnitude of costs associated with food-borne illness that might be found in a developing country context. The estimated medical costs, productivity losses and value of premature deaths due to diseases caused by five food-borne pathogens (*Campylobacter*, non-typhi *Salmonella*, *E. coli* O157, *E. coli* non-O157 STEC and *Listeria monocytogenes*) in 2000 are $6.9 billion per year (Table 10). The assumed cost of each death ranges from $8.9 million for children who die before their first birthday to $1.7 million for individuals who die at age 85 or older.

Table 8. Reported and estimated illness, frequency of food-borne transmission, and hospitalization and case-fatality rates for known food-borne pathogens, United States, 1996:

Disease or Agent	Estimated Total Cases	Reported Cases by Surveillance Type			% Food-borne Transmission	Hospital-isation Rate	Fatality rate
		Active	Passive	Outbreak			
Bacterial							
Bacillus cereus	27,360		720	72	100	0.006	0.0000
Botulism, food-borne	58		29		100	0.800	0.0769
Brucella spp.	1,554		111		50	0.550	0.0500
Campylobacter spp	2,453,926	64,577	37,496	146	80	0.102	0.0010
Clostridium perfringens	248,520		6,540	654	100	0.003	0.0005
Escherichia coli O157:H7	73,480	3,674	2,725	500	85	0.295	0.0083
E. coli, non-O157 STEC	36,740	1,837			85	0.295	0.0083
E. coli, enterotoxigenic	79,420		2,090	209	70	0.005	0.0001
E. coli, other diarrheogenic	79,420		2,090		30	0.005	0.0001
Listeria monocytogenes	2,518	1,259	373		99	0.922	0.2000
Salmonella Typhi	824		412		80	0.750	0.0040
Salmonella, non-typhoidal	1,412,498	37,171	37,842	3,640	95	0.221	0.0078
Shigella spp.	448,240	22,412	17,324	1,476	20	0.139	0.0016
Staphylococcus food poisoning	185,060		4,870	487	100	0.180	0.0002
Streptococcus, foodborne	50,920		1,340	134	100	0.133	0.0000
Vibrio cholerae, toxigenic	54		27		90	0.340	0.0060
V. vulnificus	94		47		50	0.910	0.3900
Vibrio, other	7,880	393	112		65	0.126	0.0250
Yersinia enterocolitica	96,368	2,536			90	0.242	0.0005
Sub-total	5,204,934						
Parasitic							
Cryptosporidium parvum	300,000	6,630	2,788		10	0.150	0.005
Cyclospora cayetanensis	16,264	428	98		90	0.020	0.0005
Giardia lamblia	2,000,000	107,000	22,907		10	n/a	n/a
Toxoplasma gondii	225,000		15,000		50	n/a	n/a
Trichinella spiralis	52		26		100	0.081	0.003
Sub-total	2,541,316						
Viral							
Norwalk-like viruses	23,000,000				40	n/a	n/a
Rotavirus	3,900,000				1	n/a	n/a
Astrovirus	3,900,000				1	n/a	n/a
Hepatitis A	83,391		27,797		5	0.130	0.0030
Sub-total	30,883,391						
Total	**38,629,641**						

Source: Economic Research Service, USDA.

By way of illustration, Table 11 presents more detailed estimates of the costs associated with Salmonellosis in the United States in 1996. The imputed value of premature deaths accounted for around 90 percent of the total cost. Perhaps of most significance to developing countries, given their prevailing resource limitations, medical costs amounted to $236 million, or around $176 per case.

Table 9. Loss of disability-adjusted life years associated with diarrhoeal disease, 1990 ('000):

Region	Diarrhoeal Disease	All Causes
Established market economies	230	98,794
Formerly socialist economies of Europe	235	62,200
India	29,480	287,739
China	3,685	208,407
Other Asia and islands	13,711	177,671
Sub-Saharan Africa	32,126	295,294
Latin America and the Caribbean	5,371	98,285
Middle Eastern crescent	14,795	150,849
World	**99,633**	**1,379,238**

Source: Murray and Lopez (1996).

The partial estimates presented above, however, provide a biased estimate of the economic costs associated with food-borne illness because they ignore the broader economic effects on producers and consumers. This is demonstrated, for example, by recent estimates of the economy-wide impact of the implementation of HACCP in the US meat and poultry sector (Golan *et al.*, 2000). Every US$1.00 of income saved due to preventing premature death produces an economy-wide income gain of US$1.92. However, every US$1.00 of medical care costs saved due to lower rates of ill-health actually produces an economy-wide income loss of US$0.27-0.32. This results from a net decline in economic activity due to reductions in health care expenditures.

Table 10. Estimated annual costs due to selected food-borne pathogens, 2000:

Pathogen	Estimated Annual Food-borne Illness			Cost
	Cases	Hospitalizations	Deaths	
	Number			*US$ Billion*
Campylobacter spp	1,963,141	10,539	99	1.2
Salmonella	1,341,873	15,608	553	2.4
E. coli O157	62,458	1,843	52	0.7
E. coli, non-O157 STEC	31,229	921	26	0.3
Listeria monocytogenes	2,493	2,298	499	2.3
Total	3,401,194	31,209	1,229	6.9

Source: Economic Research Service, USDA.

In conclusion, the available data suggest that food-related hazards (and in particular microbiological illnesses) are a significant problem world-wide, imposing a significant burden in terms of both human morbidity and premature mortality and economic costs. Whilst there is a paucity of data on the incidence in developing countries, those data that are available, as well as information on the incidence and associated costs in industrialised countries, suggest the burden is considerable. Indeed, the available evidence suggests that both the incidence and related costs is greater than in comparable high-income countries. It is also evident, however, that better and more extensive surveillance of food-borne illness is required, not only as a means to assess the magnitude of the problem faced by developing countries and the impact of interventions, but also to guide the development and design of such interventions in a bid to maximise policy efficiency.

4. Markets for food safety and the role of government:

One of the key issues from an economist's perspective is whether markets for food products will operate efficiently, that is whether the quantity and types of foods supplied and consumed and the prices paid by consumers are 'acceptable' in terms of the level of risk. In general, economists make reference to the concept of the 'social optimum' when assessing whether markets are operating efficiently and use this as a benchmark when assessing the need for government intervention. The social optimum is the point at which the net economic value of the good in question is maximized.

Table 11. Estimated cost of Salmonellosis in the United States from all sources, 1996:

Cost component	No physician; recover fully	Visit physician; recover fully	Hospitalized; recover fully	Visit Physician/ Hospitalized, Die	Total
Number of cases	1,294,107	101,903	15,906	582	1,412,498
Medical:	$0	$26,312,612	$202,487,604	$6,697,527	$235,497,743.30
Medications	$0	$0	$0	$0	$0
Office visit	$0	$13,887,836	$1,083,874	$56,656	$15,028,365
Emergency room	$0	$2,792,219	$1,307,509	$47,842	$4,147,571
Outpatient visit	$0	$9,632,556	$1,002,361	$36,676	$10,671,594
Hospitalization	$0	$0	$199,093,859	$6,556,354	$205,650,213
Productivity, nonfatal	$55,631,845	$14,571,616	$6,153,514	$0	$76,356,975
Disutility, nonfatal	$0	$0	$0	$0	$0
Premature death				$2,691,267,988	$2,691,267,988
Total cost	$55,631,845	$40,884,229	$208,641,117	$2,697,965,515	$3,003,122,706
Average cost per case	$43	$401	$13,117	$4,635,680	$2,126

Source: Economic Research Service, USDA.

Economists represent markets as the inter-play between demand and supply functions for the good or one of its attribute, in this case food safety (Figure 2) (Stevens, 1993). The demand function (D) reflects the marginal benefits (MB) of the good to consumers – it is expected that the benefit of an additional unit of the good declines as more is consumed at any point in time. The supply function (S) reflects the marginal costs (MC) of producing the good – the cost of producing an additional unit of the good is expected to increase as more is produced at any point in time. Where the demand and supply functions intersect, the marginal benefits to consumers and marginal costs to producers are equated and net economic value is maximized. At this point, the market price and quantity are at the 'social optimum'.

This very simple market model is used as a starting point to assess whether markets in practice are likely to operate efficiently - they are likely to maximize the net economic

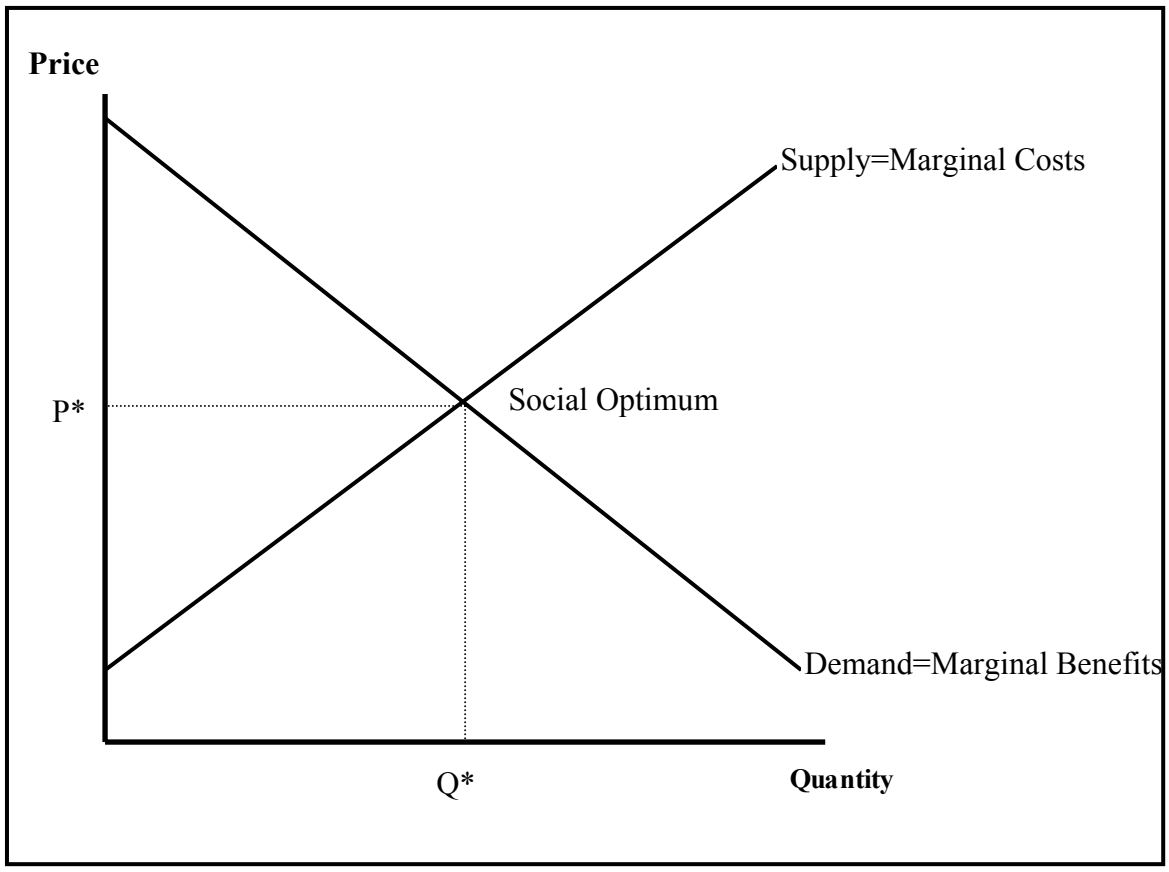
value of the good/attribute in question. Economists have identified a number of conditions required if markets are to achieve the 'social optimum'. The term 'market failure' is used to refer to situations where these conditions are violated (Ramsay, 1989):

- All of the economic costs associated with the good, including those borne directly by the seller and by society as a whole, must be reflected in the supply function.

- All of the economic benefits associated with the good, including those derived directly by the buyer as well as by society as a whole, must be reflected in the demand function.

- Buyers and sellers must be sufficiently well informed about the good in question and its characteristics in order to make appropriate decisions.

Figure 2. Simple market model:



- Buyers and sellers must be able to analyse and apply the information available to them in such a way as to make 'appropriate' decisions.

- There must be a sufficient number of buyers and sellers of the good and opportunities for relatively free entry and exit from the market to ensure market transactions are competitive.

- There should be limited costs of making and carrying out market transactions, including gathering and evaluating information and assessing the outcomes of the decision.

This checklist can be used to assess the extent to which goods and the markets in which they are allocated might be expected to 'fail'. Whilst most markets are acknowledged to operate imperfectly, and government intervention does not always act to improve the outcome of markets, these conditions do serve to establish an *'a priori'* case for intervention of some form or another. Furthermore, they enable the source of efficiency problems in markets that have been observed to be operating imperfectly to be identified.

As well as identifying the ways in which markets may fail, economists have also examined the potential for 'government failure' (see for example Wolf, 1988). Indeed, the claim that market failure is a sufficient condition for government intervention has been the subject of growing criticism, reflecting an acknowledgement that regulation can itself create transaction failures as well as exacerbate the failures that already exist (see for example Peltzman, 1976). Such non-market failures result because of a disjuncture of the costs and benefits associated with government regulation, existence of 'internalities' and private organisational goals[1], derived externalities resulting from the unanticipated effects of government intervention, and distributional inequalities, for example where regulators serve the economic interests of one group over and above another (Wolf, 1979). Thus, whilst market failures may have negative implications in terms of social welfare, it is not unambiguous that government regulation will improve things!

[1] The market failure approach implicitly assumes the government to be a neutral provider of policies without any interests of its own. However, this is clearly not the case; both elected representatives and bureaucrats may themselves have interests that are pursued through the promulgation and application of regulations.

Having established this checklist it is now possible to explore the nature of food products with respect to their safety and the markets in which they are purchased and sold, to identify any potential 'market failures'. In turn, this will provide some indication of the nature and extent to which markets are likely to operate efficiently within the context of food safety.

Externalities:

One of the fundamental requirements for markets to operate efficiently is that all of the economic costs and benefits associated with the good, in this case a specific food product, must be reflected in the supply and demand functions. The most common situation where this does not occur is where there are externalities associated with the good – gains or losses to society that are not reflected in market prices. In this situation, whilst the buyer may gain some of the benefits and the seller may bear some of the costs, benefits or costs are generated for others who are not directly party to the market transaction (Stevens, 1993).

In the case of food products, there are potentially significant externalities associated with the impact on human health. In turn, these health effects will be dependent on the safety of the product on the one hand and any potential beneficial effects on health (for example the nutritional value of the food) on the other. The key issue here is the extent to which the costs associated with human disease, for example health care and loss of productivity, are borne by society as a whole rather than the individual consumer. To the extent that these costs are borne by society, it is unlikely that the supply and demand functions will fully embody the economic consequences of the consumption of the food. If the product increases the incidence of human disease, and in turn disease-related costs, the market is likely to under-estimate their value and the established market supply of food safety will be less than the 'social optimum'.

Supply of information:

In order that consumers are able to make effective decisions regarding the purchase and consumption of products they must be adequately informed about their characteristics and the associated costs and benefits. In many markets, the amount of information made available to consumers is insufficient and/or of poor quality. In such situations, consumers are likely to make sub-optimal decisions.

Consumers are best informed and make the most effective decisions where the performance of a product can be directly observed prior to purchase or immediately following consumption. The physical appearance and taste of food fall into these categories, as do any acute health effects. However, consumers face considerable difficulties where the experience of a product does not reveal clearly its performance. These are termed credence characteristics. Clearly, the longer-term health effects of foods fall into this category. On the one hand, consumers may not be able to observe directly the associated health effects, for example in terms of their risk of contracting cancer. On the other, it may not be possible to relate these health effects directly to the consumption of a particular product.

In the case of credence characteristics, consumers have to rely on external sources of information to assess indirectly the performance of the product. Common sources of information used by consumers include product claims, labelling, brand and price. This raises concerns regarding the reliability of these information cues as measures of product performance. For example, to what extent are product claims substantiated and relate directly to the potential health effects for the individual consumer? Likewise, to what extent does a higher product price correlate with better performance? Clearly, trust plays an important role in this respect – consumers will only put credence on information they consider to be reliable and trustworthy.

Markets tend to operate most effectively where buyers and sellers are equally well informed about the characteristics of the products and associated costs and benefits. However, in many markers there are asymmetries between the quantity and quality of information available to the seller and to the buyer. This is particularly the case with products that are scientifically or technologically complex, such as many processed foods, where the consumer may find it extremely difficult to assess whether the product is safe to eat or not. In situations of asymmetric information, the seller can derive market power over the buyer, particularly where the buyer has few alternative sources of information on the performance of the product.

Whilst suppliers may have incentives to communicate the benefits associated with their products, there is less incentive to provide information on risks or defects. This is

particular the case where the negative performance of the product cannot be observed directly post-consumption. Furthermore, where all products share similar risks or defects, there is little incentive for competing suppliers to divulge information on each other's products. For example, in the absence of a regulatory requirement to do so, there is little incentive for manufacturers of cigarettes to warn consumers of the negative health effects associated with their products. Likewise, manufacturers of soft drinks may have little incentive to provide information on the sugar content of their products and the potential impact on dental health. Thus, we might reasonably expect that markets for many food products will provide little or no information to consumers on risks.

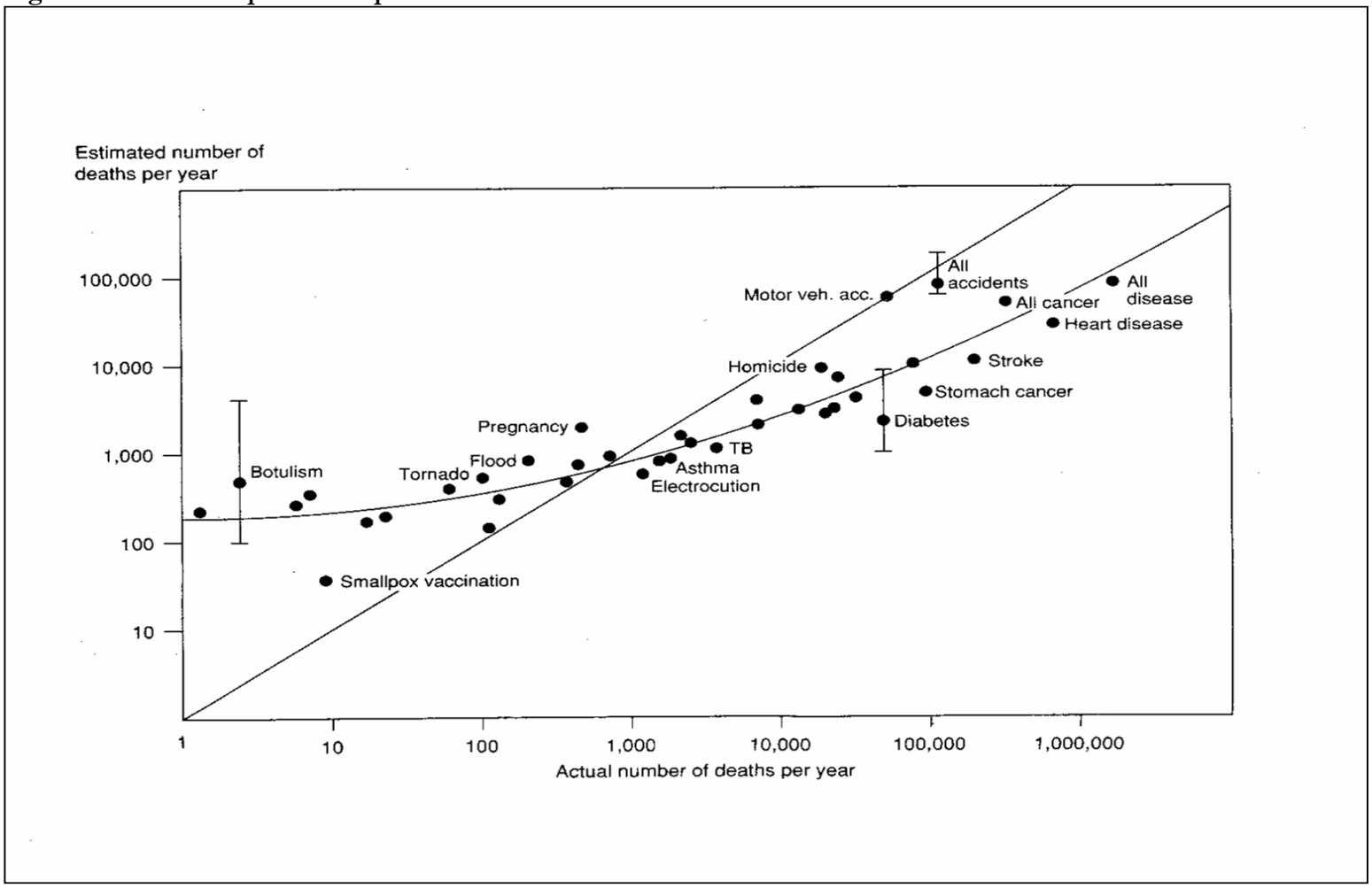
Consumer decision-making:

Having established whether consumers are adequately informed about the costs and benefits of food products, the next concern is the manner in which this information is utilised and decisions are made regarding the purchase and consumption of such products. In turn, this will relate to the manner in which consumers perceive the potential health effects of the foods they choose to consume, or not to consume.

Consumer demand for a particular food product will be directly related to perceptions of the associated risk to health, for example due to food poisoning or cancer. Thus, everything else being equal, we might expect the demand for a particular food product to decline as the perceived risk increases. Research suggests, however, that consumers routinely under-estimate the risk of death due to relatively high probability events such as cancer and heart disease, whilst over-estimating the risks due to low probability events such as botulism (Figure 3). Thus, consumers will tend to over-demand, and in turn markets will tend to over-supply, foods that are relatively more risky, whilst under-supplying products that are relatively more safe.

More widely, the response by consumers to particular foods will also reflect their wider perceptions of the determinants of human health and the impact of their own actions. Consumers who perceive that they have some control over their health are more likely to consume foods that are perceived to be 'risky'. Conversely, consumers who perceive that their health is largely out of their own control are unlikely to consume foods that they perceive to be risky

Figure 3. Relationship between perceived and actual risk of death from selected causes:



Source: Lichtenstein et al. (1978).

Transaction costs:

For markets to operate effectively, the costs associated with transactions should be limited, and ideally zero. In the case of many food products there may be significant transaction costs, in particular associated with the search for information on alternative products and assessment of the associated risks to health. This is particularly the case with new products and/or products for which the risks are perceived to be difficult to predict and understand. Classic examples are new technologies such as irradiation and genetic modification that many consumers perceive to be 'unknown', and thus inherently 'risky'.

Market competition:

For markets to operate effectively, sufficient competition must exist between buyers and sellers, none of which should have enough power to extract market rents. Thus, in order to assess the competitiveness of markets for food products in the context of food safety, the characteristics of the supply-side and the conduct and performance of suppliers, both individually and collectively, must be explored. Further, given that markets in general operate imperfectly, a benchmark must be defined against which comparison can be made.

In most industrialised countries, large corporations typically dominate markets for food products. However, whilst individually these corporations have the potential to yield significant market power, whether they do so in practice is an empirical question. In many developing country contexts, however, food markets remain fragmented and are typified by numerous small suppliers with little or no market power, except perhaps at the very local level.

5. Food safety regulations:

A wide range of safety control systems is in place for the typical food product being offered for sale to consumers (Henson, 1997; Caswell, 1997; Caswell and Johnson, 1991). Direct *ex ante* regulation in the form of standards, inspection, product testing, and other programmes attempts to ensure the safety of the product by specifying how it is produced and/or its final quality. Suppliers that are found not to meet the standard are penalised, for example through a system of fines. Further, product liability is *ex post* regulation that punishes suppliers of unsafe products through damage awards to those harmed by their actions.

Direct regulation and product liability may complement or substitute for each other (or even conflict) in establishing incentives for companies to engage in effective food safety controls.

Figure 4 details the standards that can be applied by governments in order to control the behavior of buyers and/or sellers in order to achieve a certain level of food safety. These regulatory approaches differ in the extent to which they impede freedom of activity (Ogus, 1994). Information-based measures require suppliers to disclose certain facts about their products, but do not otherwise impose behavioral controls. Examples include health warnings, ingredients labels, and instructions on appropriate product use. At the other extreme, individuals or firms may be prevented from lawfully supplying a product without first obtaining prior approval. To obtain such approval, it must be demonstrated that the products meet certain safety criteria. This approach is most widely used in the regulation of pharmaceutical products and novel foods, for example the products of genetic-modification.

Figure 4. Forms of food safety regulation:

Low → High: Degree of Intervention				
Information Provision	**Standards**			**Prior Approval**
	Target	**Performance**	**Specification**	

Source: Ogus (1994)

The standards approach allows the activity to take place without any *ex ante* control, but suppliers who fail to meet the specified safety standards commit an offence. Standards can be sub-divided into three categories that themselves differ in the amount to which they impede freedom of activity. A target standard prescribes no specific standard for the supplier's product or processes, but imposes criminal liability for certain harmful consequences arising from the product. Performance standards require certain conditions of safety to be satisfied, although the supplier is free to choose how to meet these requirements. Finally, specification standards either require the use of certain production techniques or inputs in a product, or conversely prohibit the use of certain production techniques or inputs in a product.

The government can also use direct economic incentives and disincentives in an attempt to influence the behaviour of buyers and/or sellers, in the form of taxes and subsidies. Thus, for example, tobacco is taxed at a high rate in many developed countries. In food markets, however, subsidies are less common, although preferential or zero rates of sales tax may be applied.

A further important element of public food safety controls that is frequently overlooked is liability laws. Under these laws, parties who are harmed by a supplier's product may sue for damages. Under strict liability, the manufacturer is liable for injuries caused by defective products even when quality controls were adequate and the manufacturer was not at fault (Cooter and Ulen 1988). Here the supplier cannot argue, as it could if a negligence standard were applied, that it took reasonable care in producing the product and should therefore not be held liable for any damages that occurred. Compliance with government regulations generally does not provide any protection from this type of liability nor would compliance with private certification standards. It should be noted, however, that the standard applied is determined on a case-by-case basis. Further, many consumer product liability cases are settled between the parties before they reach the courts. For example, Buzby and Roberts (1997) found only 49 jury awards for food-borne illness cases over the years 1983-1995. Elements such as whether reasonable care was taken (for example compliance with regulations, certification) plays a role in settlement negotiations.

Alternatively, a negligence standard may be applied in cases arising from food safety breakdowns. For example, companies along the supply chain may sue each other for damages resulting from loss of business and reputation, whilst shareholders may sue errant companies for breach of duties or issuing misinformation. Here evidence of how the companies' actions compare to a reasonable standard of care is relevant. Where regulatory standards establish a baseline, violation of the standard is usually considered to be negligence *per se*, whilst compliance with the standard the is only evidence to be considered in defining a reasonable standard of care (Rose-Ackerman, 1991). Thus 'reasonable' standard of care may be defined, at least in part, by reference to regulatory and certification standards.

Alongside government regulation operates private systems of food safety control, for example self-regulation and various forms of certification by other parties. Self-regulation includes internal control systems that assure product safety, where the company sets, monitors, and self-certifies the control parameters. It can take place at the level of the individual firm or be instituted by trade organisations which cover the predominance of market supply. Certification involves the setting of product quality standards and their monitoring and certification by parties outside the firm, for example customers, industry trade associations, or national or international standards-setting bodies such as the International Organisation for Standardisation (ISO). Certification may be voluntarily sought by the company or required by those with whom it does business. Indeed, increasingly certification to private standards is becoming *de facto* mandatory as a predominant proportion of market buyers require them. Both self-regulation and certification can act in both an offensive and a defensive manner. In the first case, for example, as a mechanism to increase market share by delivering higher or more dependable quality, and in the second, for example, by protecting current market share from erosion. In both cases this is an incentive for the adoption of private controls by individual operators in the food supply chain.

6. Nature of food safety capacity:

National food safety controls and, more generally, food safety capacity, can be examined from a variety of perspectives. The framework adopted here is that developed by the Inter-American Institute for Co-operation in Agriculture (IICA) (IICA, 1999a) and which is summarised and further developed in Figure 4. This framework defines three basic objectives of a food safety control system:

- **Protection** of the human population from hazards in agricultural and food products that pose of threat to human health.

- **Improvement** of hygienic handling of agricultural products for human consumption.

- **Regulation of inputs** used in agricultural production, including animal feed, agro-chemicals and biological materials.

In pursuit of these objectives, a national food safety control system must possess the capacity to undertake a series of functions as detailed in Figure 5. These include (IICA, 1999a; Reid, 2000):

- **Epidemiological surveillance:** Capacity to detect the presence (or demonstrate the absence) of biological, chemical or physical hazards that may pose a risk to human health. It includes systems of reporting where problems are encountered and active surveillance efforts aimed at detecting and/or monitoring a specific agent.

- **Management of epidemiological information:** Having established a system of epidemiological surveillance and more generally for the capture of epidemiological information, procedures are required to utilise this information in decision-making with respect to food safety controls in domestic production, whether for domestic consumption or export, and imports.

- **Monitoring of emerging issues:** Systems to ensure access and appropriate management of information on new and emerging hazards to food safety.

- **Quarantine procedures:** Capabilities to undertake emergency actions for the protection of food safety in the case of emerging hazards and/or outbreaks.

- **Risk assessment studies:** Studies, based upon rigorous risk assessment methods, to assess the level of risk to food safety associated with new, emerging or established hazards.

- **Verification and certification:** Technical and organizational capabilities to verify the status of food and agricultural products that are imported and exported with respect to established risks to food safety.

Figure 5. Elements of a national food safety control system:

Focus	Objectives	Functions	Capacity
• Domestic Consumption • Imports • Exports	• Protection	• Epidemiological surveillance • Management of epidemiological information • Monitoring of emerging issues • Quarantine procedures • Risk assessment studies • Verification and certification • Diagnosis and analysis	• Institutional structures and procedures • Physical infrastructure • Human capital • Sustainability
	• Improvement	• Identification and traceability • Hygienic practices	
	• Regulation of inputs	• Regulation and control of feed, agro-chemicals etc.	

- **Diagnosis and analysis:** Capacity to analyze food safety hazards in agricultural inputs and agricultural and food products.

- **Identification and traceability:** The ability to establish and maintain the identity of agricultural products through the supply chain, in order to permit traceability in the event of a food safety emergency.

- **Hygienic practices:** The establishment and maintenance of systems for hygienic practices in the handling, transformation and packaging of agricultural and food products throughout the supply chain. A key element of such systems is Hazard Analysis Critical Control Point (HACCP).

- **Registration and control of feed, agrochemicals and other inputs:** Systems for the registration and control of the production, distribution and use of agricultural inputs that pose a risk to food safety.

Superimposed on these functions at the national level, there is a need for governments to interact at the international level, in particular with international standard-setting bodies relevant to food safety issues, most notably the Codex Alimentarius Commission, and the World Trade Organization (WTO). Further, the SPS Agreement imposes certain obligations on WTO Members with respect to the food safety measures they apply (see below).

Perhaps of greatest interest there are the basic capacity issues that underlie the establishment of an effective and efficient system of food safety controls. By identifying these capacity issues, the constraints faced by developing countries and the associated technical assistance needs can be identified more easily. Key elements of capacity are as follows (Henson *et al.*, 2000a):

- **Institutional structures and procedures:** Fundamental to the establishment and operation of a system of food safety controls are well-defined and effective institutional structures and procedures. These include regulations and rules that

reflect current scientific understanding and international commitments, a system of enforcement with sanctions for non-compliance, clearly delineated administrative responsibilities between the separate departments and agencies of government, and effective communication and co-ordination of efforts between these departments and agencies. In turn, there is a need for the processes by which regulations and rules are developed, implemented and enforced to be transparent and open to scrutiny by interested parties, as well as the international community. Indeed, increasingly these institutional structures and procedures are required to operate at both the national and international levels.

- **Physical infrastructure:** Probably the main issue that comes to mind when considering the capacity needs of developing countries with respect to food safety and agricultural health controls is basic infrastructure. This includes laboratory facilities for testing, surveillance and research activities, production and processing establishments in which hygienic controls can be implemented effectively, co-ordinated and well-functioning supply chains, computer facilities and access to the Internet.

- **Human capital:** The effective implementation and operation of a system of food safety and agricultural health controls is also dependent on the development and maintenance of the necessary human capital. This includes scientific and technical expertise and experience in methods of surveillance, testing and control, risk assessment and other elements of risk analysis, and methods of hygienic control (for example HACCP), research capabilities, and the legal and other administrative knowledge in order to implement and enforce regulations and other rules. In turn, this requires appropriate teaching, training and research capacity.

- **Sustainability:** Having established an effective system of food safety controls a crucial element is their sustainability in terms of effectiveness, scientific and technical relevance, and access to financial, physical and human resources. In turn, this requires that sufficient political and economic priority be given to the maintenance of such controls, both from the perspective of trade promotion, and also the welfare

of domestic producers and consumers. Further, there may be a need for systems of cost recovery, for example user fees, where appropriate. This is a particularly salient issue for developing countries; there are numerous cases of food safety controls being implemented through externally funded technical assistance, which have become redundant in the medium to long-term because of lack of access to domestic resources.

Whilst this framework has a different structure and emphasis, it is broadly in accordance with the 'Guidelines for Strengthening National Food Control Systems' recently published by FAO and WHO (2003).

The foregoing discussion emphasises the need for food safety controls to be considered as dynamic rather than static entities. Further, controls should be assessed regularly and updated in the light of developments in science and technology. The international standards developed by Codex Alimentarius are an important source of reference and information in this respect. Further, the controls adopted at the national level are increasingly subject to scrutiny by the international community under the provisions of the SPS Agreement (see below).

Whilst basic scientific and technical infrastructure are clearly vital elements of food safety capacity, the framework described above also emphasises a number of wider strategic issues, including administrative structures, management, financing and human capital. Indeed, the experiences of many countries, including a number of industrialised countries, suggest that failures in strategic management, in both a static and dynamic sense, can seriously compromise the effectiveness of food safety controls. For example, these issues are prominent among the common deficiencies in national food safety control systems identified by FAO (2000):

- Failure to develop and implement any type of national strategy for establishing a food control system.

- Lack of a system of management to develop and implement effective and efficiently managed food control programmes.

- Need to up-date food laws and regulations.

- Food control officials that are poorly equipped to perform their respective functions.

- Food control personnel that are generally inadequately trained and often lack the technical information needed to perform their functions.

- Lack of co-ordination between government organizations and agencies with food control responsibilities.

Indeed, FAO (2001) cautions against overly fragmented systems of food safety control, emphasising the need for controls to be both unified and integrated. This contrasts with most traditional food control systems, for example, with several administrative structures being responsible for control activities. Recognising this, a number of countries have implemented administrative reforms with the creation, in the most extreme cases, of a single body responsible for SPS controls. A case example is the Canadian Food Inspection Agency (CFIA), which has been used as a 'model' for administrative reform in some other countries, for example Belize.

Alongside the development of food safety capacity, the importance of standardization capacity and activities more generally must be recognized (see for example Stephenson, 1997). Standardization is an integral component of the process of industrialisation across all sectors, and in particularly manufactured products. Key components include the administrative structures, scientific and technical infrastructure and human capital required to undertake the elaboration of standards at the national level and participation in international standard-setting (for example ISO), and conformity assessment procedures.

Traditionally, many of these functions have been considered the role and responsibility of government. Whilst there are many differences in the manner in which governments

administer such responsibilities, for example the types and range of agencies involved, the public sector has typically played a predominant role. Increasingly, however, it is recognised that many agents have a role to play in the successful implementation and operation of a national food safety control system. These include agricultural producers, food industry, importers and exporters, industry organizations, professional and their associations, academic and other teaching and research institutions etc. Further, the actions of these various agencies need to be co-ordinated in such a way that repetition of and conflicts between efforts and responsibilities are avoided. Thus, food safety controls should be seen truly as a national and multi-sectorial system rather than the preserve of government.

Thus, food safety controls are increasingly focusing on the food chain as a whole. Indeed, FAO has recently published its own position paper on the food chain approach to food safety (FAO, 2003). FAO sees this approach as recognising that the responsibility for the supply of safe food is shared along the entire supply chain by all involved with the production, processing, trade and consumption of food (Figure 6). This holistic approach to food safety differs from previous 'models' in which responsibility for food safety tended to concentrate on the food processing sector. Its implementation requires both an enabling policy and regulatory environment at national and international level and the establishment of food control systems and programs at national and local levels throughout the supply chain.

The food systems approach to food safety currently being promoted by FAO corresponds closely with the perspective of WHO which emphasises that food safety is a collective responsibility at both the national and international levels (Figure 7). It also fits with the ecosystem approach to health (Figure 1) that is currently being promoted by certain development and donor agencies, for example the International Development Research Centre (IDRC) in Canada.

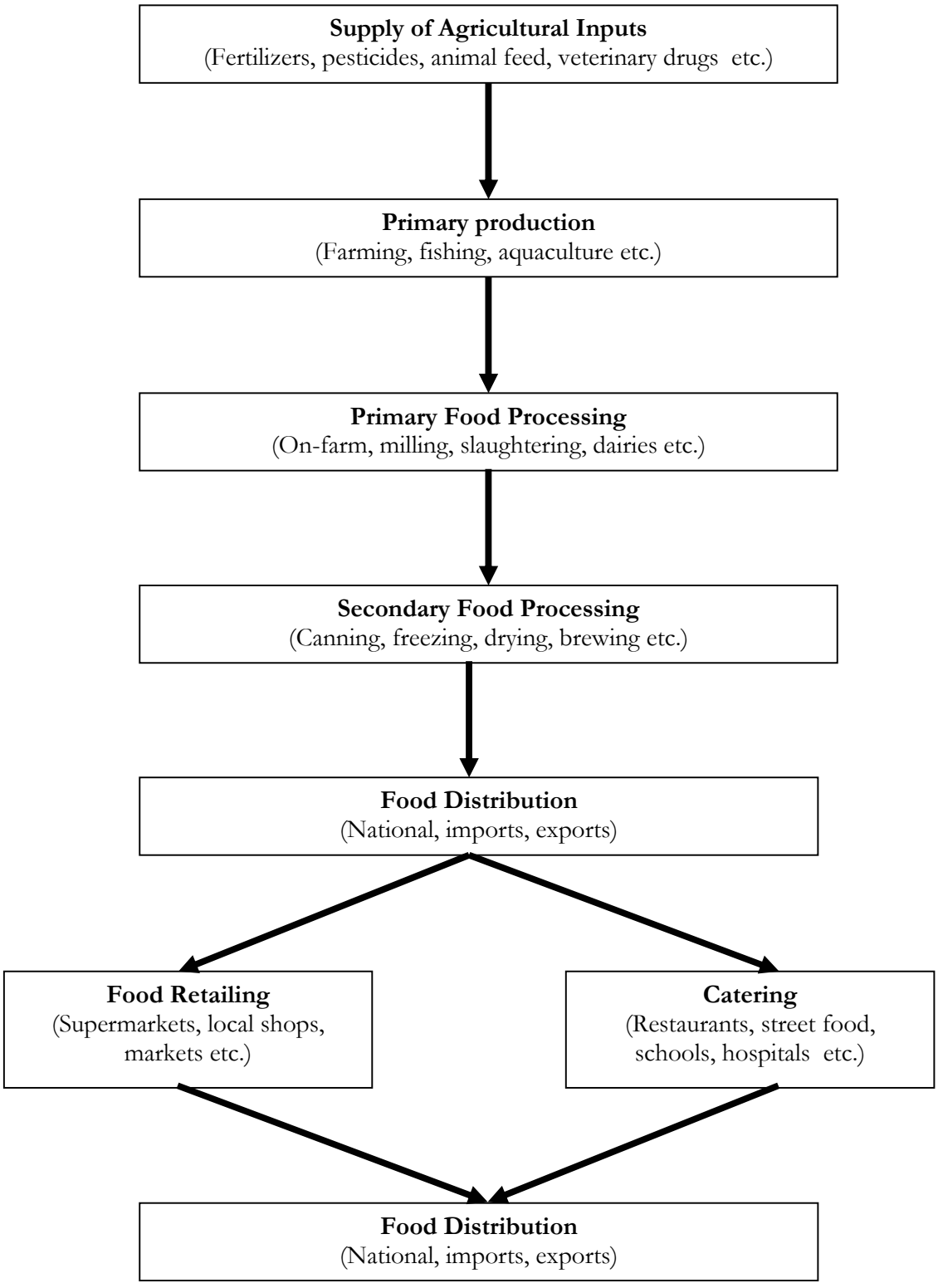
All of these approaches and perspectives serve to highlight the multiple levels at which food safety controls can (and must) operate from farm production through to retail distribution (Figure 8). In certain cases, the safety of food at the point of final consumption is highly dependent on farm production practices because post-harvest practices can do little to

mitigate the hazard. Pesticide residues are a good example. In others, for example microbiological contamination, post-harvest practices can serve to mitigate the hazard. However, even in such instances farm production practices can play an important and integral part in the control of the hazard. Further, the food handling practices of consumers, whilst missing from Figure 8, must be recognised as integral to systems of food safety control. Food preparation practices in many developing countries have evolved as a means to control prevailing hazards in food, in particular microbiological pathogens. The changes brought about by processes of economic development can mean that such practices are abandoned and/or become redundant as effective mechanisms for the control of food-borne risks. An example of this more system-based approach is provided by Indonesia (see Box 5 below), which has made efforts to implement 'good practices' in agricultural production as part of efforts to enhance food safety.

Reflecting this, there is an increasing literature on the nature of food safety controls implemented by agricultural producers and food processors within developing countries in both the formal and informal sectors (also see below). For example, Tabai and Salay (2003) explore the attitudes of food manufacturers to the adoption of quality assurance programs in Sao Paulo. Conversely, Toh and Birchenough (2000) investigate attitudes amongst informal hawkers in Malaysia. Within the informal sector, much of this literature has focused on street food (see for example Johnson and Yawson, 2000), indeed FAO (1998) has published guidelines on the safety of street food in developing countries. An interesting and welcome trend in this literature is attempts to explore the incentives/disincentives for food processors and handlers, predominantly in the informal sector, to adopt food safety practices. Perhaps the best example is work at the International Livestock Research Institute (ILRI) on milk hawkers in Africa (Omore *et al*., 2000; 2001; Mwangi *et al*., 2000).

Increasingly, system-based approaches to food safety control have been implemented, most notably Hazard Analysis Critical Control Point (HACCP). In some countries this approach has been mandated for certain product sectors, for example the United States, European Union, Canada and Australia. Further, an increasing number of food processors have adopted HACCP on a voluntary basis or under the impetus of industry codes of practice.

Figure 6. Food chain and food safety:



HACCP specifies procedures to prevent food-borne hazards through control of the production process rather than reliance on end-product testing that is both costly and unreliable for certain hazards. The development and operation of HACCP is based on seven guiding principles (Unnevehr and Jensen, 1996):

- Assess the hazards, list the steps in the process where significant hazards can occur and describe the preventive measures.

- Determine the critical control points (CCPs) in the process at which the loss of control could result in an unacceptable level of food safety risk.

- Define critical limits for each CCP.

- Define procedures to monitor each CCP relative to the defined critical limit.

- Establish corrective actions to be taken when a deviation of the CCP from the critical limit is identified.

- Establish record-keeping covering all elements of the HACCP system

- Establish procedures through which the effective operation of the HACCP system can be verified.

International bodies such as Codex Alimentarius have established guidelines for the implementation of HACCP. This recognises that HACCP is fast becoming the established standard for food products in international trade. For example, both the United States and European Union (for example) require that fish and fishery products are processed in facilities that have implemented HACCP, whether domestic or in exporting countries. Further, developing country governments are increasingly recognising the role of HACCP and mandating adoption, particularly in export-oriented sectors (see Box 1).

Figure 7. WHO vision of shared responsibility for food safety:

Food Safety		
Food legislation and Enforcement	Educated and Knowledgeable Public	Good Practices by Primary Producers/ Distributors
Advice for Industry/Trade	Discriminating and Selective Consumers	Quality Assurance and Control of Processed Food
Consumer Education	Safe Food Practices in the Home	Appropriate Processes and Technology
Information Gathering and Research	Community Participation	Trained Managers and Food Handlers
Provision of Health-Related Services	Active Consumer Group	Informative Labelling and Consumer Education
Government	**Consumers**	**Industry/Trade**
National Commitment to Food Safety		

Source: WHO (1996).

Alongside processes of economic development, the structure and *modus operandi* of markets for food products change (Figure 9). In turn, there are shifts in the need for specific food safety interventions and their appropriateness (Unnevehr and Hirschhorn, 2000). These changes cause a shift in both the responsibility for, and ability to, undertake food safety controls from consumers to producers and processors. At low levels of economic development, consumers mitigate the potential risks associated with food through their food choices and/or preparation methods. However, as formal food markets evolve, food processors and producers play an increasing role. Further, as their incomes increase, consumers begin to demand enhanced food safety controls through their market transactions and political processes.

Figure 8. Food safety activities in food production:

Farm Production	Transport of Animals and Agricultural Products	Slaughtering Packing Houses and First Distribution	Transport of Products	Industrial Processes	Retailing Food Service
Hygiene of facilities	Cleaning	Hygiene of establishments	Cleaning vehicles	Hygiene of establishments	Hygiene of establishments
Hygiene of personnel	Disinfection	Hygiene of personnel	Cooling	Hygiene of personnel	Hygiene of personnel
Use of water		Ante- and post-mortem inspection and hygiene handling	Hygiene of personnel	Hygienic handling of products	Hygienic handling of products
Sewage contamination		Hygienic handling of products		Microbiological monitoring	Labelling
Control of use of pesticides		Monitoring of agro-chemical residues		Labelling	
Control of use of veterinary drugs		Monitoring of residues of veterinary drugs			
		Microbiological monitoring			
		Labelling			

Source: Walker (1999); Unnevehr and Hirschhorn (2001).

Figure 10 summarises the priority forms of food safety control at different levels of economic development. Across these specific measures a number of common trends are apparent as economies develop:

- There is a shift in emphasis from basic investments and simple interventions to more complex and comprehensive regulatory systems.

- Priorities for action change. For example, in low-income countries basic water and sanitation infrastructure is a priority. As food supply systems change and capacity is enhanced, it is possible to undertake targeted interventions to address specific hazards. In high-income countries, comprehensive more comprehensive systems of regulation can be implemented.

- There is a shift from reliance on international standards and/or implementation of standards developed in high-income countries to the promulgation of national standards that take account of local circumstances, consumer demand, socio-cultural; factors etc.

- The provision of information shifts from targeted interventions to general campaigns and product labelling.

- Regulatory systems develop in both scope and depth as enforcement capacity evolves and there is a shift in the importance of the informal and formal sectors.

This highlights the need for efforts to enhance food safety controls in developing countries in order to implement measures that are appropriate given prevailing levels of development and local circumstances and capacity. It also emphasises the role of international institutions, in particular international standard-setting organisations as modes of knowledge and technology transfer to developing countries.

In developing countries, food safety is closely linked with basic sanitation, water supply, housing conditions, access to adequate nutrition, environmental conditions etc. For example, food may become contaminated because of the way in which it has been produced and/or processed, through contact with non-potable water or the environment, contact with animals or humans, or a combination of these. Thus, the enhancement of food safety is only one of numerous interventions required in order to promote public health, recognising the need to adopt a more holistic framework as suggested by the ecosystem approach to health discussed

above. Further, efforts aimed at enhancing food safety, for example through food handler training, may be ineffective if these other risk factors are not addressed simultaneously.

Figure 9. Changes in food markets with processes of economic development:

	Low Income	High Income
Role of food markets	Own production a major source of food supply. Markets may be a relatively minor source of food, particularly in rural areas.	Own production an insignificant source of food supply. Virtually all food obtained through market
Food Processing Sector	Informal sector consisting of small-scale operations that are not legally-registered predominates	Formal sector consisting of legally-registered enterprises predominates
Branding	Non-branded food products predominate	Branded food products predominate
Food preparation	Most food preparation undertaken within the households	Significant proportion of food preparation undertaken outside the household by food processors and/or the food service sector
Food Retailing	Small informal retailers predominate	Large retail chains predominate
New food products	Low rates of entry of new food products	High rates of entry of new food products
Geographical distribution	Local food distribution networks predominate	Wide food distribution networks encompassing both national and international sources of supply
Consumer demand	Income and prices are main factors influencing consumer demand	Perceived food safety and quality have major influence on consumer demand

Bolanos *et al.* (2000) provide an assessment of the food safety and agricultural health control systems of 33 countries in the Americas relative to the requirements to comply with and implement the SPS Agreement. Three elements of key elements of SPS capacity are identified and assessed:

- **Institutional:** Mechanisms through which national food safety and agricultural health interests are represented and defended, agreements implemented, and commitments acquired at the international level fulfilled.

Figure 10. Public food safety controls by level of economic development:

<table>
<tr><th rowspan="2">Activity</th><th colspan="3">Evolution with level of Economic Development</th></tr>
<tr><th>Low Income</th><th>Middle Income</th><th>High Income</th></tr>
<tr><td rowspan="3">Decision-Making Capacity</td><td colspan="3">Stakeholder involvement in policy-making
Disease or hazard surveillance
Participation in international standard-setting organisations</td></tr>
<tr><td colspan="2">Qualitative risk assessment to inform risk management</td><td>Quantitative risk assessment
Cost-benefit analysis</td></tr>
<tr><td colspan="2">Adopt international standards or standards of major import markets</td><td>Set standards according to local risk conditions or preferences</td></tr>
<tr><td>Provision of Information</td><td>Targeted interventions for reduction of childhood illness and malnutrition</td><td>Consumer and industry education for improved food handling and preparation</td><td>Labelling and certification to inform consumers about production methods, product safety and potential hazards</td></tr>
<tr><td>Prevention and Control</td><td>Hygiene training at key points in food supply chain</td><td>Control of external or single-source hazards
Phased implementation of standards
Monitoring of key hazards in food supply chain</td><td>Control programs for single-source hazards
Phased implementation of regulations for formal food sector
Provide generic HACCP models for small processors and vendors</td></tr>
<tr><td>Infrastructure and Research</td><td>Water supply
Sanitation
Marketing facilities
Applied research to reduce hazards</td><td>Basic and applied research on many hazards</td><td>Sanitation and water supply
Marketing infrastructure
Research to develop hazard controls</td></tr>
</table>

Source: Unnevehr and Hirshhorn (2000).

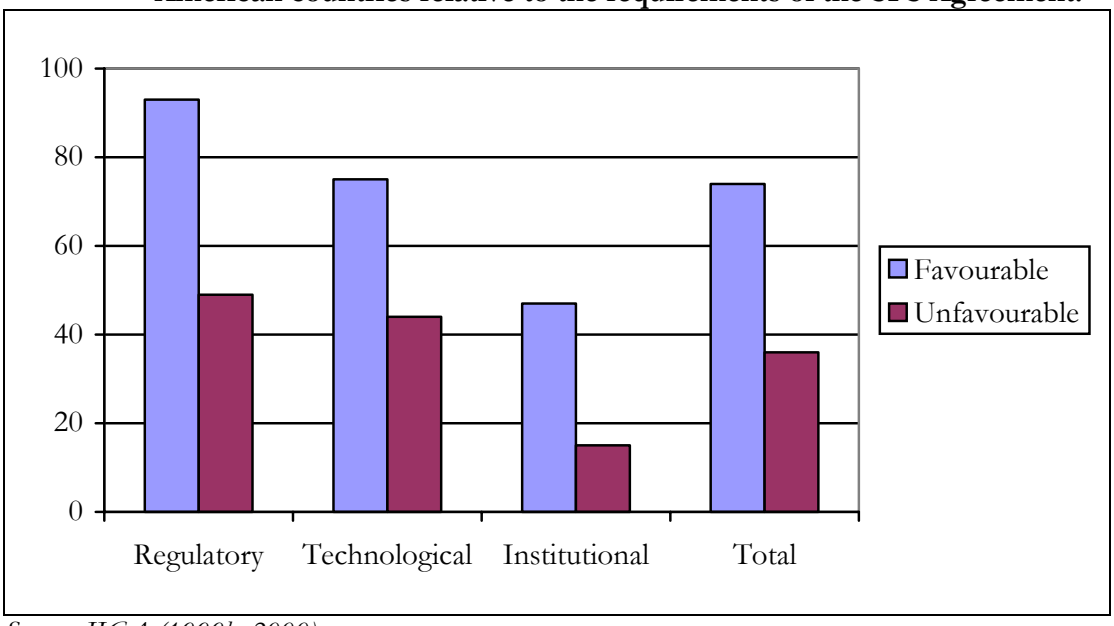
- **Technological:** Systems of food safety and agricultural health controls through which problems are identified, controls undertaken and performance monitored.

- **Regulatory:** Systems of legislation relating to food safety and agricultural health issues and the mechanisms through which these are brought into compliance with international commitments.

A distinction is made between seven countries that are judged to have food safety and agricultural health control systems that are generally favourable in terms of their ability to meet the requirements of the SPS Agreement, and 26 countries with SPS systems that are judged to be unfavourable (Figure 11). In both countries judged to be favourable and unfavourable, the institutional framework is the weakest element of the food safety and agricultural health control system.

Amongst the surveyed countries, perhaps not surprisingly, the United States and Canada followed by the major upper middle-income economies of Latin America were judged to have the greatest capacity. The low and lower middle-income countries, and in particular the island economies of the Caribbean, had much lower levels of capacity, particularly relating to technological and institutional elements. Across all countries, institutional capacity was weakest, again reinforcing the importance of wider strategic issues highlighted above.

Figure 11. Development of food safety and agricultural health control systems in American countries relative to the requirements of the SPS Agreement:



Source: IICA (1999b; 2000).

A major issue in the promulgation of food safety standards at both the national and international levels is the application of risk analysis techniques. Risk analysis is a structured approach through which the risks associated with a particular food-borne hazard are

identified and appraised (risk assessment), decisions made regarding appropriate food safety standards for the control of this risk within 'acceptable' levels (risk management), and the communication of the manner in which this process has been undertaken and the nature of the risk itself (risk communication). The Codex Alimentarius Commission has developed Working Principles for Risk Analysis for use in the promulgation of international standards. In the future it plans to elaborate guidelines for governments on the application of risk analysis to the development of national food safety standards

The adoption of risk standards or priorities from industrialised countries within a developing country context may be inappropriate in terms of both public health and economic efficiency where hazards and risks differ (Unnevehr and Hirschhorn, 2000). For example, developing countries have a greater incidence of diarrhoea disease and virulent pathogens such as Cholera linked to contaminated food and water. These are likely to be of greater priority than the chronic effects of other contaminants, for example chemical residues. However, over time and as countries develop economically, these priorities will change. Further, at any point in time the concerns of low-income and middle and high-income populations will differ. The challenge for policy-makers is to make appropriate trade-offs in view of prevailing hazards and risks and the level of protection that is demanded.

A good example is the trade-off between the risk of Cholera through contaminated water and the potential chronic carcinogenic effects of water chlorination (Unnevehr and Hirschhorn, 2000). In the early 1990s, the Peruvian Government decided not to implement chlorination of drinking water because of the associated risk of cancer. Subsequently, a major outbreak of Cholera occurred that would have been prevented by chlorination (Anderson, 1991). The costs in terms of human health and loss of economic productivity were considerable.

Whilst great emphasis is typically placed on the role of the public sector in national food safety control systems, the role of the private sector is frequently neglected. The development of private sector capacity is of fundamental importance to the implementation of effective food safety controls, both in national markets and for exports. Indeed, the

framework discussed above emphasises the role of a wide range of stakeholders in the development and operation of a food safety control system.

The SPS Agreement requires that, where WTO members apply standards that are not based on international standards, guidelines and recommendations, a risk analysis be undertaken (see below). However, many developing countries lack the necessary capacity, both in terms of skills and experience and the facilities and institutions to collect scientific data. Indeed, in many cases the technical assistance requirements in order to develop the necessary capacity are considerable. Further, the application of risk analysis has implications for the nature of food safety standards, for example with less emphasis on detailed product standards in favour of performance-based measures. This implies significant change in the standards faced by exporters of agricultural and food products.

A rather contentious issue in the establishment of food safety standards is the nature of risk analysis or other decision-making processes under conditions of scientific uncertainty. Whilst precaution is an established and generally accepted element of risk assessment (for example as is seen with the application safety factors in the setting of MRLs for pesticides in food), there is a lack of agreement on the role of precaution in risk management. Some countries suggest that the 'precautionary principle', a concept developed in the sphere of environmental protection, can be legitimately applied in the context of food standards. This implies that, although current scientific knowledge may be insufficient to assess fully the level of risk associated with a product or process, controls can be applied in order to ensure food safety where there is some evidence that a risk exists. The European Commission, in particular, has communicated its support for the 'precautionary principle' as applied to food safety issues.

Developing countries, as well as many other major food exporting nations, have expressed concerns that the 'precautionary principle' can be employed as a form of disguised trade protectionism. Indeed, the role of precaution in general, as well as the 'precautionary principle' in particular, has been a cause of contention within the Codex Alimentarius Commission. Whilst a position has been agreed on the appropriate action to be taken by Codex in situations of uncertainty, no guidance has been elaborated for national

governments in the development of their own food safety measures. Whilst the SPS Agreement does permit Members to take apply measures on a temporary basis under conditions of uncertainty, there is a lack of consensus on whether this sanctions the application of the 'precautionary principle' *per se*.

The role of the private sector is most easily defined by recognising that, in many cases, it is through the specific actions of individual producers, processors and the like that compliance with food safety measures is achieved. A case example is the application of HACCP and other elements of hygienic practices in the production, processing and handling of agricultural and food products. Further, capacity building in the private sector can complement, and indeed may substitute for the development of public sector capacity. An example is investment in laboratory testing facilities. In a number of developing countries, the private sector has established its own laboratories, either within individual enterprises or an industry organisation, because there is insufficient public capacity to meet food safety requirements in export markets.

In general, there is a need for closer co-operation between government and interested groups within developing countries, including agricultural producers, food manufacturers, exporters, consumers and other elements of civil society. However, in many countries food safety matters are considered the sole responsibility of government and there is little or no involvement of other parties. As a consequence, government officials are often poorly informed about the problems that exporters face and inadequately equipped to represent their interests in international forums.

However, in some countries the government has recognised the need to work with the private sector and support the development of capacity at the enterprise level. For example, in Malaysia the Ministry of Health has acknowledged the need for hygiene standards to be enhanced in the food-processing sector. The Ministry of Health operates a voluntary HACCP certification programme. This programme was introduced in 1996-97 in response to EU requirements for HACCP in fish processing plants. As of September 2001, 42 food-processing plants were certified under the programme (Table 12). However, there are remaining concerns regarding the general level of awareness, understanding and motivation

to implement HACCP, particular amongst small and medium-sized enterprises (SMEs). In response, new food hygiene regulations are being promulgated that will require the adoption of a quality assurance system based on Codex. In the early stages the key priority will be the implementation of such systems in export-oriented sectors.

Table 12. Number of HACCP certified enterprises in Malaysia by sector, September 2001:

Sector	Number of Enterprises
Cereal, cereal products, starch and bread	2
Edible fats and oils	1
Fish and fishery products	33
Cocoa and cocoa products	1
Meat and meat products	1
Food ingredients	2
Fruit and fruit products	1
Vinegar, sauce, chutney and pickle	1
TOTAL	**42**

Source: Ministry of Health, Malaysia.

The adoption of control systems and other elements of hygienic practice by private enterprises is an important element of capacity building in developing countries. Indeed, the export competitiveness of agricultural and food enterprises can be enhanced by the adoption of such practices. Zaibet (2000) demonstrates that adoption of HACCP, as well as general standards of sanitation, is positively related to export performance in the case of fish and fishery products in Oman. Further, a survey of South Africa agribusiness firms in 1998 indicates that 36 percent have implemented ISO 9000 (Turner *et al.*, 2000). Major factors motivating adoption include improving customer service, provides a basis for more general quality improvement and the need to improve operational efficiency (reduce wastage). Most non-certified firms had adopted some alternative quality assurance system.

Box 1. Food safety capacity in the Brazilian food processing sector:

The need for government to work with the private sector and to take appropriate actions to facilitate compliance with SPS measures, both domestically and for exports, is illustrated by experiences in Brazil. The Ministry of Health mandated the adoption of HACCP by all food processing establishments under its jurisdiction in 1993. However, to date very few establishments have actually implemented HACCP. Indeed, the Ministry of Health appears to have made little or no effort to enforce the legislation. It is suggested that the Ministry of Health considered that, once the Decree was in effect, the food sector would automatically comply (Salay and Caswell, 1998). In contrast, the Ministry of Agriculture and Supply initiated a program to implement HACCP in 1997 for fish, meat and milk. Implementation by companies involved in exports was given priority. In the case of fish exporters, for example, 53 companies had adopted HACCP by 1998.

The Brazilian Government has also encouraged the adoption of certification and other mechanisms for the enhancement of quality, for example through the Brazilian Program for Quality and Productivity (PBQP). In particular, this policy encourages the adoption of ISO 9000 and ISO 14000 and the implementation of quality control programs in companies (Salay and Caswell, 1998). As of March 1997, a total of 1,854 companies in Brazil were certified to ISO 9000, although only 46 of these were in the food, drink and tobacco sector.

Where there are severe limitations in public sector capacity in developing countries there may be a potentially valuable role for third party certification. Systems of third party certification have become established in many industrialised countries as a means to confirm compliance with voluntary standards (see Box 1). In some cases public sector bodies provide certification services. In others, certification is through an accredited private sector body, which may itself be a commercial enterprise. International standards exist for auditing and certification services that ensure compatibility across national borders.

In certain circumstances, the structure and *modus operandi* of production systems and supply channels for agricultural and food products in developing countries is incompatible with effective food safety controls or requires that major investments are made to achieve compliance. For example, supply chains with large numbers of small-scale producers or intermediaries can be difficult to co-ordinate and control. Furthermore, traditional methods of production may conflict with food safety requirements in export markets where methods of production are very different. For example, EU hygiene requirements for fish and fishery

products prohibit fish from making contact with wood, although most traditional fishing vessels in developing countries are wooden in construction.

Measures to enhance food safety can contribute to improvements in public health but also raise the cost of food production and processing, and thus food prices. They can also threaten the viability of the informal sector and/or erect barriers to entry to infant formal food processing sectors. This highlights the need for countries to aim for a level of protection that is 'appropriate' to their level of development and that takes account of the wider socio-economic implications of enhanced food safety controls. The beef slaughtering sector in China provides a good example of this. Brown *et al* (2002) suggest that the implementation and enforcement of more stringent food safety standards could have negative economic and social effects and be contrary to wide rural development objectives. In particular, food safety regulations act to consolidate beef slaughtering in large public abattoirs rather than traditional household slaughtering. Currently there are thousands of household slaughters which have played a role in enhancing the diversity of economic activities in rural areas. The competitiveness of household slaughtering relies on low operating costs which reflect, at least in part, non-existent or limited ante- and post-mortem inspection. Any major changes to inspection regimes and/or requirements to up-grade facilities could change the entire cost structure of the sector in favour of large facilities.

In recent years, systems of food safety regulation have undergone significant change in industrialised countries. These changes have involved legislative reforms in order to consolidate legal provisions and administrative restructuring to streamline responsibilities within and across government departments and agencies. For example, as discussed above, the Canadian Food Inspection Agency (CFIA) has sole responsibility for the implementation of Federal food safety controls in Canada, bringing together the responsibilities formally held by the agriculture and health ministries. In many developing countries legislation is out-dated and administrative responsibilities are fragmented. However, many are also implementing reforms in a bid to enhance the efficacy of prevailing controls. For example, Boxes 2 and 3 describe the cases of Zimbabwe and Jamaica that have made efforts to rationalise administrative responsibilities for food safety controls alongside the more general development of food safety control capacity.

Box 2. Zimbabwe:

As a country that is heavily reliant on agricultural and food exports, Zimbabwe is very concerned about the efficacy of its food safety controls. It also has comparable concerns about the controls applied to imports; there have been numerous cases of sub-standard food products entering Zimbabwe because of what are perceived to be inadequate border controls. Thus, efforts are currently being made to enhance both administrative arrangements for food safety controls and basic infrastructural capacity.

In the case of food safety, for example, responsibility lies with several government departments within various ministries, as well as local authorities. Simultaneously, there are many legal instruments dealing with food safety with considerable overlap in some areas but no controls at all in others. Thus, it is not uncommon for an exporter of an agricultural or food product to require clearance from three government departments before the product can leave the country.

In certain cases, laboratory capacity is weak. For example, the laboratory of the Government Analyst does not have sufficient capacity to serve all of its responsibilities for food control, both with respect to products sold on the domestic market, whether domestically produced or imported, and to exports.

A technical co-operation project was initiated in June 1999 with funding from FAO. This project aimed to improve the food control system in Zimbabwe by addressing three main objectives (FAO/WHO, 2002):

1. Strengthening the administration of food safety controls.

2. Strengthening food import inspection.

3. Improving quality assurance and information systems for the laboratory of the Government Analyst.

At a stakeholder workshop in 2000, it was recommended that an autonomous independent body should take responsibility for food safety controls. Legislation was subsequently drafted for the establishment of a National Food Control Authority. The Authority will be responsible for defining national policy on food safety, determining priorities for food control programs, setting standards, providing support to implementing agencies, and ensuring the uniform application of food standards and regulations nationwide. It will also be the focal point for Zimbabwe's relations internationally, for example with Codex Alimentarius.

An initial assessment of the existing import food inspection system was undertaken. A number of problems were identified, including: 1) the organisational structure of the Port Health Authority was bureaucratic and hampered effective functioning; 2) the Authority did not have a separate budget and had been given insufficient priority such that resources (including infrastructure, human capital and equipment) were inadequate; 3) port health officers typically lacked the skills to undertake their duties effectively; and 4) there were no documented policies and procedures for the inspection of imported foods. Subsequently, training was provided for port health officers and an inspection manual was developed and put in place. An assessment of the project indicated a positive impact on the functioning of the import inspection system in Zimbabwe.

One of the key priorities for the laboratory of the Government Analyst was the implementation of an internationally-recognised quality management system. Thus, plans were put in place to obtain accreditation against the ISO/IEC 17025 standard – General Requirements for Competence of Testing and Calibration Laboratories. A project team was established and a development and implementation plan defined. The team received training from a consultant and subsequently developed a quality policy statement and manual. Subsequently, training was provided for all professional staff on the implementation of the policy. The aim is to seek accreditation for the most frequently performed tests. A potential problem, however, is the lack of a national accreditation body. Not only is the use of an accreditation body from overseas costly, but also Zimbabwe has an acute shortage of foreign currency.

More generally, the need for a national accreditation body has been recognised. At the request of the Food Standards Advisory Body, plans have been initiated for an accreditation body to be established through the Ministry of Industry and International Trade Priority is being given to testing and calibration laboratories and to inspection services.

Whilst resources continue to be a significant constraint on food safety controls, the strategy adopted in Zimbabwe has been to pool those resources that are available in order to focus on priority issues. The establishment of the National Food Control Authority is seen as fundamental to this, ensuring integration of all food control activities nationwide and throughout the food supply chain.

In some developing countries, most notably upper-middle income countries and/or countries with well-developed exports of processed/value-added food products, food safety capacity is well-developed. One example is Malaysia as described in Box 4. In such countries the basic elements of a national system of food safety control have generally been put in place and efforts typically focus on up-grading to achieve compliance with international standards and/or to develop capacity within the private sector. For example, there is typically an emphasis on the development and application of risk analysis techniques in the promulgation of new food safety controls and the assessment of risks associated with

emerging technologies and/or imported food products. This is typical, for example, in a number of countries in Latin America (for example Brazil, Argentina, Chile and Mexico) and South East Asia (for example Thailand, Malaysia, South Korea and Taiwan).

Box 3. The case of Jamaica:

Responsibility for food safety controls in Jamaica is highly fragmented, involving a number of government ministries and agencies and more than 20 different pieces of legislation and attendant regulations (Reid, 2000). The key institutions are as follows: 1) Ministry of Health (in particular Health Promotion and Public Health Division, National Public Health Laboratory and Pesticides Control Authority); 2) Ministry of Agriculture (in particular Plant Quarantine/Produce Inspection Unit and Veterinary Services Division); 3) Ministry of Industry, Commerce and Technology (in particular Food Storage and Prevention of Infestation Division); and 4) Jamaica Bureau of Standards (JBS). Further, the Ministry of Foreign Affairs and Foreign Trade is involved in relations with the SPS Agreement which acts as the National Notification Authority for new/revised food safety measures.

Overall responsibility for food safety in Jamaica lies with the Ministry of Health under the Public Health Act (1975) and Food and Drugs Act (1974). The Ministry of Health has three divisions: 1) Standards and Regulation Division; 2) Health promotion and protection Division; and 3) Planning and Integration Division.

The Health Promotion and Protection Division (HPPD) is responsible for establishing policy and guidance with respect to food safety and veterinary public health. For the purposes of enforcement, the Ministry of Health is decentralised into four Regional Authorities that provide health services, including food safety and veterinary public health inspection. The Environmental Health Unit of the HPPD, which works with regional inspectors to provide training and develop work plans and priorities, however, has only one food safety officer and one veterinary public health officer.

The Food Storage and Prevention of Infestation Division (FSPID) of the Ministry of Commerce and Technology is responsible for controlling the infestation of food entering commerce and has the power to condemn and destroy infested foods. Its activities include controls on rodents, residues (including mycotoxins and pesticide residues), microbiological contaminants and pests in domestic production, as well as imports and exports. Further, there are provisions for private pest control operators that are licensed in conjunction with the Pesticides Control Authority (Reid, 2000).

The FSPID operates five laboratories, covering entomology, microbiology, pesticide residues, mycotoxins and post-harvest technology, which are staffed by three personnel. Both of these laboratories participate in a results comparison programme with the National Institute of Science and Technology (NIST) in Jamaica, but not with other laboratories in the region. The residue chemistry laboratory is well equipped to undertake most of the required residue tests except heavy metals. However, the capacity of the current equipment is limited and a backlog can develop when there are sudden surges in the number of samples. Furthermore, the equipment is currently operating at 40-50 percent capacity due to shortages of solvents and other chemicals because of financial constraints. The mycotoxin laboratory is able to undertake semi-quantitative tests only. If mycotoxins are detected, samples have to be sent elsewhere for quantitative tests to be undertaken.

A major cost for FSPID is the maintenance of equipment. For example, the only engineer in the region that can maintain the equipment in the residue chemistry laboratory is based in Trinidad and Tobago and has to be flown in at great costs. Furthermore, the software library of this equipment needs to be updated every three years to incorporate new chemical residues. Likewise, pesticide standards have to be imported from overseas.

The JBS is responsible for inspecting and registering establishments that manufacture processed foods under the Processed Food Act 1959. It was established in 1968 as a statutory body reporting to the Ministry of Industry, Commerce and Technology. Some commodities, however, are regulated by more than one agency, each of which may apply different requirements. For example, the Ministry of Health has responsibility for sanitation and quality of milk produced at processing plants approved by the JBS.

The JBS is also responsible for the development of both mandatory and voluntary standards for agricultural and food products. In the case of food and food products, it establishes mandatory standards under the Processed Food Act 1973 and voluntary standards under the Standards Act 1973. Wherever possible, international standards are used as the basis of national standards.

To date, the JBS has established 65 standards specifically for food products, including canned and frozen fruit and vegetables, fruit and vegetable juices and nectars, meat products, sauces and dressings and other products. There are also standards governing the labelling of products in general, and food products and alcoholic beverages in particular. Jamaican standards are largely based on Codex or CARICOM standards, although sometimes with adjustment to meet local requirements. Jamaica has, however, experienced considerable problems getting its standards accepted internationally (Reid, 2000). In certain cases this may be due to Jamaica's tardiness in seeking international accreditation and/or in harmonising its national standards with those of Codex. However, in reality informal arrangements exist, whereby regulatory agencies in importing countries accept certification by, for example, the JBS.

The Veterinary Services Division (VSD) of the Ministry of Agriculture is responsible for issuing permits for imports and exports of meat and fish products. The control of slaughtering and processing facilities at the local level is the responsibility of the Ministry of Health and export processing/slaughtering facilities the responsibility of the VSD. The VSD operates a laboratory for the screening of meat and meat products for veterinary drug and pesticide residues.

The laboratory of the VSD is able to undertake analyses for most micro-organisms and some antibiotics and pesticide residues. These facilities were recently upgraded at a cost of JAM$10 million, although are in need of further investment. However, the lack of staff with appropriate skills and high rates of staff turnover are a major problem. For example, the laboratory recently purchased an High-Performance Liquid Chromatograph (HPLC) at a cost of US$80,000. However, this equipment is currently not operational because of lack of the required expertise. The VSD laboratory would like to achieve laboratory accreditation for bio-toxin and residue testing in order to perform analyses on a regional basis.

Control of pesticides in Jamaica is the responsibility of the Pesticides Control Authority (PCA), an autonomous agency of the Ministry of Health. The Authority is responsible for registering and approving pesticides, controls on imports and domestic production, and residue and quality analysis. Jamaica does not have national maximum residue levels (MRLs) for pesticides in foodstuffs, although use is made of Codex MRLs where required.

The formulation of policy on the control of genetically-modified organisms (GMOs) in Jamaica is the responsibility of the National Biosafety Committee. This Committee was formed by the National Committee on Science and Technology (NCST) within the Office of the Prime Minister to develop a coherent national policy, taking account of consumer interests and national economic interests.

The National Public Health Laboratory (NPHL) provides laboratory-testing facilities for the purposes of food safety controls in Jamaica. Facilities at the NPHL are relatively modern and capable of undertaking a wide range of the analyses required by major export nations. However, there is a need for upgrading of facilities and retraining of staff and for international accreditation of testing facilities (IICA, 2000). Furthermore, current capacity is considered inadequate to undertake high-volume quick-turnaround analyses (Reid, 2000).

It is acknowledged that food safety legislation needs to be updated in order to comply with international standards and to be consolidated to enhance the effectiveness of enforcement efforts (Reid, 2000; IICA, 2000). In certain areas efforts have been made to modernise legislation, usually to address to requirements of export markets. For example, the Aquaculture, Inland and Marine Products and By-Products (Inspection, Licensing and Export) Act 1999 implements hygiene requirements for fish and fishery products that are equivalent, to those of the EU. Subsequent legislation has implemented equivalent requirements for meat and meat products, aimed at facilitating exports to the EU and United States. This legislation was first drafted 12 years ago, but was only eventually implemented because of the demands of potential export markets.

Clearly, there is considerable scope for overlap of responsibilities and repetition of tasks between the different agencies responsible for regulating food safety. Furthermore, responsibilities are not always allocated in an efficient and effective manner. For example, whilst the Ministry of Health is responsible for inspection of slaughter facilities and inspection of carcasses, the Ministry of Agriculture has responsibility for issuing permits for imports and exports of meat and fish and products.

Across the agencies responsible for food safety controls there are limitations in skills and experience in risk analysis and equivalency. While the implementation of the HACCP is in its initial stages in Jamaica, generally speaking the VSD's staff of around 30 inspectors are fully trained and certified in HACCP. Further, the fish processing sector is fully HACCP-based and in compliance with international standards. Overall, however, there is a need to enhance further capacity with respect to HACCP. Indeed, a number of overseas agencies have provided training in this area. For example, the FSPID recently received HACCP training from the CFIA.

In 1987, a National Food Protection Committee (NFPC) was established within the Ministry of Health. The NFPC has no legal status, but brings together a wide cross-section of representatives and experts from various ministries, trade, industry, and research organisations. It provides advice and develops strategies, plans of action and position papers on food safety and protection in Jamaica. Furthermore, it advises on food legislation and regulations. Over time, however, attendance at meetings of the Committee has lapsed and it is currently being reformed as part of the Ministry of Health's overall programme of reform of the health sector (Reid, 2000).

A number of initiatives have been taken to identify weaknesses in current food safety control capacity in Jamaica and to implement reforms in a bid to comply with international standards. Firstly, IICA has undertaken two assessments of the food safety control system in Jamaica. These reviews identify weaknesses in current legislation, administrative structures and controls on food safety (IICA, 2000; Reid, 2000).

Secondly, the Swedish International Development Co-operation Agency has funded a project that aims to support the development of national quality infrastructure in Jamaica. This takes the form of a technical co-operation project between the Ministry of Industry, Commerce and Technology and the Swedish Board for Accreditation and Conformity Assessment (SWEDAC). The project started in October 2001 and will last for 30 months. The aims are as follows: 1) the development of an overall policy for the organisation of national quality infrastructure in Jamaica; 2) adapting one important product sector to the new principles for technical regulation and conformity assessment; 3) establishment of a national accreditation body; 4) preparation of selected laboratories for accreditation; and 5) enhancing the activities of the Packaging Department in the JBS. Specifically related to food, the project will develop food safety legislation based on the HACCP approach, consistent with international requirements by reviewing existing legislation and liaison with relevant agencies. Furthermore, proposals will be developed for the reorganisation of enforcement mechanisms for food safety.

Thirdly, the Government of Jamaica has received funding from the Inter-American Development Bank (IDB) for an Agricultural Support Services Project that aims to enhance the competitiveness of Jamaican agriculture in domestic and global markets, making a substantial contribution to the goal of increasing the incomes of agricultural producers. One element of this programme is the strengthening and consolidation of food safety controls. This aims to improve the effectiveness of food safety systems to protect domestic consumers from disease and contamination, while ensuring that Jamaica's exports meet international standards. The key outputs are as follows: 1) development of an appropriate policy, updating and enacting legislation and strengthening of co-ordination mechanisms; 2) hiring and training of personnel in the areas of food safety, animal health and plant health; 3) acquisition of equipment and supplies; 4) strengthening and upgrading of infrastructure; 5) implementation of a public awareness campaign; 6) development of databases and strengthening of record-keeping systems; 7) updating of methodologies; and 7) implementation of surveillance programmes.

As part of this component of the project, the Government is to establish an Agricultural Health and Food safety Co-ordination Committee to co-ordinate food safety controls. Furthermore, Memoranda of Understanding will be formulated to formalise and strengthen the working relationships between, fort example, the Ministry of Health, Ministry of Agriculture and Ministry of Commerce, Industry and Technology.

In many cases the impetus to enhance national food safety capacity can be observed at a number of levels and the actions taken by governments will reflect one or a combination of these factors depending on local circumstances, domestic and international factors etc. Firstly, there is increasing pressure in many developing countries to enhance the safety of the domestic food supply, both as a means to promote well-being of the population and to reduce the economic burden associated with food-borne disease. There may also be political pressure for action to be taken resulting, for example, from media coverage of outbreaks of disease, adulteration of food etc. Secondly, as food safety requirements in international markets become stricter, national governments are being required to enhance their own capacities in order to comply. Indeed, in certain cases reforms at the domestic level are a pre-requisite for compliance with food safety requirements in industrialised country markets. Thirdly, in many developing countries there are very significant post-harvest losses due to spoilage and there are well-recognised needs to enhance controls in order to boost domestic food security, enhance agricultural productivity (and thus the livelihood of producers) etc.

Box 4.Case of Malaysia:

Overall, food safety capacity is well-developed in Malaysia compared, for example, to other countries at a similar level of economic development. Government officials are well informed about the importance of food safety controls, both domestically and relating to exports/imports, and what improvements are required to enhance capacity. Recognising the fact that the integrated approach is undertaken for food safety, coordination of food safety control needs to be strengthened. The Government has acknowledged this problem and one of the objectives of establishing the National Food Safety Advisory Council is to optimise available resources and expertise, and minimising duplication of efforts.

Malaysia has a relatively well-developed laboratory infrastructure that can undertake most of the analyses required for food safety controls relating to domestic production, whether for domestic consumption, exports or imports, including microbiology, additives, pesticide residues, veterinary drug residues and chemical contaminants. The Ministry of Health has laboratories that each specialise in particular types of analysis and can perform most of the required tests. These laboratories work closely with other agencies including the Ministry of Agriculture, Department of Chemistry, Department of Standards Malaysia, and universities. Malaysia was only the second country in Asia to undertake tests for dioxins following the contamination of foodstuffs in Belgium.

The Malaysian Government is aware of the need to strengthen capacity in the area of risk analysis. A national Committee has been established to co-ordinate activities, in particular the collection of data by various agencies, research teams etc. The key weakness at the current time is a lack of baseline data. Furthermore, that data which has been collected tends to be fragmented and lacks comparability.

One area of particular concern to the Malaysian Government is the efficacy of controls on imports. Controls are based on a 'black list' system, although there are weaknesses in the monitoring and management of data on contraventions of requirements. A computerised system is being introduced that links customs with the Ministries of Health and Agriculture.

The Ministry of Health has acknowledged the need for hygiene standards to be enhanced in the Malaysian food processing sector. The Ministry of Health operates a voluntary HACCP certification programme (see above). This programme was introduced in 1996 in response to EU requirements for HACCP in fish processing plants.

APEC has undertaken a review of food safety infrastructure in Member countries within the context of the SPS Agreement (APEC, 2000). In the case of Malaysia, this review highlighted the following priorities: 1) understanding of SPS Agreement; 2) review of food safety infrastructure; 3) strengthening of laboratory infrastructure; 4) capabilities in risk analysis; 5) capabilities in HACCP; and 6) awareness and understanding of SPS Agreement obligations. It was recognised, however, that food safety issues had been given a high priority, not only in the case of products of export interest to Malaysia, but also protection of health and safety of domestic consumers.

Malaysia makes great use of international standards when promulgating domestic legislation. Furthermore, international standards are considered a vital element of control on agricultural and food imports. This is particular so in the case of food safety regulations that are predominantly based on Codex standards. Examples include MRLs for pesticide residues in foodstuffs, limits on veterinary drug residues in food and hygiene standards for food processing.

The system-based approach to food safety currently being promoted by agencies such as FAO serves to highlight the role of multiple stakeholders in the implementation of enhanced food safety capacity. Beyond the, perhaps, obvious role of government (from both the national levels at one extreme to the local level at the other) and the private sector, the academic/research community, consumer groups and other NGOs also have a role to play. Indeed, evidence suggests that the most effective efforts to enhance capacity have involved all of these groups in a truly collaborative. The case of food safety standards for restaurants and street food in Thailand (Box 5) provides an excellent example of this.

Box 5. Street food in Thailand:

In Thailand, restaurants and street vendors are found along the streets in both local and tourist areas. On the one hand, food consumption patterns are changing in Thailand as family size declines and people spend longer periods of time at work. Thus, in most communities a range of street vendors set up stands on major roadways in the early evening to cater to people returning home from work. On the other, in major tourist areas, street vendors cater to foreigners who are attracted by local food at low prices. In both cases, however, there are very real concerns about food safety (FAO/WHO, 2003).

In order to protect consumers as well as promote tourism in Thailand, a project aiming at assuring the good sanitation of all restaurants and street vendors was introduced in 1989. The Department of Health of the Ministry of Public Health, together with the Tourism Authority of Thailand and the Ministry of the Interior (which is responsible for all local governments in provinces around the country) have collaborated in this project with support from many other agencies and groups. The 'Clean Food Good Taste' project aims to benefit local people while also reassuring tourists that Thai food is safe to eat.

The project i has three main goals: 1) to reduce the risk of food-borne diseases in restaurants, cafeterias and vendors; 2) to promote clean and good sanitary food service in tourist areas and also around the country; and 3) to support and encourage local authorities in managing food safety for consumers and tourists in their areas of jurisdiction. The success of the 'Clean Food Good Taste Project' is due to four strategies which have been applied at all levels, namely partnership and co-ownership, quality assurance, sustainability, and public awareness and involvement.

A committee comprising of various agencies was appointed with the Director of Food Sanitation Division, Department of Health as the secretariat. The committee agreed the plan of the project and representatives from regional offices and local authorities were briefed. Seminars were conducted for involved agencies and bodies to enable views to be exchanged and suggestions based on local experiences. The action plan was drafted on the basis of this process. Regional offices co-ordinated the work of local bodies and also provided technical and financial support.

Restaurants, cafeterias and vendors are generally inspected and controlled by local authorities that are empowered by the Sanitation Act, 1992. Through this project other partners were involved, including the private sector and consumer groups. First, interested food establishments indicated their willingness to participate. Then, inspection was conducted by a team consisting of local officers, the local food service or restaurant association and consumer groups.

The Committee sets procedures for quality assurance and specified roles for each participating body. It also sets requirements and procedures for reports and evaluation. Each year, regional offices and the Department of Health conduct random checks on 30 percent of awardees around the country to ensure that good sanitary condition is maintained even after the logo has been awarded. Thus, the aim is to assure consumers that restaurants or vendors that display the 'Clean Food Good Taste' logo will consistently meet the standard.

Once an application to join the project is received, the inspection is conducted according to different criteria for restaurants, cafeterias and vendors. If the establishment does not pass the inspection, improvement must be made as recommended by local officers. Ten samples are drawn, five from food, three from containers and utensils and two from food handlers' hands. To be awarded the 'Clean Food Good Taste' logo nine of the 10 tests must be negative. The inspection is repeated every two months.

Training sessions are held for local authorities, food service personnel, and consumer groups so that the concept of good sanitary practices is well understood and correctly and efficiently applied. Regional offices also encourage the formation of restaurants or vendors associations and support them in the management of quality among members. Consumer groups are encouraged, informed, and educated to be able to protect their rights. Technical and financial support is provided locally, including support for research.

The Committee has undertaken public campaigns and co-ordinates this work nationwide. Regional offices arrange public campaigns to draw attention and create awareness of the logo and the project among consumers across the country. Further, consumers are informed that complaints can be made to regional offices or local authorities or public media. The media regularly reports the progress of the project and the names of establishment where the award and logo have been awarded or have been revoked.

To date, 5,377 restaurants (of 11,731 applicants) and 3,045 vendors (of 6,843 applicants) have passed the criteria and been awarded the 'Clean Food Good Taste' logo.

7. Food safety and trade:

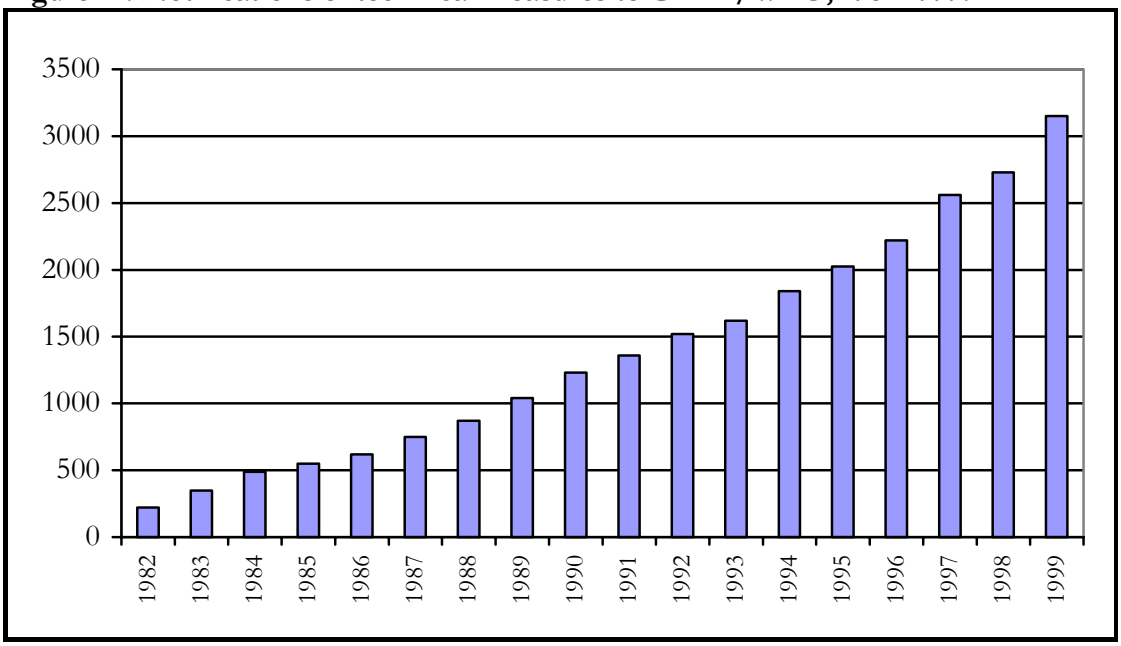
It is widely recognized that food safety capacity is of vital importance to agricultural and food exports from developing countries (IICA, 1999b). Whereas much of the focus of food safety controls at the national level is on domestic security issues, including protection of consumers against food-borne hazards, such capacity is also necessary in order to comply with food safety requirements in export markets, particularly in industrialised countries. For example, importing countries frequently require guarantees that minimum standards of hygiene have been applied in the manufacture of a food product, or that fresh fruits and vegetables do not have excessive residues of pesticides. The exporting country must have the capacity both to comply with such requirements and to undertake the necessary controls in order to demonstrate that compliance has been achieved.

Further, a number of agricultural and food products, for example fresh fruit and vegetables and fish, can provide significant opportunities for developing countries to develop non-traditional exports in the face of secular declines in the terms of trade for established commodity exports. However, these products are also associated with a range of potential food-borne hazards and, as a result, must comply with often strict regulatory requirements in high-income markets (Unnevehr, 2000). Indeed, the future growth of these exports will be dependent on the ability to up-grade food safety capacity in both the public and (in particular) private sectors. At the same time, this will bring about changes in the structure and *modus operandi* of supply chains, creating opportunities for some and a loss of livelihood for others.

In recent years there has been heightened interest in the impact of food safety and other SPS measures on trade in agricultural and food products. Whilst not having the restriction of trade as their primary objective, there is evidence that food safety requirements can act as a significant barrier to trade, particularly for developing countries (Henson *et al.*, 2000a). Such concerns reflect the global proliferation of food safety and other technical measures in recent times, particularly in industrialised countries. This is evident from the number of notifications of technical measures to GATT/WTO over the period 1981 to 1999 (Figures 12 and 13). Furthermore, it is now more widely recognised that food safety and other

technical measures can act, either explicitly or implicitly, as barriers to trade (see for example Sykes, 1995, Laird and Yeats, 1990, Vogel, 1995; Henson *et al.*, 2000a).

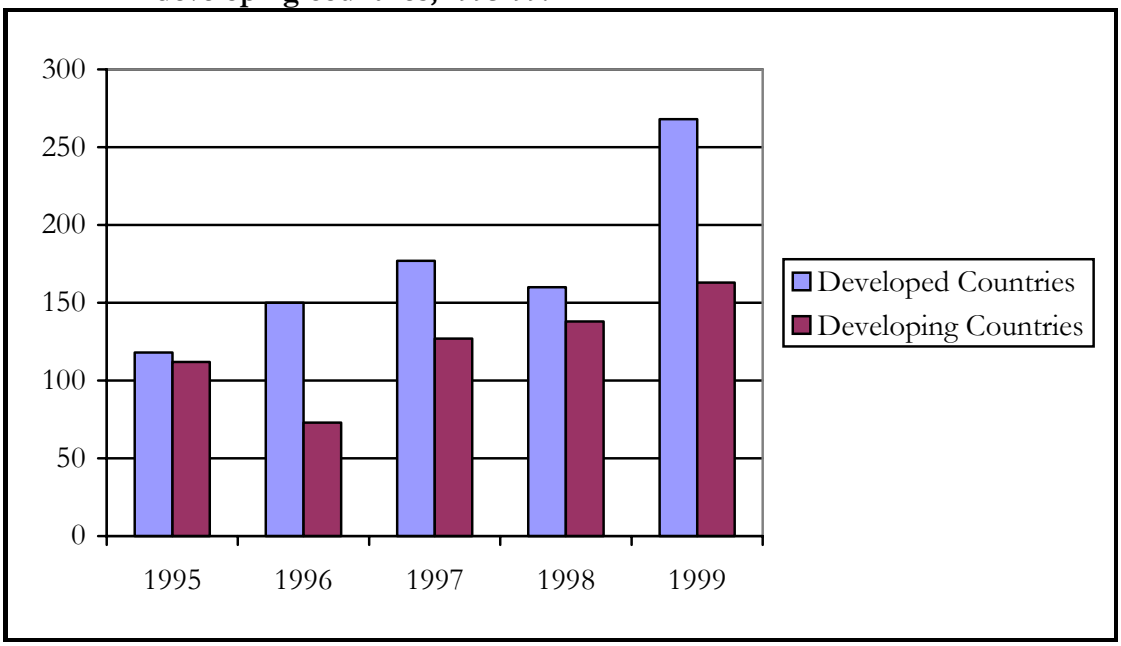
Figure 12. Notifications of technical measures to GATT/WTO, 1981-1999:



Source: GATT/WTO.

A number of studies provide a commentary on the impact of food safety and other technical measures on developing country exports, although with no attempt to quantify the impact in terms of cost of compliance or volume/value of exports (see for example UNCTAD/Commonwealth Secretariat, 1996; Johnson, 1997; FAO, 1998). These studies suggest that developing countries face considerable difficulties complying with food safety requirements in industrialised country markets. Some more in-depth studies that do attempt to quantify the impact of SPS measures are described below. Further, some specific cases are provided as illustration in Boxes 6 to 10. A recent review of 'Food Safety in Food Security and Food Trade by the International Food Policy Research Institute (IFPRI) (Unnevehr, 2003) provides further examples.

Figure 13. Number of notifications of SPS measures to WTO by developed and developing countries, 1995-99:



Source: WTO

Cato and Lima dos Santos (1998) and Rahman (2001) assess the impact of EU hygiene standards on the Bangladeshi shrimp sector. Over the period August to December 1997, exports of frozen shrimps from Bangladesh to the EU were prohibited because of concerns about hygiene standards in processing facilities and the efficiency of controls undertaken by Bangladeshi government inspectors. It is estimated that the loss of export revenue as a result of this ban was $14.6 million. Furthermore, the costs of upgrading sanitary conditions in the frozen shrimp industry to satisfy the EU's hygiene requirements over the period 1997-98 is estimated to have been $17.6 million; an average cost per plant of $239,630. However, subsequently exports to the EU have increased significantly suggesting, perhaps, a not inconsiderable return on this investment!

Over the period 1998-99, there were two periods during which Tanzanian exports of fresh fish to the EU were prohibited because of concerns about hygiene controls in the supply chain and pesticide residues. Musonda and Mbowe (2001) estimate that, as a direct result of these restrictions, export revenue declined by Tsh80 million per day. Similar restrictions were applied to exports from Kenya. Henson *et al.* (2000a) indicate that the landed price of

Nile Perch declined from 60sh per kilogram to 35Ksh per kilogram due to these restrictions (see also Box 6).

Box 6. Hygiene requirements and fresh fish exports from Kenya:

Since the late 1970s, the Nile Perch fisheries on Lake Victoria have expanded rapidly in Kenya, Uganda and Tanzania and simultaneously become progressively more export-oriented. In 1995, 30,000 people were directly employed in the Nile Perch Fisheries in Kenya alone. Over 98 percent of landed fish was exported, of which the EU accounted for 59 percent.

The EU lays down harmonized requirements for standards of hygiene throughout the supply chain for fish and fishery products, including fishing vessels, landing facilities and processing plants. Third Countries are expected to implement requirements that are at least equivalent to these requirements. An approved 'Competent Authority' in a Third Country is responsible for undertaking these controls and for approving processing facilities for export to the EU.

A number of low- and middle-income countries have experienced problems complying with the EU's hygiene requirements for fish and fishery products and have faced restrictions on imports, including India, Tanzania, Jamaica, Uganda and Kenya. In the case of Kenya, the European Commission has undertaken inspection visits on four occasions and identified deficiencies in prevailing hygiene standards and controls. Furthermore, emergency measures restricting exports from Kenya were taken on various occasions over the period December 1997 to December 2000 to address specific food safety concerns, namely *Salmonella* and general conditions of hygiene, Cholera and pesticide residues.

The impact of these restrictions was considerable. Whilst the loss of exports to the EU was partially offset by increases in trade with other countries, overall exports declined. For example, during the first period of restrictions (December 1997 to June 1998) total exports were 29 percent lower than in 1996. Furthermore, the restrictions had a direct impact on the livelihood of fishing communities. For example, the landed price of Nile Perch during the first period of restrictions was 33 percent lower than in 1996. All restrictions on exports of fish from Kenya were finally withdrawn in December 2000 and exports recommenced in the first half of 2001.

Otsuki *et al.* (2000; 2001) estimate the impact of standards for aflatoxins in cereals, dried fruit and nuts on exports from nine African countries over the period 1989-98, including the new and stricter standard applied by the EU and the international standard developed by Codex Alimentarius. The loss of exports from applying the EU rather than the Codex standard is estimated to be US$379 million/annum (Table 13). Furthermore, the National Peanut

Council of America (1997) has estimated that complying with the EU's sampling regime could result in additional costs for exporters of approximately $9.5/tonne (see also Boxes 7 and 10).

Table 13. Impact of EU and Codex standards for aflatoxins imports of cereals and cereal preparations to the EU (US$ million):

EU Member State	EU Standard	Codex Standard	Difference Between Scenarios (%)
Austria	+5	+5	0
Belgium/Luxembourg	-10	+13	80
Denmark	0	+5	50
Finland	-1	+3	61
France	-92	+123	80
Germany	0	+10	50
Ireland	-3	+4	80
Italy	-22	+29	80
Netherlands	-8	+11	80
Portugal	-35	-22	87
Spain	-10	+13	80
Sweden	-1	+3	61
UK	0	+3	50
EU	-177 (-59%)	+202 (+58%)	76

Source: Otsuki et al. (2000; 2001).

The impact of safety and quality requirement, in particular governing mould, moisture content and maximum levels for aflatoxins, on Sri Lankan exports of spices and beverage crops is assessed by Herath (2001). It is estimate that, as a direct result of these requirements, the loss of exports during the period 1990-2000 was 5,500 million tonnes,

equivalent to 34 percent of total exports. The value of this loss of exports is estimated to be US$2.9 million/annum.

Broad indications of the impact of food safety requirements on developing country exports of agricultural and food products are provided by border detention/rejection data. The US Food and Drugs Administration (FDA) routinely publish data on consignments of agricultural and food products that are detained at the US border. These data only cover products and controls for which the FDA is responsible (and thus most meat and meat products are excluded) and until 2002 did not provide information on the eventual fate of detained consignments – whether they were eventually permitted to enter, re-exported, or destroyed.

Box 7. Production of brazil nuts in Bolivia:

Bolivia is by far the largest exporter of Brazil nuts (*castaña*) in the world, accounting for about 75 per cent of world trade; this product is Bolivia's fourth biggest export. Most of the product is exported to Europe. The product grows wild and is harvested from deep in the forest by indigenous *campesinos* in the far north of the country. The product is picked by hand and packed into bags ready for transport (600 km) to La Paz for air or sea freight to Europe. EU restrictions on aflatoxins, especially limits of 4ppb for aflatoxin B1, have the potential to seriously impede this trade or add significantly to its costs. Although it is possible to grow the product on a plantation scale, it is felt that the economics of such production would not prove adequate. Furthermore, it is claimed that this would act against the social objective of offering poor farmers an economic alternative to coca leaf production in these remote areas.

The Bolivian government and traders, together with assistance from the EU, are considering ways around the problem posed by the new limits, but it seems inevitable that investment in transportation and storage facilities (which may not be merited by the overall size of the market) will have to be made. To date, some laboratory facilities have been set up (and have been accepted by the EU) to allow in-country testing of the export crop. However, such facilities, and inspection in general, represent major costs.

Table 14, for example, details the number of detained consignments from Mexico in 2001. Overall, processed fruit and fresh vegetables were most frequently detained, collectively accounting for 58 per cent of all detentions. Beverages processed vegetables and confectionery were also frequently detained. The predominant reasons for detention were

pesticide residues, microbiological contamination, filth and non-permitted additives (Table 15).

Table 14. US border detentions of Mexican agricultural and food products exports by product, 2001:

Product	Number of Consignments Detained
Fresh vegetables	716
Processed vegetables	252
Fresh fruit	152
Processed fruit	1,188
Fish	156
Beverages	336
Baked goods	180
Confectionery	216
Spices/seasoning	22
Meat products	24
Dairy products	0
Other	15
TOTAL	**3,257**

Source: Analysis of FDA data.

It is evident from the selected cases and studies described above that food safety requirements can have a major impact on exports of agricultural and food products from developing countries. In cases where food safety requirements impede established export flows, the economic costs at both the macro and micro-economic levels can be high. It might also be expected that the associated social costs at the community level will be considerable, as in the case of restrictions on Kenyan exports of fresh fish to the EU.

Conversely, the economic benefits of achieving access to a market by overcoming food safety requirements can be significant.

The international community has addressed the impact of food safety and other SPS measures on trade in agricultural and food products through the SPS Agreement. The Agreement grew out of several trade disputes, most notably between industrialised countries, that could not be resolved under the existing Standards Code or dispute settlement procedures[2]. The SPS Agreement, as part of the Uruguay Round Agreements (URAs), entered into force with the establishment of the World Trade Organisation on 1 January 1995.

Box 8. Fungicide use and exports of yam from Jamaica to the United States:

Jamaica has experienced particular problems with exports of yam to the US relating to fungicide use (Henson, 2001a). Fungicide is routinely applied to the cut ends of yams to prevent the growth of blue mould, in particular during sea shipments. However, the fungicide most widely used, Imazilil, is not registered for this use by the US Food and Drugs Administration (FDA) and the MRL is consequently at the limit of detection (LOD). Spot checks, periodically undertaken by the US authorities detected residues of the fungicide in 2000. Consequently, several large yam exporters lost large consignments that were rejected at the border. The US did not place a ban on Jamaican yams, however, but gave them provisional entry: the subsequent five consignments required certification as residue-free by an approved laboratory.

In response, the Jamaican Government established a Yam Task Force. The Task Force requested permission from the US authorities for the use of two fungicides (Deccosol and Botran) that are currently used on sweet potato and for which MRLs have been established. In the interim, the task force recommended that chlorine be used instead of Imazilil, although this provides less protection against mould growth. Other measures the task force has undertaken include encouraging farmers to reduce the number of cut surfaces on yams and to allow drying time so the root creates its own protective scab. The task force is also encouraging use of a Miniset yam that yields a smaller but more uniform product that eliminates the need to cut the yam and thus the need to use fungicides.

The SPS Agreement permits WTO Member countries to take legitimate measures to protect the life and health of consumers, animals and plants given the level of risk that they deem to

[2] The first time national food safety, animal and plant health measures were the subject of an international agreement was the GATT Agreement 1947.

be 'acceptable', provided that such measures can be justified scientifically and do not unnecessarily impede trade. The key elements of the Agreement are detailed below: (WTO, 1995; Roberts, 1997; Stewart and Johanson (1998):

Table 15. US border detentions of Mexican agricultural and food product exports by reason, 2001:

Reason for Detention	Number of Consignments Detained
Microbiological contamination	1,044
Filthy	624
Labelling	312
Pesticide residues	1,140
Non-permitted additives	576
Non-registration	165
Other	48

Source: Analysis of FDA data.

- **Harmonisation:** In many circumstances the harmonisation of SPS standards can act to reduce regulatory trade barriers. Therefore, Members are encouraged to participate in a number of international standards-setting organisations, most notably the Codex Alimentarius Commission (CAC), World Organisation on Animal Health (OIE) and the International Plant Protection Convention (IPPC). Members are expected to base their SPS measures on the standards, guidelines, or recommendations set by these organisations where these exist. They are, however, entitled to adopt measures that achieve a higher level of protection, provided this can be justified scientifically.

- **Equivalence:** Members are required to accept the SPS measures of other members where they can be demonstrated to be equivalent; they offer the same level of protection. This protects exporting countries from unjustified trade restrictions, even when these products are produced under simpler and/or less SPS standards. However, in practice,

the right of the importing country to test imported products limits the access to equal treatment.

- **Assessment of risk and determination of the appropriate level of sanitary or phytosanitary protection:** Members are required to provide scientific evidence when applying SPS measures that differ from international standards. This evidence should be based on a risk assessment taking into account, when possible and appropriate, risk assessment methodologies developed by the international standards organisations. Further, Members are obliged to achieve consistency in the application of SPS measures, in order to avoid arbitrary or unjustifiable distinctions in the levels of protection considered appropriate if such distinctions act to distort trade.

Box 9. Pesticide residue testing for horticultural product exports from The Gambia:

Although exports of horticultural products to the EU are relatively small, they are of great economic importance to a country the size of The Gambia and are considered an important element of the country's programme of export development. Although public authorities, and in particular the Department for Agricultural Services, have implemented the necessary procedures to perform SPS certification they have experienced a number of problems in meeting the EU's requirements. Indeed, some consignments of product have been rejected following border inspection.

The problems faced by the Gambian authorities are two-fold. Firstly, they find it difficult to obtain reliable information on the EU's SPS requirements for the products that they export. In particular, the time taken for information to reach the appropriate authorities when the EU's requirements change can delay implementation and in the meantime there is a risk that product consignments will be rejected. Secondly, in certain cases the appropriate testing equipment is not available in The Gambia. This is a particular problem in the case of MRLs for pesticides, which can be beyond the detection capability of the equipment that is available. Thus, in certain cases, tests can be undertaken and certificates issued, but there can be no guarantee that the product complies with the EU's requirements.

- **Adaptation to regional conditions, including pest- or disease free areas and areas of low pest or disease prevalence:** The Agreement recognises that SPS risks do not correspond to national boundaries; there may be areas within a particular country that have a lower risk than others. The Agreement, therefore, recognises that pest- or disease-free areas may exist, determined by factors such as geography, ecosystems,

epidemiological surveillance and the effectiveness of SPS controls. A good example in this respect is Foot and Mouth Disease (FMD)-free areas within countries that do not have an FMD-free status overall.

- **Transparency:** The Agreement establishes procedures for enhanced transparency in the setting of SPS standards amongst Members. Members are required to notify the SPS Secretariat of all proposed and implemented SPS measures. This information is relayed to the 'National Notification Authority' of each Member. Moreover, Members are required to establish an 'Enquiry Point' which is the direct point of contact for any other Member regarding information on notifications of SPS measures.

- **Consultation and dispute settlement:** The Agreement establishes detailed and structured procedures for the settlement of disputes between Members regarding the legitimacy of SPS measures that distort trade. This takes the form of a dispute settlement body consisting of Member representatives.

- **Provisions for developing countries under the SPS Agreement:** Given that developing countries typically implement quantitatively lower SPS standards than industrialised countries, in principle the Agreement should help to facilitate exports to industrialised countries by improving transparency, promoting harmonisation and preventing the implementation of SPS measures that cannot be justified scientifically. Much of this is dependent, however, on the ability of developing countries to effectively participate in the Agreement. The Agreement itself tries to facilitate this by acknowledging the special problems that developing countries can face in complying with SPS measures and allowing for special and differential treatment:

  - Members are instructed to take account of the special needs of developing countries, and in particular least-developed countries, in the development of SPS measures.

  - Members are encouraged to maintain opportunities for exports from developing countries, where the appropriate level of protection permits scope for the phased

introduction of new SPS measures, longer periods should be given for products that are of special interest to developing countries.

- The SPS Committee is permitted to grant developing countries time-limited exemptions from obligations under the Agreement, taking into account their financial, trade and development needs.

- Members should encourage and facilitate the active participation of developing countries in international organisations such as Codex Alimentarius, OIE and IPPC.

- Members are encouraged to provide technical assistance to other Members, in particular developing countries, for the purpose of allowing such countries to meet the level of SPS measures protection required in their export markets.

Box 10. Limits on aflatoxins and Egyptian groundnut exports:

Aflatoxins are a group of naturally-occurring acute liver carcinogens that result from fungal growth in cereals, nuts and fruit and vegetables. In 1997, the EU established harmonized limits and sampling and analytical methods for aflatoxins in groundnuts. Initially, the EU set a maximum acceptable level for aflatoxins in groundnuts for direct human consumption of 4ppb (2ppb for aflatoxin B1) and for groundnuts for further processing of 10ppb (5ppb for aflatoxin B1). Subsequently, the level for groundnuts for further processing was revised to 15ppb (8ppb for aflatoxin B1) in 1998 after a number of countries raised concerns about the scientific justification for these levels and the potential impact on their exports. The EU's standards on aflatoxins in groundnuts are stricter than international standards. Codex Alimentarius has established a maximum acceptable level for total aflatoxins in groundnuts for further processing of 15 ppb, but has not established a separate level for aflatoxin B1.

A number of low- and middle-income countries have experienced problems complying with the EU's standard for aflatoxins in groundnuts. For example, over the period February 1998 to May 1999 there were 22 alerts due to aflatoxin contamination in groundnuts exported from Egypt. As a result, in May 1999 the EU suspended imports of groundnuts and groundnut products from Egypt. In August 1999, the European Commission inspected controls on aflatoxins in groundnuts in Egypt. Deficiencies were found in sampling and analysis of export consignments, traceability through the supply chain, control of drying by small producers and documentation of quality control procedures. One exporter has reported non-recurring costs of compliance with the EU's requirements of US$1.55 million and increased production/supply costs of 6.5 percent (Henson, 2001c). The prohibition on imports was lifted in December 1999.

Further, the Agreement permitted additional time to developing countries to implement all or some of its provisions. Developing countries were permitted an additional two years (until 1997) to comply with the all provisions except those associated with transparency. The least developed countries were permitted an additional five years (until 2000) to comply with the Agreement in its entirety. It is evident, however, that a number have failed to achieve compliance even today (see below).

There is evidence that the SPS Agreement has had some positive impacts on the application of SPS measures by WTO Members and their governance internationally. For example, it has enhanced transparency, encouraged the use of risk assessment techniques in the development of national SPS measures and emphasized the importance of pest and disease-free areas, both within and across national boundaries (IATRC, 2000). However, in other areas, for example equivalency, there has been less success. Whilst the SPS Committee has established general guidelines on the assessment of equivalency, there are few concrete examples of equivalency having been established between trading partners. Arguably, the equivalency provision is one of the most valuable elements of the SPS Agreement to developing countries.

Whilst concerns have been expressed about specific provisions of the Agreement and the manner in which the Agreement has been applied by WTO Members, in particular industrialised countries (see for example Henson *et al.*, 2000a, Zarrilli, 1999, Jensen, 2002), perhaps of greatest concern are the capacity constraints faced by developing countries that limit their effective participation. Indeed, it is argued that, although the Agreement offers a number of potential benefits to developing countries, they will only actualise these if they are willing and able to comply with their obligations under the Agreement and participate fully in its institutions (Henson *et al.*, 2000a). It is evident that many developing countries have struggled to do so. For example, only 56 percent of low-income countries had established a National Notification Authority by March 2002, whilst only 64 percent had established an Enquiry Point (Table 16).

Table 16. Proportion of WTO members implementing transparency obligations under SPS Agreement, March 2002:

Income Group	Enquiry Point	National Notification Authority
Low	64.4%	55.6%
Lower-middle	87.8%	84.8%
Upper-middle	92.9%	89.3%
High-income OECD	100.0%	100.0%
High-income non-OECD	92.8%	85.7%
TOTAL	**84.7%**	**79.9%**

Source: WTO.

The main forum for dialogue on SPS measures and decision-making with respect to the implementation of the SPS Agreement is the SPS Committee, which meets three times annually in Geneva. The majority of developing countries, and in particular low-income countries, are unable to participate in this Committee. In many cases they have very small missions in Geneva, whilst ten have no mission at all and deal with WTO matters through their embassy in a neighbouring country.

The SPS Agreement places particular emphasis on the role of international standards as a mechanism to overcome the trade effects of SPS measures. Further, international standards can play a potentially valuable role in the development of national SPS control capacity (see above). The Agreement utilises international standards as a frame of reference against which to assess the legitimacy of national SPS measures. Moreover, the Agreement obliges WTO Members to participate in the work of Codex Alimentarius, OIE and IPPC to the extent possible.

The Codex Alimentarius Commission was established to co-ordinate the Joint FAO/WHO Food Standards Programme, the purpose of which is to:

- Protect the health of consumers and ensuring fair practices in food trade.

- Promote co-ordination of all food standards work undertaken by international governmental and non-governmental organizations.

- Determine priorities, and initiate and guide the preparation of draft standards through and with the aid of appropriate organizations.

- Finalize standards elaborated under the Programme and, following acceptance by governments, publish them in a Codex Alimentarius either as regional or world-wide standards, together with standards already finalized by other bodies wherever this is practicable.

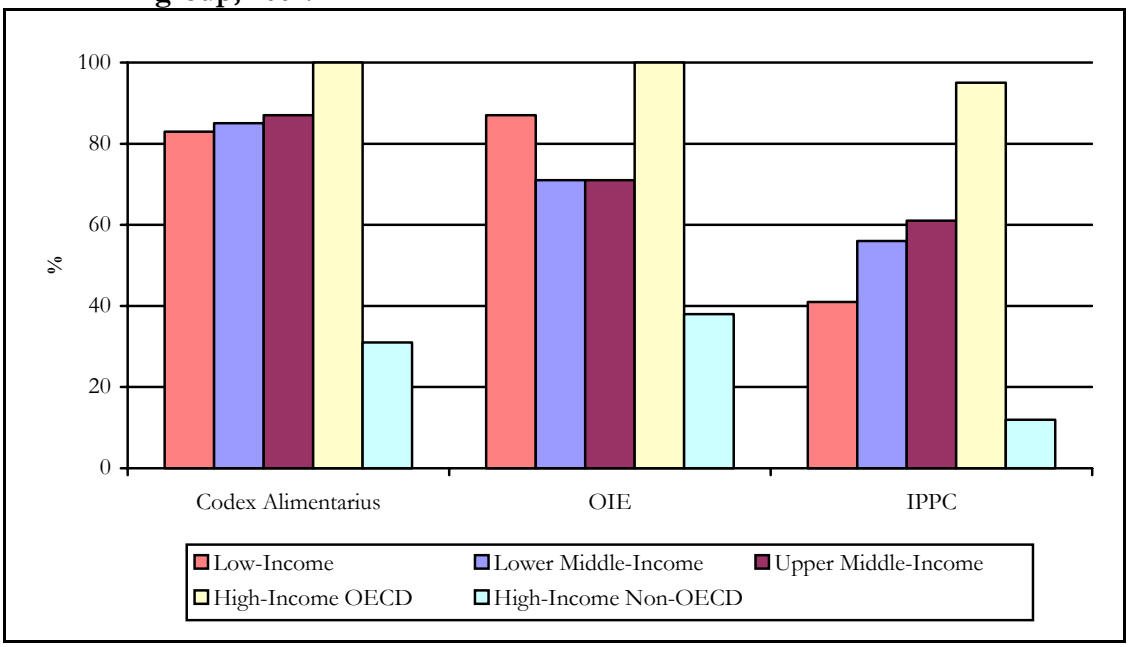
- Amend published standards after appropriate survey in the light of developments.

The Commission is responsible for establishing international standards on food quality and safety and promulgates compositional and quality standards for commodities and codes of hygienic and technological practices, evaluates pesticides, food additives and veterinary drugs and sets limits for pesticide residues and guidelines for contaminants.

It is evident that the majority of developing countries lack the resources to participate in the standard-setting activities of Codex Alimentarius. Around 80 percent of developing countries are members of Codex Alimentarius (Figure 14), which compares favourably with the OIE and IPPC ((Henson *et al.*, 2001c; Henson, 2002). More important, however, is the level of participation of developing countries Members in the promulgation and acceptance of international standards. In the case of Codex Alimentarius, standards are approved by the Commission which meets once every two years in Rome or Geneva. In 2001, around 49 percent of developing country Members participated (Figure 15). This exceeds the level of participation of developing countries in the IPPC's Interim Commission on Phytosanitary Measures (ICPM), but is significantly below that of the OIE's International Committee.

It is evident, however, that some developing countries have made efforts to enhance their participation in Codex Alimentarius. This involves the establishment of national administrative structures and infrastructure to enable national interests in proposed standards to be identified and articulated clearly and the assembly of scientific and technical data to support negotiating positions. The efforts made by Malaysia (Box 11) provide a good example of this.

Figure 14. Rate of membership of Codex Alimentarius, OIE and IPPC by income group, 2001:

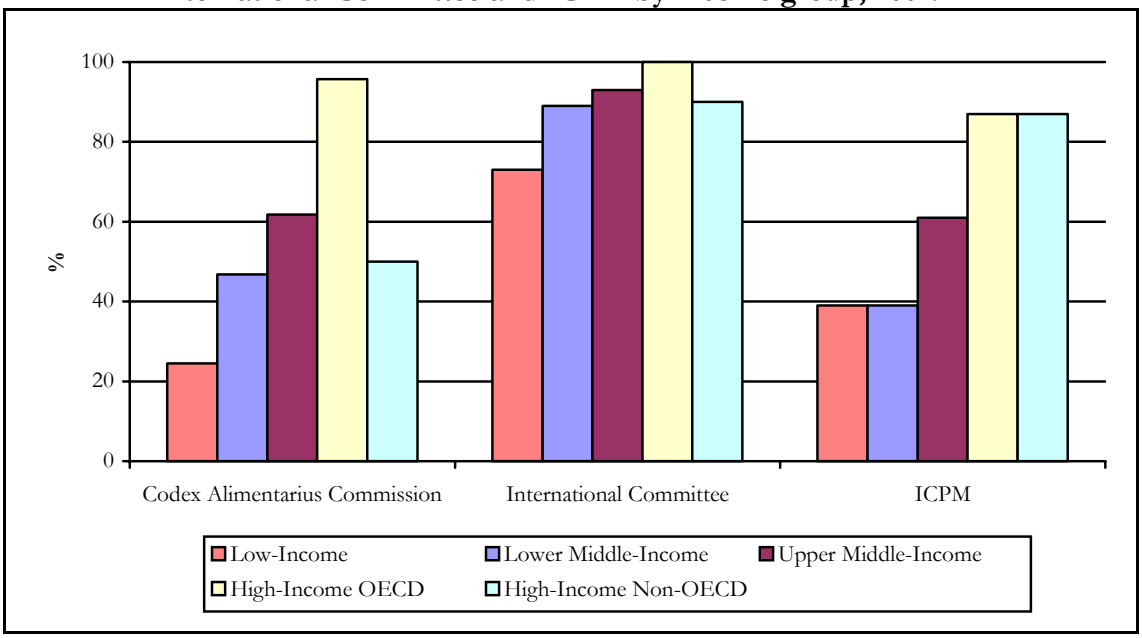


Source: Henson (2002).

7. Enhancing capacity in developing countries:

The foregoing discussion has highlighted the key issues associated with the economics of food safety in developing countries. It has highlighted the high incidence of food-borne disease in many developing countries and the associated welfare and economic costs. Currently, there is great impetus to enhance food safety capacity in developing countries as part of efforts to enhance public health and also facilitate exports of agricultural and food products, most notably to industrialised country markets. The key elements of food safety control capacity are highlighted above and efforts made by a number of developing countries to establish and/or reinforce capacity are discussed.

Figure 15. Rate of participation in meetings of Codex Alimentarius Commission, International Committee and ICPM by income group, 2001:



Source: Henson (2002).

It is evident, however, that whilst considerable investment in the enhancement of food safety capacity is being made by agencies such as the World Bank, FAO and WHO, as well as on a bilateral basis by a number of industrialized countries, the needs of developing countries clearly exceed the available resources. This suggests that new and strengthened approaches need to be applied to capacity building in the area of food safety controls (Orriss, 2002), in order to utilise the available resources effectively and to promote the sustainability of food safety control capacity once it has been established. Some ideas are as follows:

Box 11. Participation by Malaysia in the Codex Alimentarius Commission:

Malaysia has been a Member of Codex Alimentarius since 1971. Since 1996 the Contact Point has been the Food Quality Control Division, Department of Public Health (Ministry of Health). Within the Food Quality Control Division, the Codex and International Affairs Section co-ordinates relations with Codex. Malaysia operates a National Codex Committee that aims to develop a national position on all Codex matters. The Deputy Director-General of Health (Public Health) chairs the Committee. Members include Government ministries, research institutes, commodity boards, industry organisations, consumer groups and university researchers. There is also active participation by industry representatives in the National Codex Committee.

Malaysia is an active participant in Codex Alimentarius, including both biennial meetings of the Codex Alimentarius and General Subject and Commodity Committees. Over the period 1990 to August 2001, Malaysia attended 74 percent of Codex Committee meetings (Table 17). Indeed, its level of participation generally exceeds that of countries at a similar level of development.

Furthermore, Malaysia has played an active role in the development of a number of Codex standards that are considered of national interest. Malaysia produced the first draft of the Codex General Guideline on Use of Term 'Halal' and was actively involved in the development of the final text. Malaysia has large exports of palm oil and has experienced problems with hygiene requirements for the transport of oils and fats to the EU. Thus, it has also been active in the development of a Recommended International Code of Hygienic Practice for Storage and Transport of Edible Oils and Fats in Bulk.

Malaysia is a major exporter of filled milk - milk substitutes based on vegetable fats – produced from palm oil. Malaysia started to attend meetings of the Codex Committee on Milk and Milk products in 2000 to participate in the development of international standards for such products. Three standards are currently being promulgated for Sweetened Condensed Filled Milk, Filled Milk Powders and Evaporated Filled Milk. The drafting group has included Australia, New Zealand, International Dairy Federation, Thailand and Malaysia. Malaysia already had standards for these products that had been developed by its own industry and wanted international standards close to these to minimise the impact on the domestic industry.

- **Needs assessments:** The first stage in the enhancement of food safety capacity should be a comprehensive needs assessment that identifies specific and prioritised requirements and defines an optimal approach through which these can be met. Ideally, the recipient country itself, in order to enhance ownership and ensure that technical assistance is demand-driven, should undertake such an assessment. In certain circumstances, assistance may be required from the outset to support the preparation of such an assessment (Orriss, 2002). As an example, IICA has undertaken needs assessments of the CARICOM countries in the area of food safety and agricultural health (IICA, 2000).

- **Learning from collective experiences:** Arguably, developing countries can learn much from each other regarding effective ways in which to enhance food safety capacity in the context of severe resource constraints and limited levels of economic development. Institutions are required at both a regional and global level to facilitate the exchange of

information and sharing of collective experiences. International organizations such as FAO and WHO mcan play a role in such processes, for example through the maintenance of databases or preparation of case studies.

Table 17. Malaysia's attendance at Codex Committee Meetings, January 1990 – August 2001:

Committee	Number of Meetings	Number Attended	Proportion Attended (%)
General Purpose Commissions			
Food Additives & Contaminants	11	11	100.0
Food Hygiene	10	7	70.0
Food Import and Export Inspection and Certification Systems	9	9	100.0
Food Labelling	8	7	87
General Principles	6	4	66.7
Methods of Analysis & Sampling	7	3	42.9
Nutrition & Foods for Special Dietary Uses	6	4	66.7
Pesticide Residues	10	9	90.0
Veterinary Drugs in Food	8	5	62.5
Commodity Commissions			
Processed Fruits & Vegetables	2	1	50.0
Fats & Oils	4	4	100
Fresh Fruits & Vegetables	8	7	87.5
Natural Mineral water	3	1	33.3
Cocoa Products & Chocolate	3	3	100.0
Fish & Fishery Products	6	2	66.6
Sugars	1	0	0.0
Milk & Milk Products	5	1	20.0
Ad Hoc Governmental Task Forces			
Foods Derived from Biotechnology	2	1	50.0
Animal Feeds	2	1	50.0
Fruit & vegetable Juices	1	1	100.0
Regional Committees			
Asia	6	6	100.0
Near East	1	1	100.0

Source: Based on attendance lists of Codex Committees and Task Forces.

- **Communication and exchange of information:** More generally, there is a need for greater and more effective exchange of information between international organizations, donor countries and developing countries with assistance needs. This would help to avoid duplication and overlap of capacity building efforts, and help to ensure technical

assistance is properly sequenced and synchronized (Orriss, 2002). Initiatives might include the development and maintenance of a comprehensive technical assistance database. It should be noted that the SPS Committee has attempted to monitor both the provision of technical assistance and the technical assistance needs of WTO Members and that a typology has been defined for this purpose (WTO, 2000). This might serve as the foundation for such an initiative.

- **Co-ordination of technical assistance:** Closely linked to the above, there is a need for providers of technical assistance, in particular international organizations, to co-ordinate and ideally integrate their technical assistance efforts in the area of food safety capacity. A good example of such an initiative is the Integrated Framework for Trade-Related Technical Assistance to Least-Developed Countries. This aims to improve the overall trade-related capacity of least-developed countries and to integrate the technical assistance provided by WTO, World Bank, UNDP. UNCTAD, ITC and IMF. There are indications that trade-related SPS capacity might become a more integral part of this framework.

- **Financial resources:** The available financial resources for capacity-building in the area of food safety controls are clearly finite. Whilst a case can be made for the pool of resources to be enlarged, there is a need to better integrate the enhancement of food safety capacity into development efforts as a whole. In such a way, efforts to enhance food safety capacity will be better integrated into overall development objectives and, furthermore, the potential for overlaps and incompatibilities between development efforts with respect to food safety controls and other priorities will be minimized.

  Whilst recognizing the above, there will remain a need for specific resources devoted to the expansion of food safety capacity in developing countries. FAO, for example, has established a Food Safety and Quality Facility that will provide technical assistance to least-developed countries to address food safety and quality concerns and to improve their competitiveness in world agricultural and food markets. This Facility will be supported by a trust fund; it is estimated that a budget of US$98 million would be required to achieve the objectives of the Facility in all 49 least-developed countries.

- **Development of administrative structures in developing countries:** Whilst much technical assistance has focused on the development of basic scientific and technical infrastructure, arguably a greater priority is the development of effective administrative structures for food safety controls. Indeed, the establishment of such structures might be regarded as a necessary prior requirement to developments in physical infrastructure. There is evidence, however, that administrative reform is being given increased priority and it is desirable that this trend continues. Further, there is a need for the administration of food safety controls in developing countries to be integrated better with international institutions such as Codex Alimentarius and the WTO.

  In many developing countries there is also a need for the development of appropriate administrative arrangements to facilitate the communication of food safety issues between government and interested parties. These would involve routine consultation on new food safety requirements, distribution of notifications, routine meetings to discuss food safety issues affecting trade etc. Such arrangements need to be given sufficient political priority and resources to ensure they operate effectively and have a real influence on decision-making and policy agendas. Further, in many cases there is a need for greater transparency of regulatory processes and relations with international organisations in order to facilitate input from interested parties.

- **Innovative forms of technical assistance:** Much of the technical assistance in the area of food safety is rather 'traditional' in nature. For example, the primary focus is the development of capacity in the public sector. Further, the recipient country is typically rather passive in the capacity-building process, often with external consultants playing the primary role. There is a need to move beyond this model and consider more innovative forms of technical assistance. An example is the IICA Executive Leadership Seminar in Food Safety, which aims to develop professionals in both the public and private sectors with the leadership skills to develop and maintain effective food safety policies (Orriss, 2002).

- **Regional co-operation and co-ordination:** In areas where common needs exist and have been identified between developing countries, whether as a whole or amongst distinct sub-groups, there is a potentially valuable role for collaboration. Probably the most practical opportunity for such collaboration is at the regional level. Possibilities include the pooling of food safety capacity and establishment of regional infrastructure, for example laboratory facilities, joint standard-setting activities, common information repositories, collaborative research and risk analysis facilities etc. A good example is provided in Box 12.

  Whilst there are numerous examples of successful regional collaboration, not all regional institutions have operated to their full potential. Indeed, many of the constraints that prevent the participation of developing countries in international institutions also impede their involvement in regional initiatives. An example is the Codex Co-ordinating Committee for Africa (Figure 16), sessions of which typically involve the participation of fewer than 40 percent of Members. This emphasises the need for technical assistance to be directed at both the establishment and maintenance of regional infrastructures, and to the participation of member countries.

Box 12. Regional standard-setting within CARICOM:

Efforts have been made within the Caribbean to establish harmonized regional standards in order to facilitate trade. To a large extent these have been based on those of Codex and thus are largely harmonized with international standards. Until recently, the Caribbean Common Market Standards Council (CCMSC) established standards. This relatively informal grouping of national standards-setting organisations in the region, in particular from Jamaica, Trinidad and Tobago, Guyana and Barbados, met annually and was ruled by an executive drawn from its Member organisations. However, it did not have a staff of its own and a relatively small number of standards were established.

To date, the CCSMC has established 45 standards, of which 27 relate to food products. However, adoption of these standards within CARICOM has been far from universal and many that were recommended as mandatory were only implemented as voluntary standards.

Recognising that a more formal system of standards setting was required, in 1996 the CARICOM Common Market Council agreed to establish the CARICOM Organisation for Standards and Quality (CROSQ). Subsequently in 1998, the Council for Trade and Economic Development (COTED) agreed that CROSQ be constituted as an inter-

governmental agency of the Caribbean Community.

The rationale behind CROSQ is that the development and application of harmonized and internationally-recognised regional standards, technical regulations and conformity assessment procedures:

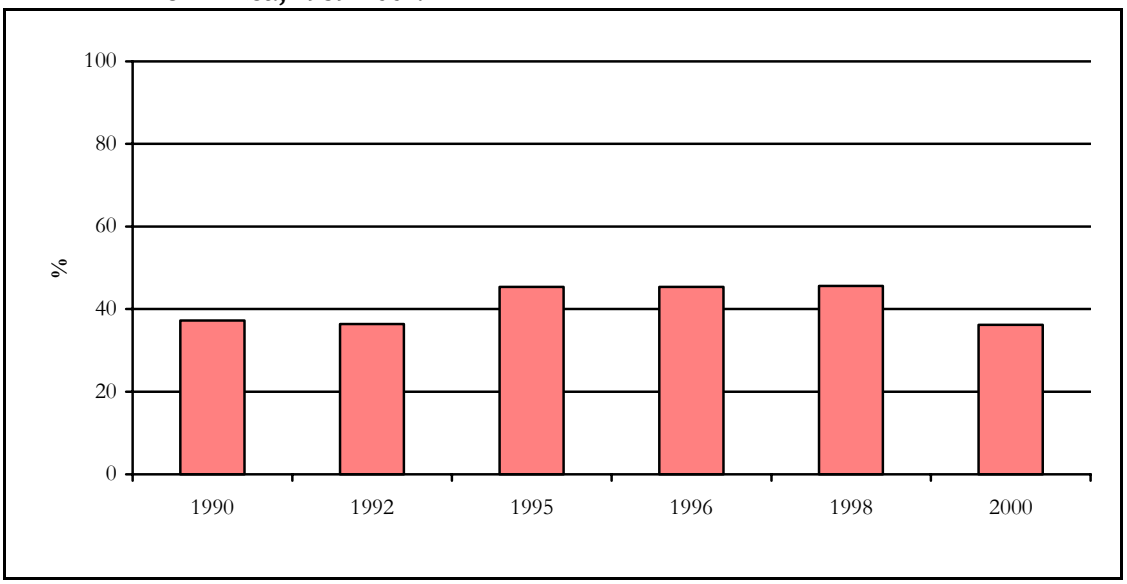
- Is essential for the efficient operation of the CARICOM Single Market and Economy (CSME) and, in particular, the international competitiveness of goods and services produced or provided in the Caribbean Community.
- Would be cost-effective and enhance the international competitiveness of goods and services produced or provided in the CSME.
- Would facilitate the operations and improve the delivery of national standards bodies of Member States of the Caribbean Community.

Furthermore, the aims of CROSQ are to:

- Promote the development and harmonization of standards, including metrology, technical regulations and the mutual recognition of conformity assessment procedures covering goods and services produced or provided in the Community with the aim of facilitating and supporting the establishment of the CSME.
- Encourage the mutual recognition of accreditation and certification systems that are based on internationally accepted criteria.
- Facilitate the achievement of international competitiveness of regional goods and services by fostering a culture of quality in regional enterprises.
- Promote consumer health and safety.
- Through its operation, contribute to the preservation of the environment and the conservation of the natural resources of the Community.
- Provide guidance to the Community Organs and Bodies regarding matters within its competence, including dispute settlement.
- Promote and protect the interests of States Parties and Associate Members in regional and international standardisation for a, including external negotiations.
- Create awareness in commerce, industry, governments and consumers on the issue of standards and quality assurance.
- Facilitate implementation of the standardisation programme.
- Assist member States in understanding and fulfilling their obligations under the Treaty and other international obligations.
- Promote the development of national standards bodies in member States.
- Facilitate access to technical assistance available in member States and in third states.

The headquarters of CROSQ are to be in Barbados. The Organisation will be funded through contributions from Member Governments calculated on the basis of contributions to the CARICOM Secretariat.

Figure 16. Rate of participation in meetings of the Codex Co-ordinating Committee for Africa, 1989-2001:



Source: Henson (2002).

The foregoing discussion has emphasised the importance of food safety capacity to both the public health and the trade interests of developing countries in the area of agricultural and food products. It clearly emphasises the need for food safety capacity-building to be integrated into overall development priorities and initiatives. Further, it is suggested that new and strengthened approaches to the development of capacity in this area need to be adopted, in order to ensure the best use of scare technical assistance resources and to meet better the needs of recipient countries. A number of suggestions have been made in this respect and doubtlessly others will have many more.

8. References:

Abdul-Raouf, U.M. *et al.* (1996). Isolation of *Escherichia coli* 0157:H7 from Some Egyptian Foods. **International Journal of Food Microbiology**, 29, 423-426.

Anderson, C. (1991). Cholera Epidemic Trace to Risk Miscalculation. **Nature**, 354, 28 November, 255.

Bhat, R.V. and Vasanthi, S. (1999). **Mycotoxin Contamination of Foods and Feed: Third Joint FAO/WHO/UNDP International Conference on Mycotoxins.** FAO, Rome.

Bolanos, E., Fernandez, P., Perez, E. and Walker, K. (2000). Situation of FTAA Members for Compliance with the WTO Agreement on Sanitary and Phytosanitary Measures. **Comunica**, 4 (15), 40-42.

Bonfoh, B., Wasem, A., Traore, A.N., Fane, A., Spillman, H., Simbe, C.F., Alfaroukh, I.O., Nicolet, J., Farah, Z. and Zinstaag, J. (2003). Microbiological Quality of Cows' Milk Taken at Different Intervals from the Udder to the Selling Point in Bamako (Mali). **Food Control**, 14, 495-500.

Brown, C.G., Longworth, J.W. and Waldron, S. (2002). Food Safety and Development of the Beef Industry in China. **Food Policy**, 27, 269-284.

Bryan, F.L. *et al.* (1992a). Hazards and Critical Control Points of Vending Operations at a Railway Station and a Bus Station in Pakistan. **Journal of Food Protection**, 55, 534-541.

Bryan, F.L. *et al.* (1992b). Hazards and Critical Control Points of Food Preparation and Storage in Homes in a Village and Town in Pakistan. **Journal of Food Protection**, 55, 714-721

Buzby, J. and Roberts, T. (1997). **Tort Liability: A Weak or Strong Incentive for Controlling Food-borne Pathogens?** Paper presented at the Annual Meeting of the American Agricultural Economics Association, Toronto, Canada.

Buzby, Jean C., Paul D. Frenzen and Barbara Rasco. 2001. **Product Liability and Microbial Food-borne Illness.** Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 799.

Camargo, M.C.R. and Toledo, M.C.F. (2003). Polycyclic Aromatic Hydrocarbons in Brazilian Vegetables and Fruits. **Food Control**, 14, 49-53.

Caswell, J.A. (1997). **Uses of Food Labelling Regulations.** Prepared for the Directorate for Food, Agriculture, and Fisheries, Committee for Agriculture, Organisation for Economic Co-operation and Development, Paris, France.

Caswell, J.A. and Johnson, G.V. (1991). Firm Strategic Response to Food Safety and Nutrition Regulation. In **Economics of Food Safety**, ed. Julie A. Caswell, pp. 273-297. New York, NY: Elsevier Science Publishing Company, Inc.

Cato, J.C. and Lima dos Santos, C.A. (1998). **Costs to Upgrade the Bangladesh Frozen Shrimp Processing Sector to Adequate Technical and Sanitary Standards and to Maintain a HACCP Program.** NE-165, University of Massachusetts, Amherst.

Cooter, R. and Ulen, T. (1988). **Law and Economics**. Glenview, IL: Scott Foresman and Company.

Effler, P., Isaacson, M., Arntzen, L., Heenan, R., Canter, P., Barrett, T., Lee, L., Mambo, C., Levine, W., Zaidi, A. and Griffin, P.M. (2001). Factors Contributing to the Emergence of *Escherichia coli* 0157 in Africa. **Emerging Infectious Diseases**, 7 (5), 1-122.

Eiguer, T. *et al.* (1990). Importancia de la Salmonella enteriditis en Brotas de Enfermedades Transmiditas por Alimentos en Argentina, Anos 1986-1988. **Revista Argentina de Microbiologia,** 22, 41-46.

Ekanem, E.E. *et al.* (1991). Food Hygiene Behaviour and Childhood Diarrhoea in Lagos, Nigeria: A Case-Control Study. **Journal of Diarrhoea Diseases Research**, 9, 216-226.

FAO (1989). **Street Foods**. Food and Agriculture Organization, Rome.

FAO (1998). **Possible Implications of Sanitary and Phytosanitary Measures for Exporters of Oilseed-Based Products to the European Union.** Food and Agriculture Organization, Rome.

FAO (2000). **Multilateral Trade Negotiations on Agriculture: A Resource Manual. Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and Agreement on Technical Barriers to Trade (TBT).** Food and Agriculture Organization, Rome.

FAO (2002). **Biosecurity in Food and Agriculture: Scope and Relevance.** Food and Agriculture Organization, Rome.

FAO (2003). **FAO's Strategy for a Food Chain Approach to Food Safety and Quality: A Framework Document for the Development of Future Strategic Direction.** Food and Agriculture Organization, Rome.

FAO/WHO (2002). **Proceedings of the Global Forum of Food Safety Regulators.** Food and Agriculture Organization, Rome.

FAO/WHO (2003). **Assuring Food Safety and Quality: Guidelines for Strengthening National Food Control Systems.** Food and Agriculture Organization, Rome.

Finelli, L. *et al.* (1992). Outbreak of Cholera Associated with Crab Brought from an Area with Epidemic Disease. **Journal of Infectious Diseases,** 166, 1433-1435.

Forget, G. and Lebel, J. (2001). An Ecosystem Approach to Human Health. International **Journal of Occupational and Environmental Health**, 7 (2), S1-S38.

Golan, E.H., Vogel, S.J., Frenzen, P.D. and Ralston, K.L. (2000). **Tracing the Costs and Benefits of Improvements in Food Safety: the Case of the Hazard Analysis and Critical Control Point for Meat and Poultry.** Economic Research Service, USDA, Washington DC.

Gran, H.M., Mutukumira, A.N., Wetlesen, A. And Narvhus, J.A. (2002). Smallholder Dairy Processing in Zimbabwe: The Production of Fermented Milk Products with Particular Emphasis on Sanitation and Microbiological Quality. **Food Control**, 13, 161-168.

Gran, H.M., Mutukumira, A.N., Wetlesen, A. And Narvhus, J.A. (2002). Smallholder Dairy pPocessing in Zimbabwe: Hygienic Practices During Milking and the Microbiological Quality of the Milk at the Farm and On Delivery. **Food Control**, 13, 41-47.

Gran, H.M., Wetlesen, A., Mutukumira, A.N., Rukure, G. and Narvhus, J.A. (2003). Occurrence of Pathogenic Bacteria in Raw Milk, Cultured Pasteurised Milk and Naturally Sourced Milk Produced at Small-Scale Dairies in Zimbabwe. **Food Control**, 14, 539-544.

Hathaway, D.E. and Ingco, M.D. (1996). Agricultural Liberalization and the Uruguay Round. In: Martin, W. and Winters, L.A. (eds). **The Uruguay Round and the Developing Countries.** Cambridge University Press, Cambridge.

Henson, S.J. (1997). **Costs and Benefits of Food Safety Regulations.** Prepared for the Directorate for Food, Agriculture, and Fisheries, Committee for Agriculture, Organisation for Economic Co-operation and Development, Paris, France.

Henson, S.J., Loader, R.J., Swinbank, A., Bredahl, M. and Lux, N. (2000a). **Impact of Sanitary and Phytosanitary Measures on Developing Countries.** Department of Agricultural and Food Economics, The University of Reading.

Henson, S.J., Loader, R.J. and Brouder, A. (2000b). Food Safety Standards and Exports of Perishable Products from Developing Countries: Fish Exports from East Africa to the European Union. **American Journal of Agricultural Economics**, 82 (5), 1159-1169.

Henson, S.J. (2001a). **Technical Assistance Needs of Developing Countries in the Area of Sanitary and Phytosanitary Measures and Technical barriers to Trade: Country Report on Jamaica.** International Trade Centre, Geneva.

Henson, S.J. (2001b). **Technical Assistance Needs of Developing Countries in the Area of Sanitary and Phytosanitary Measures and Technical barriers to Trade: Country Report on Malaysia**. International Trade Centre, Geneva.

Henson, S.J., Preibisch, K.L. and Masakure, O. (2001c). **Enhancing Developing Country Participation in International Standards-Setting Organisations.** Department of Agricultural and Food Economics, The University of Reading.

Henson, S.J. (2002). **The Current Status and Future Directions of Codex Alimentarius.** World Health Organization, Geneva.

Herath, A. (2001). **Cost of Compliance of Sanitary and Phytosanitary Requirements in Beverages and Spices in Sri Lanka.** CUTS centre for International Trade, Economics and Environment, Jaipur.

IATRC (2001). **Agriculture in the WTO: The Role of Product Attributes in the Agricultural Negotiations.** International Agricultural Trade Research Consortium, St Paul.

IICA (1999a). **Model for a Modern National Agricultural Health and Food Safety System.** Inter-American Institute for Co-operation in Agriculture, Costa Rica.

IICA (1999b). **Food Safety in International Agricultural Trade.** Inter-American Institute for Co-operation in Agriculture, Costa Rica.

IICA (2000) **Country Reports Arising From Needs Assessment of Food Safety Status and Infrastructure in CARICOM Member States**. Inter-American Institute for Co-operation in Agriculture, Trinidad and Tobago.

Jensen, M.F. (2002). **Reviewing the SPS Agreement: A Developing Country Perspective.** Centre for Development Research, Copenhagen.

Johnson, P-N.T. and Yawson, R.M. (2000). **Enhancing the Food Security of the Peri-Urban and Urban Poor Through Improvements to the Quality, Safety and Economics of Street-Vended Foods**. Natural Resources Institute, Chatham Maritime.

Johnson, R.W.M. (1997). Technical Measures for Meat and Other products in Pacific Basin Countries. In: Orden, D. and Roberts, D. (eds.) **Understanding Technical Barriers to Agricultural Trade.** International Agricultural Trade Research Consortium, University of Minnesota.

Laird, S. and Yeats, A. (1990). Trends in Non-Tariff Barriers of Developed Countries. **Weltwirtschaftliches Archiv,** 126, 299-325.

Lebel, J. (2003). **Health: An Ecosystem Approach**. International Development Research Centre, Ottawa.

Lichtenstein, S., Slovic, P., Fischoff, B., Layman, M. and Combs, B. (1978). Judged Frequency of Lethal Events. **Journal of Experimental Psychology**, 79, 236-240.

Lopez, C.E., Ramos, L.L., Ramadan, S.S. and Bulacio, L.C. (2003). Presence of Aflatoxin M1 in Milk for Human Consumption in Argentina. **Food Control**, 14, 31-34.

Lopez, E.L., Diaz, M., Grinstein, S., Devoto, S., Mendila-Harzu, F. And Murray, B.E. (1989). Hemolytic Uremic Syndrome and Diarrhea in Argentine Children: The Role of Shiga-Like Toxins. **Journal of Infectious Diseases**, 160, 469-475.

Mead, P.S., Slutsker, L., Dietz, V., McCaig, L.F., Bresee, J.S., Shapiro, C., Griffin, P.M. and Tauxe, R.V. (1999). Food-Realted Illness and Death in the United States. **Emerging Infectious Diseases,** 5 (5), 1-37.

Molbak, K. *et al.* (1989). Bacterial Contamination of Stored Water and Stored Food: A Potential Source of Diarrhoeal Disease in West Africa. **Epidemiology and Infection**, 102, 309-316.

Motarjemi, Y., Kaferstein, F., Moy, G., Miyagawa, S. And Miyagishima, K. (1993). Contaminated Weaning Food: A Major Risk Factor for Diarrhea and Associated Malnutrition. **World Health Statistical Quarterly,** 50, 124-131.

Murray, C.J.L. and Lopez, A.D. (1996). **The Global Burden of Disease**. Harvard University Press, Cambridge MA.

Musonda, F.M. and Mbowe, W. (2001). **The Impact of Implementing the SPS and TBT Agreements: case of Fish Exports to the European Union by Tanzania.** CUTS Centre for International Trade, Economics and Environment, Jaipur.

Mwangi, A., Arimi, S.M., Mbugua, S., Kang'ethe, E.K., Ouma, E.A., Omore, A.O., McDermott, J.J. and Staal, S. (2000). Application of HACCP to Improve the Safety of Informally Marketed Raw Milk in Kenya. In: Salman, M.D., Morley, P.S. and Ruch-Gallie, R. (eds). **Proceedings of the 9th Symposium of the International Society for Veterinary Epidemiology and Economics**. International Society for Veterinary Epidemiology and Economics, Nairobi.

Ogus, A. (1994). **Regulation: Legal Form and Economic Theory**. Clarendon Press, Oxford.

Omore, A.O., McDermott, J.J., Staal, S., Arimi, S.M., Kang-ethe, E.K. and Ouma, E.A. (2000). Analysis of Public Health Risks from Consumption f Informally Marketed Milk in Sub-Saharan African Countries. In: Salman, M.D., Morley, P.S. and Ruch-Gallie, R. (eds). **Proceedings of the 9th Symposium of the International Society for Veterinary Epidemiology and Economics**. International Society for Veterinary Epidemiology and Economics, Nairobi.

Omore, A., Stall, S., Kurwijilla, L., Osafo, E., Aning, G., Mdoe, N. and Nurah, G. (2001). Indigenous Markets for Dairy Products in Africa: Trade-offs Between Food Safety and Economics. In: de Gooijer, J.H.A. (ed).**Proceedings of 12th Symposium on Tropical Animal Health and Production.** Utrecht University, The Netherlands.

Orriss, G.D. (2002). **Food Safety Capacity Building.** Paper presented at the FAO/WHO Global Forum of Food Safety Regulators. FAO, Rome.

Otsuki, T., Wilson, J.S. and Sewadeh, M. (2000). **A Race to the Top? A Case Study of Food Safety Standards and African Exports.** World Bank, Washington DC.

Otsuki, T., Wilson, J.S. and Sewadeh, M. (2001). What Price Precaution? European Harmonisation of Aflatoxin Regulations and African Groundnut Exports. **European Review of Agricultural Economics**, 28 (2), 263-283.

PAHO (1990). **Primera Reunion de la red Lationoamericana de Vigilancia Epidemiologica de las Enfermedades.** VETA II, Pan American Health Organization, Washington DC.

Peltzman, S. (1976). Towards a More General Theory of Regulation. **Journal of Law and Economics**, 19, 211-240.

Rahman, M. (2001). **EU Ban on Shrimp Imports from Bangladesh: A Case Study on Market Access Problems Faced by the LDCs.** CUTS Centre for International Trade, Economics and Environment, Jaipur.

Ramsay, I. (1989). **Consumer Protection: Text and Materials.** Weidenfeld and Nicolson, London.

Rao, R.N. *et al.* (1989). A Study of Recorded Cases of Food-Borne Diseases at Hyderabad during 1984 and 1985. **Journal of Tropical Medicine and Hygiene**, 92, 320-324.

Reid (2000). **Needs Analysis of the Readiness of Jamaican Institutions for WTO-SPS.** Inter-American Institute for Co-operation in Agriculture, Costa Rica.

Ries, A.A. *et al.* (1992). Cholera in Piura, Peru: A Modern Urban Epidemic. **Journal of Infectious Disease***,* 166, 1429-1433.

Roberts, D. (1997). **Implementation of the WTO Agreement on the Application of Sanitary and Phytosanitary Measures: The First Two Years.** Paper presented at the meeting of the International Agricultural Trade Research Consortium, December 1997.

Rose-Ackerman, R. (1991). Regulation and the Law of Torts. **American Economic Review,** 81 (2), 54-58.

Salay, E. and Caswell, J.A. (1998). Developments in Brazilian Food Safety Policy. **International Food and Agribusiness Management Review**, 1 (2), 167-177.

Salleh, N.A., Rusul, G., Hassan, Z., Reezal, A., Isa, S.H., Nichibuchi, M. and Radu, S. (2003). Incidence of *Salmonella* spp. In Raw vegetables in Selangor Malaysia. **Food Control**, 14, 475-479.

Shekhar, S.R. *et al.* (1992). Food-Borne Disease Outbreaks in the Twin Cities of Hyderabad and Secunderabad (India) during 1984 to 1989. In: **Proceedings of the 3rd World Conference of Food-Borne Infections and Intoxications**. Berlin.

Stephenson, S.M. (1997). **Standards and Conformity Assessment as Non-tariff Barriers to Trade.** World Bank, Washington DC.

Stevens, J.B. (1993). **The Economics of Collective Choice.** Westview Press, Boulder CO.

Stewart, T.P. and Johanson, D.S. (1998). The SPS Agreement of the World Trade Organization and International Organizations: The Roles of the Codex Alimentarius

Commission, International Plant protection Convention and International Office of Epizootics. **Syracuse Journal of International Law and Commerce**, 26, 27-53.

Sudhakar, P., Nageswara R.R., Ramesh, B. and Gupta, C.P. (1988). The Economic Impact of a Food-Borne Disease Outbreak Due to *Staphylococcus aureus*. *Journal of Food Protection*, 51 (11), 898-900.

Swaddiwuthipong, W. *et al.* (1988). Surveillance of Food Poisoning Outbreaks in Thailand 1981-86, S**outh East Asian Journal of Tropical Medicine and Public Health**, 19, 327-331.

Sykes, A.O. (1995). **Product Standards for Internationally Integrated Goods Markets.** Brookings Institution, Washington DC.

Tabai, K.C. and Salay, E. (2003). Opinion of the Food Processors, Wholesale and Retail Companies Towards the Program for Product Quality Analysis in Sao Paulo Brazil. **Food Contro**l, 14, 545-551.

Tamplin, M. and Pardodi, C.C. (1991). Environmental Spread of *Vibrio cholerae* in Peru. **Lancet**, 338, 1216-1217.

Teufel, P. *et al.* (1992). Risks of Salmonellosis and Staphyloccocal Food Poisoning from Pakistani Milk-Based Confectioneries**. Journal of Food Protection**, 55, 588-594.

Todd, E. (1997). Epidemiology of Food-Borne Diseases: A World-Wide Review. **World Health Statistical Quarterly**, 50, 20-50.

Toh, P.S. and Birchenough, A. (2000). Food Safety Knowledge and Attitudes: Culture and Environment Impact on Hawkers in Malaysia. **Food Control**, 11, 447-452.

Turner, C.R., Ortmann, G.F. and Lyne, M.C. (2000). Adoption of ISO 9000 Quality Assurance Standards by South African Agribusiness Firms. **Agribusiness**, 16 (3), 295-307.

UNCTAD/Commonwealth Secretariat (1996). **The Global Spice Trade and the Uruguay Round Agreements. UNCTAD**, Geneva and Commonwealth Secretariat, London.

Unnevehr, L.J. (2000). Food Safety Issues and Fresh Food Products Exports from LDCs. **Agricultural Economics**, 23, 231-240.

Unnevehr, L. (ed) (2003). **Food Safety in Food Security and Food Trade**. International Food Policy Research Institute, Washington DC.

Unnevehr, L. and Hirschhorn, N. (2000). **Food Safety Issues in the Developing World.** World Bank, Washington DC.

Unnevehr, L. and Hirschhorn, N. (2001). **Designing Effective Food Safety Interventions in Developing Countries.** World Bank, Washington DC.

Unnevehr, L. and Jensen, H.H. (1996). HACCP as a Regulatory Innovation to Improve Food Safety in the M

Vogel, D. (1995). **Trading Up: Consumer and Environmental Regulation in a Global Economy:** Harvard University Press, Cambridge MA.

Walker, K.D. (1999). **Political Dimensions of Food Safety, Trade and Rural Development**. World Bank, Washington DC.

WHO (1996). **Guidelines for Strengthening a National Food Safety Programme**. World Health Organisation, Geneva.

WHO (2002a). **Food Safety and Food-Borne Illness.** World Health Organisation, Geneva.

WHO (2002b). **WHO Global Strategy for Food Safety.** World Health Organisation, Geneva.

WHO (2002c). **World Health Report, 2002**. World Health Organisation, Geneva.

Wolf, C. (1979). A Theory of Non-Market Failure: Framework for Implementation and Analysis. **Journal of Law and Economics**, 21 (1), 107-139.

Wolf, C. (1988). **Markets or Governments: Choosing Between Imperfect Alternatives.** MIT Press, Cambridge MA.

WTO (1995). **Agreement on the Application of Sanitary and Phytosanitary Measures.** World Trade Organization, Geneva

WTO (2000). **Technical Assistance Typology** (G/SPS/GEN/206). World Trade Organization, Geneva.

Zaibet, L. (2001). Compliance to HACCP and Competitiveness of Oman Fish Processing. **International Journal of Food and Agribusiness Management Review**, 3, 311-321.

Zarrilli, S. (1999). **WTO Sanitary and Phytosanitary Agreement: Issues for Developing Countries.** South Centre, Geneva.

ESA Working Papers

WORKING PAPERS

The ESA Working Papers are produced by the Agriculture and Economic Development Analysis Division (ESA) of the Economic and Social Department of the United Nations Food and Agriculture Organization (FAO). The series presents ESA's ongoing research. Working papers are circulated to stimulate discussion and comments. They are made available to the public through the Division's website. The analysis and conclusions are those of the authors and do not indicate concurrence by FAO.

ESA

The Agriculture and Economic Development Analysis Division (ESA) is FAO's focal point for economic research and policy analysis on issues relating to world food security and sustainable development. ESA contributes to the generation of knowledge and evolution of scientific thought on hunger and poverty alleviation through its economic studies publications which include this working paper series as well as periodic and occasional publications.

Agricultural and Development Economics Division
The Food and Agriculture Organization
Viale delle Terme di Caracalla
00100 Rome
Italy

Contact:
Office of the Director
Telephone: +39 06 57054358
Facsimile: + 39 06 57055522
Website: www.fao.org/es/esa
e-mail: ESA@fao.org