Interrelations between Trade, Climate Change and Food Safety

Tapani Yrjölä and Kyösti Arovuori

Selected paper prepared for presentation at the 2019 Summer Symposium: Trading for Good – Agricultural Trade in the Context of Climate Change Adaptation and Mitigation: Synergies, Obstacles and Possible Solutions, co-organized by the International Agricultural Trade Research Consortium (IATRC) and the European Commission Joint Research Center (EU-JRC), June 23-25, 2019 in Seville, Spain.

Interrelations between trade, climate change and food safety

Tapani Yrjölä & Kyösti Arovuori

Pellervo Economic Research PTT
Eerikinkatu 28A
00180 Helsinki, Finland

email: tapani.yrjola@ptt.fi (corresponding author)

Abstract

Increasing agricultural and food trade is often considered means for food safety risks to spread more rapidly. Also climate change has a potential effect on prevalence of foodborne diseases including zoonosis. Risks are also often used as a pretext for protectionism. Therefore, commensurate and reliable rules become more and more important. We have created an analytical framework which aims at structuring the interrelations between international agricultural and food trade and food safety. According to the results there is a direct connection between agricultural and food trade and food safety. The severity of food safety risks depends on e.g. the nature of the traded goods and the magnitude of the effects of changes in trade and consumption on food system. Furthermore, the study suggests that preventing and minimising the effects of food safety crises are of utmost importance to the society and preparedness for such events is mandatory.

Keywords: Food safety, risks, food trade, climate change

JEL codes: F130, Q130, Q170, Q180

Interrelations between trade, climate change and food safety

1 Introduction

International trade, climate change and food safety formulate a complex system. A number of sources indicate that climate change has a potential effect on prevalence of foodborne diseases including zoonosis.

Climate change affects the transmission of foodborne diseases in a number of ways. Climate change has an impact on the seasonality of foodborne diseases, the patterns of diseases caused by temperature changes and through climbing number of foodborne diseases in severe weather conditions (Hall et al. 2002, Rose et al. 2001). Climate change is considered to increase the susceptibility of animals to different diseases (Hameed et al. 2006, McLaughlin et al. 2005).

Furthermore, climate change may increase range and abundance of disease vectors as well as prolong transmission cycles of vectors (Purse et al. 2005, Baylis and Githeko 2006). Climate change may also dictate farming practices to develop in a manner that increase exposure to certain pathogens.

The food safety and threats related to it are often used as examples of the negative effects of the growth of the international trade. The growth of the trade and the opening of the market are considered a channel for the different risks to transfer from areas and market to one another faster than before. Therefore, the role of reliable supervision, responsibility and rules that have been jointly accepted will be emphasised. The lack of the supervision methods and rules that have been jointly accepted creates barriers in the trade between regions.

The regulation and the non-tariff barriers are in the key role for agricultural sector and, especially for the measures related to animal and plant diseases. Significant economic advantages will not be gained by solely decreasing the customs. On the other hand, the customs have already been decreased or completely removed. However, customs are still applied to certain farm products. The technical differences in the laws and regulations related to the animal and plant diseases between the countries causes significant costs in international trade. These costs may be complex to measure.

The food safety risks are used as grounds for the protecting of the own market. In trade negotiations and agreements exceptions concerning food are often required. For example, the manufacturing processes or conditions are often considered obstacles of trade if they include factors which are banned or cause uncertainty in domestic market.

The character of the risks related to the international trade of foods differs according to the traded products. The source of the risk is different for raw materials, living animals, fresh products or frozen foods. Furthermore, the character of raw materials has effect. The food safety risks of grain products and other plant products are different from risks of meat or milk products. Also, the origin of the risk varies. Food safety risks may originate from agricultural production, processes of food industry, logistics and preservation or domestic handling of the food.

The international agricultural trade has increased substantially in the last a couple of decades. In addition to growth, the structure of trade has also changed. The increasing trade means that growing share of the world food production is consumed in a separate place than it is produced. Furthermore,

the share of refined products of the trade has increased and at the same time expanded the variety of food safety risks related to the agricultural and food trade.

The main objectives of the study are to clarify:

> *How does the international trade affect food safety in food exporting and importing countries?*
>
> *How do the source, character, location of possible food crises and scope affect the food trade?*

Furthermore, results of the study facilitate understanding food safety rules of international trade and the effects of food safety risks on different parts of the food chain.

2 Methodology

The observed effects of different food safety scandals have been analysed. These scandals include Bovine Spongiform Encephalopathy (BSE) (Hussain and Dawson 2013, Morgan 2001, Weeraheva *et al.* 2008), Food and Mouth Disease (FMD) (Thompson *et al.* 2002, Knight-Jones and Ruston 2013) as well as different pathogens (Hoffmann and Tobenna 2013., Crutchfield *et al.* 2001, Scharff 2012).

The effects of different crises formulate a complex system. These effects have been generalised and combined. As a result, a general analytical framework for food safety risks has been created. The framework consists of effects on production, effects on consumers and effects of health together with needs for crisis management in the regions affected by the food crisis as well as political crisis management.

Furthermore, the effects of a food safety crisis on international food trade and policy as well as the effects of international food trade and policy on food safety have been analysed and depicted. The analytical framework facilitates understanding interdependencies between risks related to food trade and food safety.

3 Framework for food safety risks

The food safety risks and the realisation of the crises related to them have multiple of effects on the food system. The effects can be economical, productional, political, human and social as well as health related. There are direct, indirect and contradictory effects between different effects.

A food safety crisis may have direct effects on production, consumption and the animals' health and public health service. A bursting crisis may also have significant multiplicative effects. The bursting of the crisis affects consumption indirectly through the production. Furthermore, a crisis affects people's health and to health service through consumption. To soften the shocks caused by these effects immediate and focused as well as more extensive and longer-term crisis management measures are needed.

Many, if not all, animal disease epidemics have direct, or at least indirect economic effects. They bring costs to the producers, to the consumers and to the public finance. Furthermore, they affect production in many ways. The political effects are typically connected to the crisis management. Also human effects are generated in a number of ways. Illnesses and deaths affect both persons

who got sick and their relatives. These effects are depicted in figure 1. The effects are analysed more in detail in this chapter.

The area of distribution of the effects of a food safety crisis varies according to the features of the crisis and the product in question. From time to time the effects remain local. On the other hand, the effects of even an individual food crisis may spread globally in the globalising world. A crisis that is perceived local may create significant international market disturbances through direct and indirect trade effects.

The effects of a food safety crisis depend on the significance of the crisis related area, country and/or product in the international trade. At its worst the effects of the crisis change trade flows significantly as the food trade from an important import area is disturbed as a consequence of the crisis. Nevertheless, even the serious crises do not necessarily distort world trade. However, any crisis has always local effects on both production and consumption. Hence, all crises require actions from the authorities.

In a crisis situation, the central goal of the measures of the authorities is to prevent the spreading of effects into other actors in the food system, for example production animals and consumers. The prevention of the spreading of effects requires different mutually supporting measures. Between these actions there may be multiplicative and contradictory effects.

The extermination of production animals in the crisis related region reduces production also in the long run. In turn, the changes in production affect the amount and quality of the consumption. On the other hand, the changes in production and consumption as a consequence of the crisis affect the consumption of the substituting products. The product that has been produced in the crisis related region can be replaced with similar or substituting product produced elsewhere. In other words, for example the locally produced beef can be replaced with beef or pork produced in regions not related to the crisis.

Systematic preparation for food safety crises is of utmost importance. When a crisis bursts, it has to be obvious what has to be done in order to minimise harmful effects of the crisis as effectively as possible.

Some measures aim at controlling the immediate effects of the crisis, whereas other measures concentrate of the time subsequent to the crisis. The central objective of all the actions is resuming the situation back to normal as fast as possible. Furthermore, measures aim at minimizing the probability for recurring of the crisis.

The crisis anticipation is important also because the curbing it requires correct focusing and scaling of the measures. The more successful timing and scaling the more efficiently the effects of the crisis can be limited. The measures carried out to manage the crisis affect production. The main objective of the measures is to terminate the acute stage of the crisis. However, they are a part of the political crisis management. Political crisis management continues for a significant time after the acute stage of the crisis. The later actions focus on hindering revival of the crisis.

3.1 Effects on production

Effects on production are most significant if the crisis fall on production animals. A crisis may lead into substantial changes in regional production structure. The may also have both regional and wide-spreading effects on supply.

The effects on production may be temporary, like extermination and replacement of production animals of certain region. Depending on the character of the crisis, a crisis may also weaken regional conditions of production permanently. Then, the entire production structure has to be adjusted for the new conditions.

The changes in the regional production have effects also on other areas because the replacing food production is necessary. This may mean that the production of corresponding goods in other areas increases or substituting products are produced instead.

Figure 1. Framework for food safety risks

In international food trade the supply from crisis related countries is replaced by supply from other countries. As a consequence, trade flows will change. From the point of view of crisis related countries the old export market dries up. Furthermore, crisis related countries import more crisis related goods from other countries.

3.2 Effects on consumers

All the effects of a food safety crisis eventually concern the consumers either directly or indirectly. Ultimately the effects concerning the consumers materialise in changes in the price relations between different products.

Many factors affect the changes in the price relations. First of all, the crisis restricts consumption possibilities and changes the supply. When part of the produced good becomes useless, the supply of the product will deteriorate. The crisis also shakes the consumers' confidence with the crisis related food. Demand for these products diminishes. However, the crisis related goods are substituted with other products. In turn, this affects the demand for the replacing products. The prices of the crisis related products as well as the replacing products change as a consequence of the above-mentioned changes. At the same time the price relations of the products also change.

The consumers' attitude to the crisis related products determines the magnitude of the market disturbance due to the crisis. The local crisis may expand into an international market disturbance if the consumer regards his own safety threatened as a consequence of the crisis.

For example, the bird flu epidemics in Asia in 1990 and the 2000's caused practically a worldwide panic reaction in the meat market. The information carried from Asia about a possible zoonosis that may in worst case turn lethal made many people quit eating poultry meat. The transition of the virus from the animals to the people is in practice fairly rare. In spite of the significant epidemics among animal populations the bird flu has not appeared as significant epidemics among the people. Nevertheless, it has had a significant effect on the world markets of the poultry meat due to the risks experienced by the people.

3.3 Social and health effects

A food safety crisis causes both direct and indirect social as well as health effects. If crisis is related to animals, the illnesses of animals cause medication costs. If crisis contracts people, direct costs, such as medication costs and absences from the work, will be caused through the illnesses of the people. A possible consequence of especially serious crises is deaths of animals and people.

A food safety crisis may cause also economic problems. First of all, the agricultural entrepreneurs' economy may suffer if the demand for their products collapses or production animals have to be exterminated to prevent the spreading of the epidemic. The crisis may also affect the economic performance of other actors of the food system. A wide-spread crisis may raise the consumer prices for food.

The communality may also crumble as a consequence of a food safety crisis. For example, the farms that have contaminated production animals may be held responsible for the worsening economic performance of every farm in the region. On the other hand, also the attitude of the consumers, or the entire surrounding society, to the farmers in general, or especially farmers whose animals have been contaminated, may become suspicious, blaming or even hostile.

The minimising of the effects requires efficient measures of the authorities. Because it is clear that in controlling the health and social effects of the wide-spread food safety crisis different authorities need to take actions, the fluency of the cooperation between the authorities is also important. Authoritative cooperation has to be efficient and fluent at both national and international level.

3.4 Political crisis management

Political crisis management with respect to food safety crisis includes both immediate and longer run measures. In political crisis management, it is essential to be able to react to the problems at different levels.

Immediate measures focus on informing everybody involved in the situation. It is important to tell the producers how the crisis affects their production. The producers have to immediately get information on for example what will happen to the products they produce, which measures are required from them to control the effects of the crisis, and who is able to help them. In turn, the consumers have to get information on, for example, how the crisis affects the safety of different products and what the consumers can do in order to avoid the possible negative effects of the crisis or spreading the negative effects further.

In the longer run the focus of political crisis management is on the actions that will reduce the probability of the recurring of the crisis. Providing the necessary conditions to return to the normal operation or to enable the needed permanent changes in the structures are the most important target for crisis management. Some of the longer-term crisis management measures are the vaccination programmes or the food standards. They aim at preventing new bursting of similar crisis by reducing the occurrence of the factors which cause the crisis. Furthermore, it is important to learn from every crisis. It is essential that the things learned are utilised in the building of risk controlling system.

4 Contradictory effects of the food crisis

Contradictory effects of the food crisis refer to the simplified market effects caused by the crisis which have multiplicated effects to the different sectors. The weights of different effects are varied. The characteristics of demand and supply for the different products, as well as price formation of different products, have a strong relation with the contradictory effects of agriculture and food markets.

Ultimately the magnitude of the effects depends on the characteristics of the products, in other words from how fast the market offsets the market disturbance caused by the crisis. The market disturbance can consist of the sudden weakening of the supply, changes in the demand, changes in trade flows or trade barriers. The speed of the changes in a demand and supply determines how big the price effects eventually become.

The short and long term effects can be very different. At the smallest, the effects form a momentary price shock to the market. In contrast, the effects may also change the relative structure of actors in the food system permanently. In this chapter the contradictory effects of the food crisis are examined from the point of view of the trade of international trade, commercial policy and foods (figure 2).

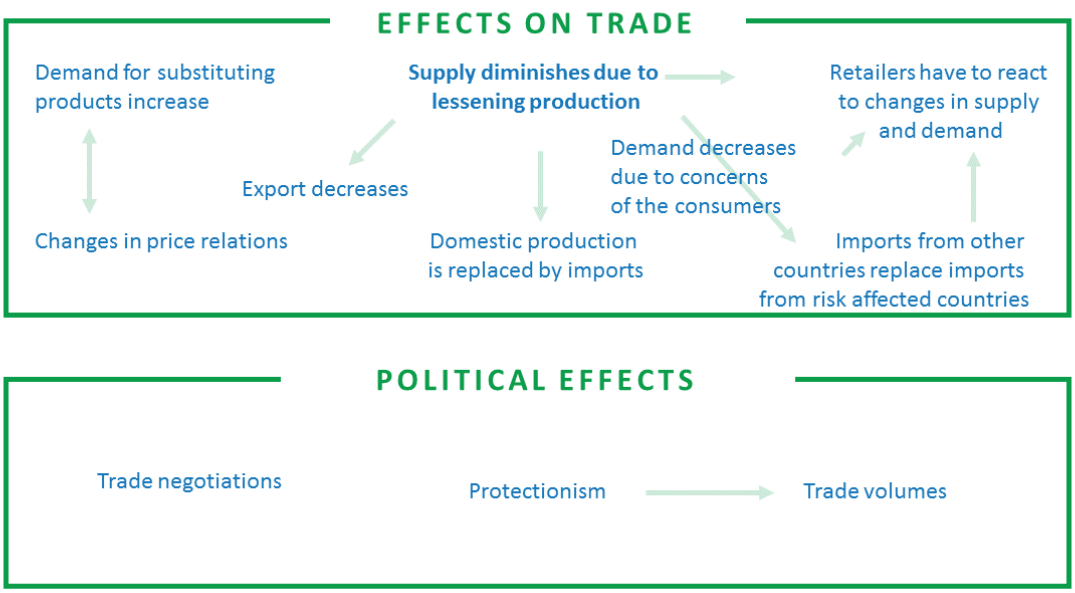

Figure 2. Effects of food safety crisis on international food trade and trade policy

4.1 Effects of a crisis on international agricultural trade

Food safety crises affect international agricultural trade via changes in both demand and supply. The changes in the supply depend on the status of the crisis related region in the international trade and the significance of the product in the global food system. The magnitude of the changes in demand depend on the consumers' behavior.

The trade flows change significantly as a consequence of the displacing effects, the new export possibilities and possible political measures. The supply of the individual region decreases due to the crisis. At the same time, the import demand from the region weakens or terminates entirely. Depending on the consumers' reaction this may provide other exporting countries with new opportunities on one hand through the growth of the market share in the crisis related region, and, on the other hand, through the increasing exporting possibilities in third countries.

The growth of the international trade also means that the food safety crises and their effects spread faster and more widely than earlier. Common rules, generally accepted monitoring systems and commitment of all parties to the prevention of crises is of utmost importance. The possibility of food safety crises and the conceivable quick spreading of their effects due to international trade also complicates the trade negotiations. Climate change, as a potential promoter of the spread of diseases, stresses the significance of anticipation and awareness.

4.2 Effects of a crisis on international trade policy

The crises can also be used as an instrument of the trade policy. The protecting of the own market and the trade barriers are sometimes justified by food safety issues. Different countries and regions

apply different acceptance procedures and certification systems. In practice, entrance to the export market requires an approval of the target country for the entire production process of the exported products. Usually the entire production chain from the agricultural production to refining, packing and logistics has to be approved.

A food safety crisis affects the trade liberalisation. The crisis or its threat may justify trade barriers. However, threat of a crisis is also used as a pretext for protectionism. For example, questions related to treatments and production methods affecting food safety have hindered the progress of trade liberalisation negotiations between the European Union and the United States.

The changes in trade volumes due to a food safety crisis and the preparing for the changes also complicates trade negotiations. The significance of the different products in the international food market changes as a consequence of a food safety crisis. For example, the relative significance of the sensitive products of different countries may change or their market can totally disappear due to the crisis.

Preparing for crises and their threats as well as preventing the spreading of them are targets in international trade negotiations and trade agreements. On the other hand, crises and their threats are used as pretext for protectionism.

4.3 Effects of agricultural and food trade on food safety

Effects of the international agricultural and food on food safety depends on the characteristics of the traded products. The risks in the trade of living animals or raw materials are very different compared to, for example, processed products. However, any risk concerns primarily the consumers.

Irrespective of the origin or the characteristics of the product the most significant individual factor in the food system is the cold chain. Even the momentary breaking of the cold chain endangers the food safety of all products retained and transported cooled or frozen. The breaking of the cold chain usually leads to the spoiling of the product or the raw material and, thus, causes a risk to the consumer.

The parasites and other pathogens may spread wide with the living animals or plants. Parasites and pathogens spread relatively easily but are difficult to exterminate.

The illicit production methods in primary production or refining cause direct risks for the consumers. It is exceptionally difficult to anticipate the scope of these risks because the operation is intentional and significant effort is put on covering the risks and their sources.

The seriousness of the food risks to the consumers varies from individual and short term illnesses to longer term and wide-spread epidemics. However, the epidemics are usually local or regional. Therefore, their market effects remain relatively small. Nevertheless, the effects may be substantially larger if the crisis causes serious illnesses or deaths for humans.

5 The effects of international agricultural and food trade on food safety

The international food trade has a notable influence on food safety risks. Risks related to the safety of most food items tend to increase if the goods are traded in larger area.

The international trade affects food safety in various ways. Firstly, storage time is longer and storage conditions become more challenging when the goods are traded to distant regions. Also transports per se increase food safety risks. For example, hygienic issues of vehicles and conditions of live animal transports raise questions on food safety. Furthermore, different crisis factors, such as pathogens and non-native species or varieties cause food safety risks.

The requirements set by these factors depend on the type of traded food. In this chapter the risks involved in trade of different types of food items are depicted (Figure 3).

5.1 Logistics and food safety

The properties of the logistics chain affect food safety. The problems of the chain generate risks and spread them. Precision of logistics chains, hygiene of vehicles together with traceability of chains play a key role in minimising food safety risks.

Precise logistics chain secures that the transportation and storage of foods is adequate from field to table. Reliable logistics processes facilitate repelling the spreading of diseases and pathogens as well as entrance of foreign materials in the ecosystem.

The hygiene of the vehicles is an absolute precondition for transporting food undamaged for long distances. Hygienic shortcomings are likely to cause problems in the quality of the products and, hence, increase food safety risks when transport takes day or weeks. The traceability of the chain is important in determining the source of problems of the possible crises and, thus, in preventing further spreading of problems.

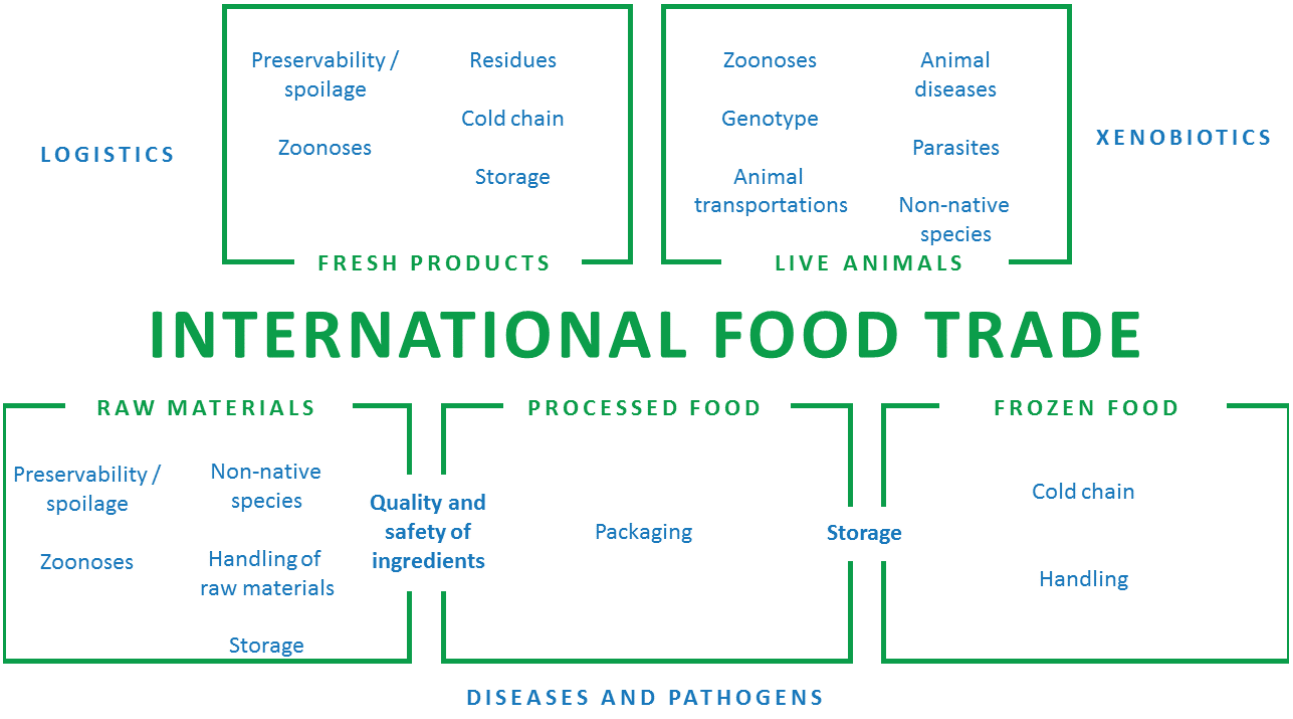

Figure 3. Effects of international food trade on food safety

5.2 Food safety risks related to fresh products and live animals

Risks involved in transportation of fresh products and live animals tend to diminish when the products are processed. For example, live animals and fresh food may act as host organism for zoonosis or phytonosis as well as parasites.

The defective preservation and transport conditions create risks in the cold chain and in storage. They increase prevalence of diseases, pathogens and parasites in transported goods. Furthermore, the conditions in the transport of live animals are of utmost importance.

There are significant differences in the preservability of different fresh products. For example, meat products require an unbroken cold chain, whereas grain is far less demanding with respect to transport and storage conditions. Level of risks is strongly dependent of the preservability of the products.

Transport of, especially, live animals to distant areas include risks that may affect the ecosystem more significantly. The foreign species and varieties mix with dominating species and varieties. Hence, also the genetic ancestry gets mixed. Varieties in genetic ancestry may have substantial effects on food safety. Also non-native species in foreign environments may increase food safety risks.

5.3 Food safety risks related to processed products

The base of the safety of the processed is the safety of the ingredients used is food industry. Risks originated from raw materials tend to spread in the food system all the way to the consumers. The risks are quite similar to above mentioned risks related to trade in fresh product and live animals. However, the processing affect probability of different food safety risks. Certain risks are eliminated in the processing process. For example, salmonellosis typically eradicates when heated. On the other hand, some risk sources are more probable in case of a higher level of processing.

Fluent logistics processes play a key role in diminishing food safety risks also with respect to processed products. Adequate storage, transport and packaging facilitate prevention of spoiling and, hence, decrease food safety risks.

Properties, like preservability, of the processed food items have a substantial effect on spreading of the food safety risks. For example, frozen goods require a perfect cold chain. In contrast, dried fruits are not very demanding with respect to transport temperature.

6 Conclusions

Significance of food safety increases as international food trade grows. Furthermore, climate change tends to promote the spread of diseases. The effects of different factors and the mutual interdependences are challenging to identify. Preventing food safety risks requires identification of these risks. In additions, policy measured has to be appropriately targeted and focused according to the character of the risk.

The analytical framework presented in this paper depicts contradictory effects of food safety risks and crises. Furthermore, we present some proposals for actions for preventing and tackling crises.

There is a direct connection between international agricultural and food trade and food safety. Also climate change has a potential effect on food safety risks. However, the level of food safety risks due to trade or climate change varies. The risks depend on, for example, character of the traded goods and what kind of effect changes in international trade or consumption have in the food system.

For example, in trade agreements the food safety issues have been used for both liberalisation and protectionism. Efficient policies as well as creation of trade rules require commonly accepted tools for defining food safety issues. For food items this is not always true. Food safety has been used as a trade barrier in both trade negotiations and concrete trade policy measures. Often food safety issues are used in a justifiable manner with respect to trade policy. In contrast, food safety issues are sometimes also used to justify measures clearly implemented to protect domestic market. We also describe how to perceive what kind of real risks are included in the international agricultural and food trade and how they are realised in reality.

The analytical framework presented in this paper facilitates understanding the big picture of food safety risks and their interrelations with international agricultural and food trade. Nevertheless, further research in needed in order to recognise detailed effects of different food safety crises, identifying the effect of climate change in crises and put the effects in monetary terms. Furthermore, this information is also essential in prioritising different policy measures to prevent and tackling food safety risks and crises.

7 References

Baylis, M. and A.K. Githeko. 2006. The effects of climate change on infectious diseases of animals. T7.3. Foresight. Infectious Diseases: preparing for the future. Office and Science and Innovation (www.foresight.gov.uk)

Crutchfield, S., J. Buzby, P. Frenzen, J. Allshouse and D. Roberts. 2001. The economics of food safety and international trade in food products. In: Microbehavior and Macroresults: Proceedings of the Tenth Biennial Conference of the International Institute of Fisheries Economics and Trade, July 10-14, 2000, Corvallis, Oregon, USA. Edited by Richard S. Johnston and compiled by Ann L. Shriver. International Institute of Fisheries Economics and Trade (IIFET), Corvallis, OR, 2001. CD ROM.

Hall G.V., R.M. D'Souza and M.D. Kirk 2002. Foodborne disease in the new millen-nium: out of the frying pan and into the fire? *The Medical Journal of Australia*, 177, 614-618.

Hameed K.G.A., G. Sender and A. Korwin-Kossakowska. 2006. Public health hazard due to mastitis in dairy cows. *Animal Science Papers and Reports*. 25(2), 73-85

Hoffmann, S. and D.A. Tobenna. 2013. Making Sense of Recent Cost-of Foodborne-Illness Estimates. Economic Information Bulletin Number 118, U.S. Department of Agriculture, Economic Research Service, Washington, DC, USA.

Hussain, M. A. and C.O. Dawson. 2013. Economic impact of food safety outbreaks on food businesses. *Foods*, 2(4), 585-589.

Knight-Jones, T. J. D., and J. Rushton. 2013. The economic impacts of foot and mouth disease – What are they, how big are they and where do they occur? *Preventive veterinary medicine*, 112(3), 161-173.

McLaughlin J.C., A. DePaola, C.A. Bopp, K.A. Martinek, N.P. Napolilli, C.G. Allison, S.L. Murray, E.C. Thompson, M.M. Dird and J.P. Middaugh. 2005. Outbreak of Vibrio parahaemo-lyticus gastroenteritis associated with Alaskan oysters. *The New England Journal of Medicine* 353, 1463-1470.

Morgan, N. 2001. Repercussions of BSE on international meat trade. Global market analysis. Commodities and Trade Division. Food and Agriculture Organisation, Rome, Italy.

Purse, B.V., P.S. Mellor, D.J. Rogers, A.R. Samuel, P.P.C. Mertens, and M. Baylis. 2005. Climate change and the recent emergence of bluetongue in Europe. *Nature Reviews Microbiology* 3, 171-182.

Rose J.B., P.R. Epstein, E.K. Lipp, B.H. Sherman, S.M. Bernard and J.A. Patz. 2001. Climate variability and change in the United States: potential impacts on water- and food-borne diseases caused by microbiologic agent. *Environmental Health Perspectives* 109:211-221.

Scharff, R. L. 2012. Economic burden from health losses due to foodborne illness in the United States. *Journal of Food Protection*, 75(1), 123-131.

Thompson, D., P. Muriel, D. Russell, P. Osborne, A. Bromley, M. Rowland, S. Creigh-Tyte and C. Brown. 2002. Economic costs of the foot and mouth disease outbreak in the United Kingdom in 2001. *Revue scientifique et technique-Office international des epizooties*, 21(3), 675-685.

Weerahewa, J., K. Meilke and D. Le Roy. 2008. An Economic Assessment of the BSE Crisis in Canada: Impact of Border Closure and BSE Recovery Programs. *Estey Centre Journal of International Law and Trade Policy*, 9(1): 25-37.