



# FEAST OR FAMINE

BUSINESS AND INSURANCE IMPLICATIONS OF FOOD  
SAFETY AND SECURITY



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# 1 EXECUTIVE SUMMARY

**FOOD INSECURITY WILL BE ONE OF THE LARGEST RISKS TO GLOBAL SOCIETY OVER THE NEXT 10 YEARS.** The world's resources are under huge stress and the issue of food security is receiving growing attention. Food security is a situation where 'all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life'. The average person needs 2,300 calories per day to live a healthy and active life. On average, in wealthy nations there is enough for each person to eat an additional 1,100 calories, while in low-income countries, national food supplies fall 100 calories short.

**GLOBAL FOOD AVAILABILITY MUST INCREASE DRAMATICALLY TO KEEP PACE WITH POPULATION GROWTH.** The FAO estimates that the world's population will peak at 9.15 billion in 2050, an increase of 30% on the 2010 population, and it estimates that global food production must increase by 70% to keep pace.

**FOOD INSECURITY IS DRIVEN BY A NUMBER OF DEMAND AND SUPPLY SIDE FACTORS.** On the demand side, global population growth, demographic change, increasing affluence and migration to urban centres are leading to growth in demand for food and changing patterns of consumption. On the supply side, climate change, water scarcity, resource competition and political drivers, amongst other factors, influence food security.

**CLIMATE CHANGE IS ONE OF THE MOST IMPORTANT SUPPLY SIDE DRIVERS OF FOOD INSECURITY WITH THE POTENTIAL TO SUBSTANTIALLY CHANGE GLOBAL FOOD MARKETS.** There is general consensus that the impact of climate change on food production will be largely negative and any modest increases in crop yields in high-latitude regions will be more than cancelled out by losses in the tropics and sub-tropics. Although there is great uncertainty about the location and magnitude of temperature changes, rainfall and extreme events, they all pose a significant threat to agricultural systems and therefore food supply. In many places, but particularly in poorer countries, climate change will act as a multiplier of existing threats to food security by 2050.

**THE EXPOSURES OF FOOD AND DRINKS COMPANIES, IN PARTICULAR, HAVE INCREASED WITH THE GROWTH IN GLOBAL SUPPLY CHAINS.** The more complex and extensive a company's food supply chain, the greater its supply chain risk. Contamination or disruption to one part can affect a number of downstream companies.

**FOOD IS FACING INCREASED COMPETITION FOR LAND USE, WHICH MAY FURTHER DIMINISH THE ABILITY OF SUPPLY TO KEEP PACE WITH DEMAND.** Except for parts of Latin America and Africa, all places where crops could be grown are largely already in use. Rising demand for food and increasing environmental pressure could lead to increasing soil erosion, deforestation and water pollution, further reducing the land available for cultivation.

**THE ISSUES SURROUNDING FOOD SAFETY AND SECURITY CREATE A NUMBER OF DIRECT AND INDIRECT RISKS, AS WELL AS OPPORTUNITIES FOR BUSINESSES.** Risks can be categorised as physical, operational, financial, reputational, geopolitical, regulatory, and societal.

**THERE ARE SIGNIFICANT FINANCIAL RISKS FOR GROWERS, MANUFACTURERS, DISTRIBUTORS, RETAILERS AND FOOD-SERVICE PROVIDERS IMPLICATED IN ILLNESS AND DEATH CLAIMS RELATED TO FOOD SAFETY.** Food safety is the condition that ensures food will not cause harm to a consumer when prepared and eaten as intended. Food security and food safety are interrelated.

**INSURANCE CAN PLAY A LARGE ROLE IN RISK MITIGATION AND MANAGEMENT, AS WELL AS INNOVATION AND INVESTMENT.** In some ways, it is already closing a number of risk management gaps; however innovative insurance solutions, in both the developed and developing world, have the potential to play a larger role in progress towards food security.

## 2 INTRODUCTION

The World Food Summit of 1996 defined food security as existing “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”. This definition implies both physical and economic access to food, and commonly refers to food that meets people’s dietary requirements, as well as their preferences<sup>i</sup>. Food security is generally described as being built on four pillars:

- Food **availability** and **stability**: i.e. sufficient quantities of food are available consistently.
- Food **access**: i.e. people have sufficient resources to obtain appropriate food.
- Food **use**: i.e. food is utilised with due regard to the basic rules of nutrition, and with adequate water and sanitation.

The average person needs 2,300 calories per day to live a healthy and active life. Food supply in advanced countries averages 1,200 calories more per person per day than in low-income economies. On average, among wealthy nations there is enough for each person to eat 1,100 calories above the benchmark, whilst in low-income countries, national food supplies fall 100 calories short.<sup>ii</sup>

Food security is a serious issue, under increasing attention. A report released by Chatham House in December 2012 paints a bleak picture of the world’s food, and other resources, explaining that – whether in terms of supply, demand or trade – they continue to face increasing stress and uncertainty<sup>iii</sup>. Similarly, the World Economic Forum’s Global Risks Report (2012) makes clear that over the next 10 years, in connection with a number of other serious issues – such as water scarcity, climate change, geopolitics, and shifts in consumer power – food insecurity will be one of the largest risks to society.

**FIGURE 1 50 GLOBAL RISKS, BY LIKELIHOOD AND IMPACT<sup>iv</sup>**



Source: World Economic Forum

Armed with this fact, and the recognition that a tightening of food supply would have a significant effect on global economic stability, around 30 sessions of this year's World Economic Forum's meeting in Davos covered environmental and natural resource related issues<sup>v</sup>. In addition, in January 2013, using the momentum gained from President Obama's New Alliance for Food Security and Nutrition (launched in May 2012) and the high level summit on hunger and nutrition hosted by David Cameron in August 2012, organisations such as Oxfam, UNICEF and Christian Aid launched the 'Enough Food for Everyone Campaign IF'. The campaign challenges leaders to take action on tackling hunger and overhauling the global food system. It focuses on four 'ifs' – which broadly correspond to four big issues – land, aid, corporate taxation and good governance – all of which are on the agenda of the G8 Summit in June. Indeed, the launch was timed to coincide with this and the Hunger Summit in the same month, along with the UK Budget, in March.

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## 2.1 REGIONAL IMPACT

The potential for, and impact of, food shortages will vary by location. Through evaluating the availability and stability of, as well as access to, food supplies across 197 countries, Maplecroft produced an index of susceptibility to famine and societal unrest stemming from food shortages and price fluctuations. According to their research, despite strong economic growth over recent years, Africa is the region where food security poses one of the biggest problems. Indeed, Africa accounts for 39 of the 59 most at risk countries, and nine of the 11 'extreme risk' countries<sup>vi</sup>.

In general, developed countries are at lower risk of food insecurity than developing countries and at the level of the private sector, insurance has been (and can be more) successful in closing certain risk management gaps. For example, crop insurance exists in various countries, as do cargo and various supply chain-related insurances. In developing countries, the insurance market is less mature. Indeed, the recent Lloyd's Global Underinsurance Report identified Hong Kong as the only high income country, as measured by GDP per capita, that is underinsured. In a few developing countries, however, microinsurance has been successful in bridging risk management gaps, and has the potential to play an increasingly important role.

The International Association of Insurance Supervisors (IAIS) defines microinsurance as "protection of low income people against specific perils in exchange for regular premium payments proportionate to the likelihood and cost of the risk involved"<sup>vii</sup>. As a rule of thumb, microinsurance is effective as long as products, procedures and policies are simple, premiums are low and distribution channels are innovative<sup>viii</sup>. Besides profit, its benefits to insurers include a larger and diversified risk pool, market intelligence and innovation that can be applied to other business activities.

## 3 DRIVERS OF FOOD SECURITY AND GENERAL IMPLICATIONS

This report will outline both the demand and supply-side drivers of food security. As far as possible (considering the interrelatedness of the drivers and their outcomes), this report outlines and describe the issues associated with each driver, before addressing food safety in more detail. It will examine the various implications for business and insurance and conclude by summarising the various risks and opportunities presented.

### 3.1 DEMAND

#### 3.1.1 Population Growth and Urbanisation

Thomas Malthus, an influential political economist and demographer, asserted that famines are caused by a decline in food availability brought about by an increase in human numbers. He said that it must be acknowledged that,

*“the increase of population is necessarily limited by the means of subsistence, that population does invariably increase when the means of subsistence increase, and, that the superior power of population is repressed, and the actual population kept equal to the means of subsistence, by misery and vice”<sup>x</sup>.*

The FAO estimates that the world's population will peak at 9.15bn in 2050, representing an increase of 30% on the 2010 population<sup>x</sup>. A large proportion of this increase will come from developing countries, as larger and wealthier urban populations demand more and better food. In order to keep pace with this increase in population, as well as satisfy changing consumption habits, the FAO estimates that global food production will have to increase by 70%. Going further, PwC assert that agricultural production will need to increase by 100% in the fastest growing economies, requiring an additional annual investment of \$209 billion<sup>xi</sup>.

While there is an obvious connection between food security and population growth, the famine question involves much more than the issue of population growth. Measuring aggregate food supply against population numbers is misleading, as it does not address the way that resources are distributed. It is more useful to consider the allocation of resources<sup>xii</sup>.

To illustrate this, the US Department of Agriculture (USDA) predicts that the number of food insecure people globally will actually decline by 2020. However, in sub-Saharan Africa, improvements in agricultural productivity and performance will be insufficient to meet population growth rates of 2.4% per year. As a consequence, the USDA predicts a 32% increase in the number of food insecure people in this region<sup>xiii</sup>. In sub-Saharan Africa, there is much more at play than a mere increase in population – for example, poor governance, conflict, instability and structural transformation – all of which must be taken into account in planning and risk management.

An additional consideration is increasing urbanisation, with a corresponding decline in the ratio of food producers to food consumers. Urbanisation brings both changing diets and demands, which in turn creates changes in the way demands are met and to whether farmers, firms, local and national economies benefit or lose out. Urban expansion also tends to take place across a nation's most productive agricultural land as most urban centres grow where they do precisely because of their highly fertile soils<sup>xiv</sup>. Yet, while urbanisation is often considered negative in terms of its impact on agriculture, agricultural producers and rural consumers also rely on urban enterprises for many goods and services – including access to markets.

#### 3.1.2 Affordability

The 'food access' pillar of food security concerns the price - and therefore affordability - of food. In the UK, figures released in mid-April by the Office for National Statistics revealed that food prices increased by 4.6% between March 2011 and 2012, following a 5.2% rise the previous year<sup>xv</sup>. International experience is similar; there have been two dramatic spikes in global food prices since 2008 and as recently as September 2011, food price inflation in, for example, China was running at over 13%.

**FIGURE 2 WORLD FOOD PRICES SINCE 1990<sup>xvi</sup>**



Despite the trend towards higher food prices shown in Figure 3, most of the populations in the UK and the developed world are still able to eat well, and food security is not viewed as a significant problem. However, food price inflation figures are important in determining the *overall* rate of inflation and therefore the country's wider economic fortunes. Additionally, as food prices continue to rise and people experience lower disposable incomes, money is taken out of other sectors of the economy. In 2011, the Office for Budget Responsibility warned that 'under the assumption that wages don't adjust (to rising oil and food prices), consumption will fall and growth will be lower<sup>xvii</sup>'. The UK should also be alert to international food price inflation. Indeed, the global economic recovery, vital to the UK's own recovery, will largely be driven by emerging economies such as China and India, where rising food prices are already an economic threat. Globalisation has led to an unprecedented amount of interdependence and interconnectivity in the global system, bringing immense benefits but also new, systemic risks<sup>xviii</sup>.

In the UK, 2012 was the second wettest year on record. Crops, and therefore livestock, failed to thrive, leaving an estimated £1.3bn financial black hole in the farming sector<sup>xix</sup>. Hovis withdrew its pledge to use only British wheat due to the collapse of the domestic wheat yield and consequent rise in prices. Heavy rains made the UK a net importer of wheat for the first time in 10 years and imports are set to double in 2013. Conversely, in the US, the most severe and extensive drought in the last 25 years hit agriculture in 2012 – particularly grain crops in the Midwest and the Western Corn Belt – forcing the USDA to declare much of the central and southern US wheat belt a natural disaster area. The impact on the crop and livestock sectors prompted fears of food shortages which pushed up food retail prices.

#### Case study: Obesity Tax

In 2011, Denmark was the first country to introduce a 'fat tax' on foods high in saturated fat; products such as butter, oil, sausages, cheese and cream were subject to increases of as much as 9%<sup>xx</sup>. The tax was well intentioned, the theory being that higher prices would reduce consumption and improve public health, and strains on health care budgets would ease<sup>xxi</sup>. However, it ended up being a demonstration of the difficulty in modifying behavior by taxing products largely seen as essential staples, especially during tough economic times. The tax inflated food prices, hurt food businesses and, according to the Danish Food Workers Union, led to a loss of 1300 retail and manufacturing jobs<sup>xxii</sup>. Many Danes bought lower cost alternatives and some (as many as 48% according to one study<sup>xxiii</sup>) crossed the border to Germany or Sweden to take advantage of lower prices.

Large cap companies with diversified product portfolios might feel slightly safer. However, in its most recent annual report, Coca Cola listed obesity-related negative publicity and the possibility of new legislation at the top of its list of 30 risks to profitability<sup>xxiv</sup>.

Finally, food affordability is also affected by commodity speculation. According to numerous news reports, the head of Glencore's food trading business stated in early 2013 that the food crisis would be good for business. Indeed, according to the World Development Movement (WDM), June 2012 markets in food derivatives were awash with \$89bn in speculative cash<sup>xxv</sup>, as financial investors in commodity markets searched for higher yields (rather than merely attempt to diversify risk)<sup>xxvi</sup> and the WDM have identified such cash as a key driver of rising prices. The Economist Intelligence Unit has also noted that instances in which speculators who treat commodity shortages as an investment opportunity have helped exaggerate sustained price rises<sup>xxvii</sup>. Arguably this is happening as financial investors search for higher yields, rather than attempt to diversify risk.

The current crisis exposes the vulnerability of a food system that is increasingly dependent on volatile global trade in a few key crops and commodities. The WDM is keen to reduce any form of betting on prices and has called for greater regulation of the buying and selling of futures contracts. These contracts were initially created to reduce uncertainty, as they ensure a guaranteed price for the producer and a guaranteed product for the buyer and so reduced the risks of doing business for both sides. However, the WDM and

other bodies now believe that trading these contracts like stocks and shares is contributing to food price increases, particularly penalising the world's poorest people.

### 3.1.3 Changing Consumer Tastes

Global population growth, demographic change, increasing affluence and migration to urban centres are leading to growing demand for food and changing patterns of consumption. It can be argued that the roots of current food insecurity lie partly in the continuing reduction of poverty in the developing world, as emerging middle classes in China, India and other developing economies can now afford to eat more. Grain consumption in the developing world has increased 80% over the past 30 years, compared with 22% in advanced economies<sup>xxviii</sup>. More significantly, meat and dairy consumption has increased considerably, particularly in the BRIC economies. Globally, over the past three decades, meat consumption per capita has doubled<sup>xxix</sup>. This trend is continuing; poultry consumption per capita will increase almost three-fold by 2050 and beef consumption more than two-fold, along with a sharp rise in milk consumption<sup>xxx</sup>.

This puts extra pressure on agriculture as meat and animal products are considerably more expensive and resource-intensive to produce than plant-based staples. In order to raise enough cows and pigs to meet meat demand, corn and grains are diverted from people to animals: on a US feed yard, it takes around six kilograms of grain to produce just one kilogram of beef, along with thousands of litres of water.

A further factor in these changing patterns of food consumption is the perception that healthy foods are expensive. Foods with a high energy density (processed foods with high sugar and fat contents) are often cheaper than their less energy-dense counterparts and less vulnerable to price increases, because the cost of the ingredients is a smaller component of the total cost<sup>xxxi</sup>. Rising food prices therefore have the potential to push consumers towards less healthy food. Coupled with the move towards more sedentary lifestyles, the reduced nutritional quality of consumer's diets can increase the risk of obesity, and pose other significant social challenges.

In 2007, the average American ate more than twice as much meat as the average Chinese consumer. Further, consumers in developed countries waste as much food as sub-Saharan Africa produces<sup>xxxii</sup>. The FAO says that more than 40% of these losses happen at retail and consumer levels, where large quantities of food are wasted due to quality standards that overemphasise appearance<sup>xxxiii</sup>; so while increasing affluence and changing diets pose particular challenges, these should be considered as part of the wider context i.e. normal practice in developed nations poses just as many issues.

## 3.2 SUPPLY

### 3.2.1 Climate Change

There are a number of supply-side factors that drive food insecurity; climate change is one of the most important and has the potential to change global food markets substantially<sup>xxxiv</sup>. According to a recent European Environment Agency (EEA) report, *Climate Change, Impacts and Vulnerability in Europe 2012*, the last decade (2002-2011) for Europe was the warmest on record, with various model projections indicating that Europe could be 2.5-4°C warmer in the later part of the 21st century against the 1961-1990 average<sup>xxxv</sup>. Further, the report states that while precipitation is decreasing in southern Europe, it is increasing in northern Europe, a trend predicted to continue. As a result, river flooding is projected to increase in northern Europe, while river flow droughts are set to become more frequent and severe in southern Europe. For global sea levels, the trend is towards an overall increase. The melting rate of the Greenland ice sheet has doubled since the 1990s, and Alpine glaciers have lost approximately two-thirds of their volume since 1850. Although sea level rise varies by location, global average sea level rose by 1.7mm a year in the 20<sup>th</sup> century, and by 3mm a year in recent decades. Future projections are difficult and vary widely, but it is likely that 21<sup>st</sup> century sea level rise will be greater than that of the 20<sup>th</sup> century, increasing the risk of coastal flooding during storm events.

Although there is much uncertainty about the location and magnitude of temperature changes, rainfall, and extreme events, they clearly all pose a significant threat to agricultural systems. There is general consensus that the impact of global warming on food production will be largely negative, with any modest increases in crop yields in high-latitude regions more than cancelled out by losses in the sub-tropics and tropics<sup>xxxvi</sup>. Developing countries are doubly vulnerable as their economies are closely linked to agriculture and a large proportion of their populations rely on agriculture and natural ecosystems for their livelihoods<sup>xxxvii</sup>. In many places, but particularly in poorer countries, climate change will act as a multiplier of existing threats to food security; by 2050, the risk of hunger is projected to increase by 10-20% and child malnutrition is anticipated to be 20% higher than would be the case without climate change<sup>xxxviii</sup>.

Climate change has the potential to affect all four dimensions of food security<sup>xxxix</sup>.

- **Availability:** Climate change is likely to affect food production directly through changes in ecological conditions; changes in land suitability, yields, and the production/cultivation of certain plants are all likely. These changes will depend on latitude; increases in cropland will be likely in higher latitudes, while declines in cropland will be likely in lower latitudes.
- **Stability:** Weather conditions will become more variable and extreme events will increase in frequency and severity. This will lead to greater fluctuations in crop yields and livestock numbers and reduce food supply stability and security. Again, impacts will vary by region, with fluctuations in semi-arid and sub humid regions likely to be the most pronounced.
- **Access:** Climate change may lead to supply shortages and hence food price increases; it may also work indirectly by affecting the growth and distribution of incomes, for example, in places where people depend on agricultural income, and thus demand for agricultural produce. As a result, access to food i.e. the ability of individuals, communities or countries to purchase sufficient food, is likely to decline.
- **Use:** Climate change may start a vicious circle whereby infectious diseases, including water-borne diseases, due to inadequate water, sanitation or storage, lead to or compound hunger, which, in turn, makes the affected population even more susceptible to

those diseases. This could lead to a decline in productivity, an increase in poverty and reduced ability to purchase sufficient food, and so the cycle continues.

### 3.2.1.1 Climate Change Vulnerability

The Maplecroft Climate Change Vulnerability Index evaluates and ranks countries' exposures to climate-related natural hazards and the sensitivity of populations to such hazards, to provide an overall score of climate vulnerability. Perhaps most worryingly, the index classifies seven important global business cities (of a list of 50) as at 'extreme risk' from changing temperatures and weather patterns: Dhaka, Manila, Bangkok, Yangon, Jakarta, Ho Chi Minh City and Kolkata<sup>xi</sup>.

In tropical and sub-tropical regions, especially seasonally dry regions, temperature increases of 2 to 3°C have the potential to reduce crop and livestock productivity significantly. By 2020, climate change could lead to high levels of desertification and salinity in certain areas of Asia, sub-Saharan Africa and Latin America, declines of 40 to 90% of grassland productivity in semi-arid and arid regions; significant decreases in crop yields in some rain-fed African systems and increases in water stress in irrigated production systems<sup>xii</sup>.

As a result of climate change, farmers in the future may also have to contend with new agricultural pests and diseases, as well as more devastating virus and fungi varieties. For example, bluetongue disease, a virus that affects cattle, deer, goats and particularly sheep, was unknown in Northwest Europe until 2006, when an outbreak occurred in the Netherlands and consequently spread. In 2007, it reached the UK and was only kept under control due to the swift action of agricultural authorities<sup>xiii</sup>. Containment will become more difficult as higher temperatures quicken the life cycles of diseases. Bluetongue may return and, more importantly, is a disease that can be spread by insects. Diseases such as schmallenberg, epizootic haemorrhagic disease (EHD) and African horse sicknesses are also spread by midges, and are a very real threat to Europe and the UK<sup>xiii</sup>.

A further concern is that many existing agricultural pests are likely to gain new attributes and characteristics. Aphids, for example, are one of the UK's main agricultural pests, and cause damage of approximately £100 million to cereal crops each year<sup>xiv</sup>. As temperatures increase, aphids are arriving in fields much earlier than used to be the case, leading to crop loss; this is because in early Spring, crops are younger and more susceptible to damage inflicted by the aphids and also to the viruses they carry.

While climate change clearly poses major threats to agriculture, it also brings some opportunities. International agricultural research could contribute to the resilience of millions of people to weather variability and uncertainty; some research might even help to mitigate climate change<sup>xv</sup> - for example, through the development of low emission farming, or the integration of food and energy systems. Climate change also encourages developments and investments in technology, through drought, heat or salt-resistant crop varieties, innovative ways to irrigate crops and new ways to manage soils. Livestock farmers can choose adapted breeds, and alternative, more sustainable, sources of food.

### 3.2.2 Water Scarcity

Global water use has grown at more than twice the rate of population increase in the last century and a growing list of regions are finding it increasingly difficult to meet water demand and deliver sustainable water services<sup>xvi</sup>. This is not just a developing world problem<sup>xvii</sup> - areas including California and Southern Spain have been affected by water scarcity issues. Renewable but finite water resources are under unprecedented levels of pressure, especially in arid regions (also vulnerable to climate change) due to economic and population growth, and demographic change. By 2025, the Food and Agriculture Organisation (FAO) expects 1.8bn people to be living in countries or regions with 'absolute' water scarcity and two-thirds of the world population to be under water 'stress' conditions<sup>xviii</sup>. Compounding the problem is the fact that the availability and geographical location of water resources are subject to constant change<sup>xlix</sup>.

Agriculture is both a cause and victim of water scarcity. Food production affects water availability through land degradation, runoff and disruption to groundwater. It also affects water quality. Water is absolutely key to food security; agriculture is the world's biggest user of water and irrigation uses nearly 70% of all freshwater appropriated for human use. In regions where water is scarce, agriculture will have to compete with other water-intensive industries, such as mining, and with consumers. Competition will be most obvious in the hinterlands of large urban areas, but scarcity can arise anywhere where the intensification of agriculture upstream reduces water supply downstream<sup>i</sup>. With increasing competition for limited water and other natural resources, it becomes necessary to make the best possible use of them, and to make sure that the goods and services produced, including food, are accessible and sustainable to all social groups.

If the global population does increase to 9.15bn by 2050, forcing a 70% increase in food production as the FAO predicts greater pressure will be placed on already-stressed water resources. This is at a time when more water is needed to satisfy global energy demand, which is expected to rise 60% in the next 30 years, and to generate electricity for the 1.3bn people currently without it<sup>ii</sup>. Further, a 2012/2013 report by the Institution of Mechanical Engineers (IME) found that approximately 550bn cubic metres of water is wasted globally in crop production that never reaches consumers<sup>iii</sup>, and that 60%-100% more food could be produced through eliminating waste. Both urbanisation and the related increase in demand for commercially-prepared, easily-consumed food lead to a longer food chain and hence even more food wastage. As a result, the future might include governmental (or other institutional) educational campaigns, taxation on certain water-intensive foods, or waste fees – all of which are risks to businesses, as well as consumers.

A further potential concern is the scope for political disagreements over water, and the potential for military conflicts. 145 countries share lakes and river basins, and more than 30 countries have been involved in water wars<sup>iiii</sup>. Potential areas of tension include the Mekong Delta, where China is planning eight dams that will divert water from Myanmar, Thailand, Laos, Cambodia and Vietnam; Bangladesh and India, where 54 rivers flow between the two countries, and India is planning to divert water from the Ganges to its water-poor areas in the south. Turkey and Syria have both dammed the Euphrates, with consequences for downstream Iraq<sup>iv</sup>. Indeed, many of the areas where water shortages are particularly problematic are the areas where there are existing political problems. Any region where these conditions combine to cause conflict, as well as any dependent region, would be at increased risk of food insecurity.

### 3.2.3 Availability of Supply

The ability to feed a rapidly growing population over the last 50 years has largely been down to advances in crop and livestock production achieved by intensification (i.e. the increased use of fertilisers, pesticides and irrigation) rather than by extending the amount of land devoted to agriculture<sup>lv</sup>. However, the UN has warned that future yield increases will likely depend on extensification rather than productivity gains – and these will come at the expense of biodiversity. Expansion is, however, limited and, except for parts of Latin America and Africa, the areas where crops could be grown are largely already in use. There has been an additional loss of productive land to urbanisation, desertification, salinisation and soil erosion, a situation likely to be exacerbated by climate change. Therefore, the worry is that rising demand for food and increasing environmental pressure will lead to increasing soil erosion, deforestation and water pollution, further reducing the land available for cultivation and diminishing the ability of supply to keep pace with demand. Brazil has been suffering delays to the harvest because of wet weather. In India, it is feared that 2012's below-average monsoon rains will reduce rice and sugar output, after two bumper years, while 2012's US drought -the most severe and extensive in at least 25 years - seriously affected US agriculture. The adverse weather conditions have affected many field crops, including corn, soybeans, sorghum and hay<sup>lvi</sup>.

In addition to the impact of climate change, there is growing competition over land use; such as for amenity and biodiversity. Increasing pressure from non-food crops, such as renewable energy and more specifically biofuels, is particularly strong. Their development has been encouraged as a means to mitigate climate change and alleviate global energy concerns – both of which tie into food security – yet their production also has implications for sustainability and for food security due to competition for land and water. Increased production of biofuels and consequent land use competition has been held responsible by some experts for a large proportion of the recent food price spike.

The 'fuel versus food' debate is familiar, but the actual extent of its impact is uncertain and estimates vary considerably. The impacts of biofuel production are dependent on context, and will vary by type of crop, technology, region, and country characteristics. Currently, most of the world's agricultural biofuels come from sugarcane in Brazil, and corn in the US – and both of these crops are grown with heavy use of inputs i.e. land, water, fertiliser; an assessment of how food security will be impacted needs to take into account the inputs used, and how the use affects market supply curves for food production<sup>lvii</sup>.

A reduction in the 'supply' of land, for whatever reason, is clearly a factor in food security and one that many countries are taking steps to alleviate. In September 2011, Oxfam reported that up to 227 million hectares of land in developing countries had been sold, leased, or put under negotiation since 2001 (and in large part since 2008). Most was sold to international investors<sup>lviii</sup> in the US, China, Saudi Arabia, South Korea and India<sup>lix</sup>. The figures vary depending on the source, but it is clear that the scale of these transactions is unprecedented.

The reasons for these purchases are widely debated. According to Oxfam, land scarcity for agriculture coupled with volatile world food prices are leading wealthy nations that import food to buy up land overseas in order to secure future food supply. The International Food Policy Research Institute adds that 'increased pressures on natural resources, water scarcity, export restrictions imposed by major producers when food prices were high, and growing distrust in the functioning of regional and global markets have pushed countries short in land and water to find alternative means of producing food'<sup>lx</sup>. Land scarcity and competition over use has led to significant land value rises and, as a consequence, growing levels of investments from a range of institutional investors, from pension funds and hedge funds to universities. Working through hedge funds, wealthy US universities are investing up to \$500 million into African land deals, with expected returns of 25%<sup>lxi</sup>. In the US, there is a hedge fund that owns enough farmland to make it the 15<sup>th</sup> largest farmer in the country<sup>lxii</sup>.

Another issue to consider when looking at the availability of supply relates to the availability of key inputs, such as fertilisers and fuel. Nitrogenous fertiliser is highly dependent on energy in the production process and is therefore vulnerable to higher energy prices. Agriculture's dependence on oil-based fuels is critical in most contemporary agricultural systems. Phosphates are a finite mineral resource also potentially subject to cost-price pressures. Phosphorus fertiliser is extracted from phosphate rock, a non-renewable resource that is used almost exclusively in agriculture. The demand for phosphorus has increased and prices soared by 800% between 2006 and 2008<sup>lxiii</sup>. The shortage of phosphorus is not only due to a drop in the availability of phosphate ore, but also to the cost of purchasing and using phosphorus-based fertilizer. In addition, phosphorus use in the food system is so inefficient that only one fifth of the phosphorus in the rock that is mined actually makes its way into our food.

A final consideration with regard to availability is that of the supply chain. As an example, the fuel protests in the UK in 2000 led to panic buying and warnings that supermarkets, unable to replenish supplies, would run out of food within just five days<sup>lxiv</sup>. As the UK food chain runs on a 'just in time' basis, rather than a 'just in case' basis, it is vital that every link in the chain runs smoothly to avoid failure - there is currently enough food in the system to last the UK 10 days<sup>lxv</sup>. While this does not make the UK food insecure, it does mean that complacency would be misguided, and the implications of knock-on effects need to be accounted for.

### 3.2.4 Politics and National Security

On the supply side, two of the main causes of food price volatility and lack of economic access to food are inefficient governance and market distortion practices. Inefficient markets in poorly governed countries, the increased cost of transportation due to fuel price inflation, damage (and non-repair) to infrastructure, hoarding, cartels (particularly of staple foods) and grain and animal smuggling, all cause food inflation and can all be tackled through better governance locally<sup>lxvi</sup>.

At the international level, the relationship between food security, conflict and revolution needs to be better understood. Food security has a major influence on national politics, which, in turn, can have a significant impact on food availability. When food prices were at record highs in 2008, riots broke out in a number of countries around the world, including Burkina Faso, Cameroon, Cote d'Ivoire, Egypt and Bangladesh. In Haiti, at least five people were killed and the government was toppled as the price of rice, beans and fruit rose more than 50%. Revolution also deposed the government of Madagascar, while in Darfur food and water related conflict left 500,000 people dead and created two million refugees<sup>lxvii</sup>.

Some analysts argue that high food prices also played a part in the recent Arab Spring protests in North Africa and the Middle East; there is strong evidence that rising food prices were an important catalyst of unrest in Tunisia in 2010. Conflicts overseas also have the potential to impact and endanger domestic interests through the disruption of trade and the economy, the displacement of people, and the expense of post-conflict reconstruction. Food price inflation is not simply the changing relationship between supply and demand. A more globalised world and food system means a more interdependent one too. A zero sum game i.e. a situation where one country's gain must be balanced by another's loss, makes the system particularly vulnerable to governments succumbing to panic, hoarding foods or limiting exports<sup>lxviii</sup>. Following severe drought and wildfires in 2010, Russia announced that it would be banning all grain exports to prevent a rise in domestic food prices. This helped raise global wheat prices to a two year high, and prices of other crops, including barley, rice and corn, also rose sharply<sup>lxix</sup>.

Policymakers also need to be aware of, and prepared for, food chain shocks much closer to home. While the likelihood of UK food-related unrest is small, MI5's (the British Security Service) maxim that we are just 'four meals from anarchy'<sup>lxx</sup> reflects concern that any significant disruption to food supply could potentially result in large-scale public disorder.

## 4 FOOD SAFETY

Food safety concerns the conditions and practices that ensure food is safe when prepared and eaten as intended. Food safety necessarily impacts on food security as food security is defined by people's access to safe and nutritious food. Indeed, food security and food safety are interrelated and there are many external factors that affect both areas.

### 4.1 GM CROPS

Fifty years ago, UK yields of wheat were four to five tons a hectare. Today, thanks to the 'green revolution' involving the development of new crop varieties, greater use of agro-chemicals and changes to farming practices, yields are between eight and 10 tons<sup>lxxi</sup>. Scientists say that a revolution of similar magnitude is now required, and some argue that the creation of a range of new crop varieties is absolutely vital.

The importance of creating new crop varieties is also highlighted by the appearance of new crop diseases. For example, Ug99 – so called because it was first seen in Uganda 1999 – is a variety of the wheat disease black stem rust, and has spread across Africa and Asia in recent years, destroying harvests and livelihoods. It is of particular concern because it can infect crops in just a few hours and invisible spores can be carried by the wind for hundreds of miles. Scientists have recently discovered a Ug99-resistant strain of wheat called Sharon grass, which has raised hopes that the outbreak might be contained<sup>lxxii</sup> and it is hoped that other key pests, including Striga (a weed that reduces Maize yields) and Banana Wilt (highly contagious bacterial disease with major impacts in East Africa), can similarly be solved through science.

Crop yield improvements delivered by better agricultural practices and technological improvements accounted for nearly 78% of the increase in crop production between 1961 and 1999<sup>lxxiii</sup>. Technology remains an important consideration today. At the heart of the agricultural biotechnology debates over the last decade has been the question of whether genetically modified crops can increase food security (safely and sustainably) for farmers and consumers, particularly in the developing world. Genetic modification is a technology that transfers genetic material from unrelated or related organisms into recipient plants or animals, in order to give them desirable features, such as improved yields, greater resistance to pests, or tolerance to drought. Indeed, the initial objective for developing plants based on GM organisms was to improve crop protection, through the introduction of resistance against plant diseases caused by insects or viruses, or through increased tolerance towards herbicides<sup>lxxiv</sup>. For example, GM means that resistance against late blight (which plagues potato farmers and allotment holders in the UK and elsewhere, and precipitated the 19<sup>th</sup> century Irish potato famine) can be given to a particular variety of potato. Either way, GM foods are developed and marketed because of some perceived advantage to the producer, consumer - or both. Arguably, they are a crucial way to help agriculture meet world food demand.

In 2011, 160 million hectares of GM crops were planted by 16.7 million farmers in 29 countries<sup>lxxv</sup>. The USA is the global leader in biotechnology and, despite historic widespread political opposition, GM crops are also increasingly being grown within the EU. GM food products are still, however, relatively few. This is due to a number of related controversies, the key ones being the risks of GM foods being dangerous to human health, questions over the need for GM foods to be labelled, the role of government regulators, the effect of GM crops on the environment and the place of GM within the industrial agricultural system. GM critics use terms such as ' Frankenfoods' and 'terminator gene', to promulgate the perceived dangers and fear of the unnatural associated with GMO technology. Opponents have warned of the potential for a generation of super weeds, whereby the eradication of other competitors may create space for other species<sup>lxxvi</sup>. Finally, debates on biotechnology and its potential impact on food security also revolve around issues of access and control and the effects of patents on the types and availability of biotechnologies developed<sup>lxxvii</sup>. The majority of GM organisms worldwide are grown by just three multinationals; Monsanto, for example, controls 90% of all GM seeds<sup>lxxviii</sup>. Restrictive intellectual property rights arguably slow and limit the role of technology in helping to feed the world, and critics argue that technology is, in any case, a mere quick fix that ignores the social, economic and political institutions and structures in which food security problems are rooted.<sup>lxxix</sup>

Despite initial criticisms, the regulatory approach seems to be softening. Greenpeace now describes GM as 'not an area of priority' and the GM industry is claiming that the media has been overly influenced by ill-informed anti-GM campaigners<sup>lxxx</sup>. Many international organisations and aid donors believe that if the public and private sectors work together then the needs of farmers and consumers in the developing world can be addressed, and GM can be harnessed to feed into better, more sustainable agriculture. However, GM cannot be seen as the magic bullet, and it must be borne in mind that companies and insurers could face liability costs and issues. It is still important to review the way in which food is farmed, produced and consumed, and to consider the wider social, financial, economic, environmental and political issues.

### 4.2 CLIMATE CHANGE

As there is only limited evidence on the effects of climate change on diets, the effects on food safety cannot be definitively stated; the common line seems to be 'altered risks and increasing unpredictability'<sup>lxxxi</sup>. Among the possible side effects of climate change on food safety are<sup>lxxxii</sup>:

- > An increase in cases of food poisoning – as pathogens that cause food poisoning grow best in warm and moist environments. Warmer temperatures may also mean that bacteria in animal feed multiply faster;
- > An increase in pest contaminants: Mycotoxins are harmful compounds produced by naturally occurring fungi that colonise grain, fruits, vegetables, and tubers. Climatic conditions are incredibly influential in their development, and while mycotoxins appear worldwide – in up to 25% of the world's food crops – the greatest threat is currently in the tropics, where environments favour fungal growth. Climate change may alter this. Generally, crops are most susceptible to fungal infection when they are under stress induced by water scarcity, heat, or invasion by pathogens. Recurrence of drought brought about by climate change may accentuate mycotoxin problems;

- > Heavy rainfall, which may wash farmland contaminants into reservoirs;
- > Algal blooms: When phosphates and nitrates are introduced into water systems, perhaps due to heavy rainfall, the resulting high concentrations cause increased growth of algae and plants. Algae tend to grow very quickly, but each alga is short-lived, which results in a high concentration of dead organic matter. This starts to decay, which uses up oxygen, and results in depleted oxygen levels in the water. Without sufficient oxygen, large numbers of animals and plants may die. A harmful algal bloom is one that causes harm to other organisms; they are often associated with large-scale marine mortality events, and have been associated with various shellfish poisonings, and;
- > More power cuts and power crises (from flood and drought conditions), which will impact refrigeration.

The fact that climate change will affect the volume of the food supply, for example, through decreases in crop productivity or shorter growing seasons, will also impact on food safety. For example, in areas where food resources have been obliterated, illnesses associated with mycotoxin moulds are becoming more prevalent, as people try to stretch their reduced food supplies over longer periods of time<sup>lxxxiii</sup>.

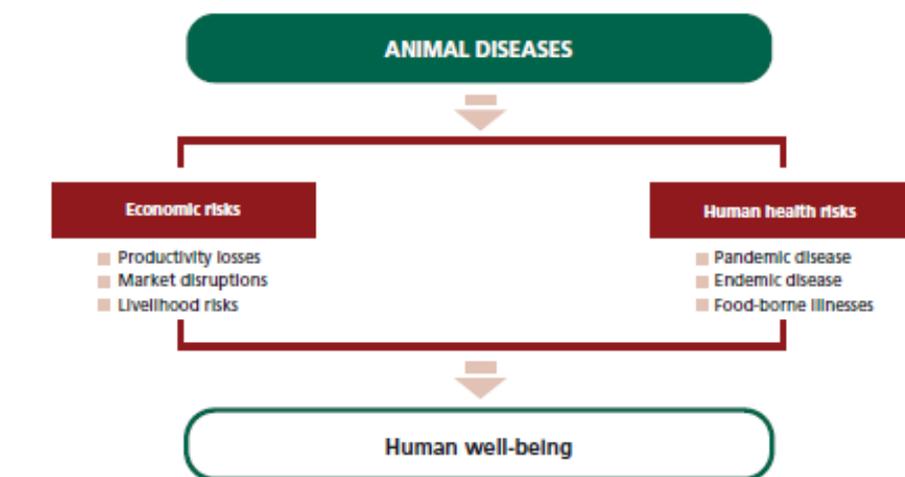
### 4.3 NEW DISEASES

Consumers are becoming more vocal about the potential risks to food safety of food-borne diseases such as salmonella and E. coli, and the spread of diseases from livestock to humans, such as animal influenza. Food-borne diseases, resulting from the ingestion of contaminated food, are a growing global public health concern, encompassing a wide spectrum of illnesses, ranging from those caused by a multitude of microorganisms, to those caused by chemical hazards<sup>lxxxiv</sup>. According to the World Health Organisation, food-borne diseases cause approximately 76 million illnesses and 5,000 deaths each year in the US, and these numbers are rising at an alarming rate<sup>lxxxv</sup>.

There are significant financial risks for growers, manufacturers, distributors, retailers and food-service entities implicated in illness and death claims resulting from food or beverage contamination. Regardless of the source of the contamination, there may be consequences for any part of the supply chain<sup>lxxxvi</sup>. Financial damage may include costs resulting from product recall, decontamination or other recovery costs, lost sales and profits, litigation costs, brand and reputational damage, trade restrictions and reduced stock price company valuation<sup>lxxxvii</sup>. In early January 2013, the US Food and Drug Administration proposed new food safety rules aiming to make farms and food manufacturers more accountable for reducing foodborne illnesses, i.e. to prevent problems rather than merely react to them<sup>lxxxviii</sup>. Under the new rules, producers (foreign or domestic) of food to be sold in the US need to develop a formal plan that prevents their products causing illness.

Animal diseases can also have severe impacts on human wellbeing:

### IMPACTS OF ANIMAL DISEASES ON HUMAN WELLBEING<sup>LXXXIX</sup>



Source: FAO.

Animal diseases can both severely constrain trade economic wellbeing, and directly impact human health. A new International Livestock Research Institute report to the Department for International Development; *Mapping of Poverty and Likely Zoonoses Hotspots 2012*, maps hotspots of human-animal infectious diseases and emerging disease outbreaks. The report finds that animal borne disease is a heavy burden to one billion of the world's poor. According to the study, Ethiopia, Nigeria, Tanzania and India have the highest zoonotic disease burdens, with widespread illness and death<sup>xc</sup>. Those most severely affected are those to whom agriculture and livestock matter the most, as well as those on whom food security is hugely dependent. The report also suggests that increasing global demand for livestock products is likely to lead to a wide range of human-animal diseases. Indeed, the north-eastern US, Western Europe (particularly the UK), Brazil, and parts of Southeast Asia may be hotspots of emerging zoonoses, i.e. those that are newly infecting humans, newly virulent, or newly drug-resistant.

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#### 4.4 AGROTERRORISM

Whilst previous sections have focused on accidental contamination of the food supply, this section highlights the importance of considering intentional contamination. Agroterrorism is the deliberate use of biological, chemical or radiological agents as weapons against the agricultural industry and food supply<sup>xcii</sup>. The agricultural sectors of all nations are vulnerable to terrorism, as agriculture might be seen as an easy sector to disrupt and carries potentially catastrophic consequences. Throughout human history, civilian food supplies have regularly been sabotaged during military campaigns as a tactic to terrorise or otherwise intimidate populations and, ultimately, to weaken opponents. Deliberate contamination of food can occur at many points in the food supply system depending on the food, the hazardous agent and the target.

Potential threats to the food chain include the sabotage of open field crops and water pipes, contamination of condiments in restaurants, or the destruction of food reserves. For example, US security officials have previously warned that al Qaeda have researched poisoning public buffet bars with lethal toxins such as ricin and cyanide<sup>xciii</sup>. The Arab Revolutionary Council used mercury to poison oranges in Israel in 1978, causing orange exports to decline significantly. In 1997 Israeli settlers used pesticides to spray Palestinian grapevines, causing the loss of seventeen thousand metric tons of produce. In 1952 in Kenya, the Mau Mau used the African milk bush to poison and kill cattle<sup>xciiii</sup>. Besides reducing food availability, an agroterrorist attack can reduce confidence in the safety of a country's food exports, create political instability, and put companies out of business.

The sector is vulnerable to attacks from many angles, but primarily by ideologically and politically motivated groups. According to the FBI, the agroterrorism threat in the US (though arguably also internationally) emanates from four categories of perpetrators<sup>xcv</sup>. The predominant threat comes from transnational groups such as al Qaeda, who are believed to be the most likely to inflict economic harm on the US. The second group includes economic opportunists with the aim of manipulating markets. They understand the potential impact of a disease outbreak on markets and, by introducing disease, are able to exploit markets for personal profit. Domestic terrorists make up the third category; those who see agroterrorism as a way to harm the state government. Also in this category are disillusioned individuals or employees. Finally, the fourth group is comprised of militant animal rights or environmental activists, who consider it wrong to use animals for food. Certain groups could see an attack on the food industry as a positive event. Groups such as these exist in most countries.

It is not just in the Western world that agroterrorism poses a threat. Gulf Cooperation States (Saudi Arabia, Oman, Kuwait, UAE, Qatar and Bahrain) are investing money into increasing domestic production and strategic food reserves and, as such, are equally interested in ensuring their safety. There is a regional threat of terrorists contaminating supplies with biological, chemical, physical or radio nuclear materials and, although the contamination of the whole food supply chain is highly improbable, crucial parts are vulnerable<sup>xcvi</sup>. A particular vulnerability in the Gulf region concerns desalination plants, which GCC states rely heavily upon for potable water. If these were damaged, Gulf States would only have, on average, three days of reserves. They could be damaged in a variety of ways, but arguably the most worrying threat is that of an oil spill, either accidental or intentional, where tar balls could damage or clog the intakes<sup>xcvii</sup>. The high volume of desalination plants and oil facilities in the Gulf make it particularly vulnerable; there is a 300 mile stretch of the coast of the UAE that contains 10 tanker ports, three coastal refineries, and 40 desalination plants.

## 5 SUMMARY OF RISKS AND OPPORTUNITIES TO BUSINESS

Food risks have several implications for business. This section summarises the key threats and separates the direct threats to businesses from the wider ramifications to the economy at large. The final section suggests potential opportunities for the insurance industry presented by gaps in risk management.

### 5.1 RISKS

#### 5.1.1 Physical and Operational

Any kind of reduction in the availability of food, or of the land on which it can be grown, has a direct impact on primary producers and agribusinesses throughout the supply chain – on raw material inputs and therefore on the amount of products sold – and can potentially adversely affect turnover and profits. Agriculture, food retail and hospitality industries could all be affected as a consequence.

Some of the main operational risks facing businesses are consequences of globalisation and interdependence. In the case of sugarcane, for example, a sudden fall in global demand due to competition from artificial sweeteners and high-fructose syrups, in addition to quotas imposed in the EU and the US, destabilised economies. Similarly, overexpansion in the production of coffee and cotton led to supply surpluses and lower prices, exacerbated by barriers to trade. New trade flows are creating new interdependencies and new risks; for example, cereal imports from Russia and the Ukraine to the Middle East and North Africa region have overtaken those from the EU and the US, and increasing Chinese meat consumption has reorganised soybean trade between China and South America<sup>xcvii</sup>. It is clear that trade is evolving; businesses need to carefully consider, and thoroughly risk assess, their proposals when embarking on new methods of trading or pursuing contracts in unfamiliar territories.

Linked to this is supply chain risk; it is vital that businesses are aware of all parts in their supply chain. As food supply chains become increasingly global, the risks of disruption to supply, traceability and accountability increase, and supply chain risk management becomes increasingly important. Simultaneously, the drive for efficiency and the move to just-in-time production have reduced stock levels throughout the supply chain, so reducing its resilience to emergencies. The 2008 Chinese milk scandal hospitalised over 50,000 babies and killed six, after they consumed melamine-tainted milk powder produced by the Chinese Sanlu Group. Subsequently, New Zealand, the EU and the US had to issue product warnings in order to contain the spread of melamine-related kidney failure amongst infants in other countries.

Terrorism experts see agroterrorism as an increasing operational risk<sup>xcviii</sup>. Any food or drink product that is produced on a grand scale, stored in large quantities or for long durations, and then distributed quickly, is particularly at risk of an agroterrorist attack. The potential for this increased where ingredients and other inputs are sourced from a distance, making it difficult to monitor and control quality. There are also several risk multipliers; for example, if a consumer ingests contaminated food or drink, it could take considerable time before a diagnosis is made and the source traced. Perhaps the most obvious threats are those to farmers, open fields, livestock and cargo. Restaurants should also be alert to the possibility of tampering, particularly with regard to condiments. Grocery stores, businesses involved in transportation and insurance companies could also be significantly affected.

Any kind of agroterrorist incident could have a reputational impact on a company, or even an entire industry, and so lead to a loss of sales and profits. This lack of confidence might also extend to the wider economy in a region or country, affecting numerous businesses and that domestic economy. It is easy to see how this might then lead to political instability, conflict, the use of food as a political tool, and the involvement of other governments or supranational bodies.

The direct cost of the 2001 outbreak of foot and mouth disease in the UK was \$1.6 billion in compensation to farmers. As expected, the output loss was heavily concentrated in the agricultural and food manufacturing sectors. Indirectly, the lost revenue due to decreased tourism – largely down to the psychological impact of the epidemic – was an estimated \$4 billion<sup>xcix</sup>. Many other sectors, including manufacturing, construction, wholesale and retail, transportation, communication and tourism, were adversely affected.

Indirect costs also included the costs of controlling and managing the disease. With outbreaks such as this, the cost of control measures carried out by state veterinary services, such as vaccination, outbreak control and culling and compensation are often borne by the tax payer. While foot and mouth disease was a naturally occurring outbreak, it does act as an indicator of the potential costs and effects of an intentional agroterrorist attack.

#### 5.1.2 Financial

One of the financial risks related to food security is that of commodity speculation. Though there can be opportunities to profit from volatile commodity prices, there are also numerous risks attached. In the long term, food price speculation could pose a threat to food security, with risks such as hunger, rioting and wider civil unrest.

Volatility and instability (exacerbated by commodity speculation) could also pose problems: Market instability and the inability to predict the state of the economy makes anticipating future price patterns difficult and creates significant price risk/uncertainty for market participants. Markets could be at risk of being distorted and futures contracts may become more tightly regulated. Food contamination could also have significant impacts on food suppliers and retailers. Businesses could face risks and costs associated with product recall, decontamination, lost sales/profits, litigation, brand and reputational damage, trade restrictions and reduced company valuations.

Food price inflation is also a large financial risk to businesses and is likely to lead to a situation where a greater proportion of household income is spent on food, while less money is spent elsewhere. As retaining and winning customers becomes more difficult, non-food

businesses will therefore need to find new ways to compete. Due to higher costs of living, businesses might also face pressure from employees and unions to increase wages.

Certain areas could be hotspots of animal diseases transmittable to humans, and both the financial and wider social effects could be devastating if the outbreak of Severe Acute Respiratory Syndrome (SARS) is anything to go by; this claimed nearly 800 lives and caused global losses totalling \$50 billion<sup>c</sup>. Emerging infectious diseases (EID) pose risks to the health of both humans and animals. Businesses may incur losses from the culling of animals, or from food wastage due to actual or suspected contamination. The food and agriculture, life sciences, and health care industries face the greatest risks from EID, and are also those with the potential to mitigate losses. In addition, industries such as retail, aviation, hospitality, media, finance and logistics are at indirect risk of economic loss. EID can also affect global employment as well as absenteeism – due to infection, fear of infection or caring for infected family members. Broader problems, such as economic recession and further unemployment, may result.

### 5.1.3 Geopolitical

Food security is necessarily a political issue. At a national level, the agriculture-food-poverty nexus is an important risk to both governments and businesses. While drought and other naturally occurring climatic events might trigger food shortages, government action or inaction will help to determine their severity, and the potential for crisis.

At the international level, the increase in globalisation over the last 20 years has had an impact on firms' trading partners, supply chains and markets (both in terms of supply and demand). Governments have the capacity to alter, transform, and even jeopardise these business relationships in a number of ways, for example, through restrictions on exports or imports. Any limitation or ban on imports or exports would affect import- or export-dependent countries. Import-dependent countries that are not able to grow their own food, or a particular type of food, could be unable to afford food imports which have doubled or tripled in price. Similarly, farmers and countries dependent on money from exports would lose out if certain trade restrictions were enforced.

Businesses might acquire land because they expect food and commodity prices to increase. Some governments have promoted the purchase of land abroad in order to secure the supply of affordable food for their citizens. Though it may be argued that initial foreign investment in agriculture in Africa is necessary to improve productivity and market access, there are a number of pitfalls; recent news reports would suggest that large land deals can be problematic – both from a legal and reputational perspective. Land grabbing could cause geopolitical and reputational risk to a number of businesses and financial institutions. For example, the lack of public disclosure in many cases could cause local tensions. On the other hand, the buying of land abroad has the potential to build positive relationships. Egypt, for example, is offering access to its natural gas in return for land in the Ukraine. Qatar is planning to lease 40,000 hectares of agricultural land in Kenya to grow fruit and vegetables, in return for building a port close to Lamu<sup>d</sup>.

As well as having operational implications, the terrorism threat obviously also has a geopolitical element. Certain businesses might find themselves at direct risk, or at greater threat than others of a terrorist attack, for example, due to the location of their HQ or flagship store, or because of their brand image. Multinational businesses could be targeted for various political/ideological reasons in local countries. Indirectly, businesses might be affected by terrorism events that take place further up or down the supply chain (for example by disruptions to inputs or because of reputational issues), or they might be affected on an industry or country level, for example, via sanctions or through a loss in confidence in a country's ability to protect its infrastructure or supply chains.

### 5.1.4 Regulatory, Legal and Reputational

Any scarce or limited resource is likely to eventually become the subject of regulation. Non-compliance with such regulation carries a number of risks to business, primarily financial and reputational. For example, environmental pollution takes many forms, and could be the subject of various and differing international regulation in the future; a direct risk to food and drink producers that pollute the natural environment. Risks include financial penalties, investigation, litigation, prosecution of key personnel, the withdrawal of operating licences and detrimental shareholder action. Similarly, the Food Safety Modernization Act (FSMA) is the most sweeping reform of US food safety laws in decades. Increased enforcement, tougher penalties and stricter regulation around record-keeping will present a variety of risks to businesses. However, by going beyond the standards set down by the new legislation, food businesses also have an opportunity to increase trust and loyalty.

Businesses producing or using GM crops face a multitude of risks: It is important to consider and question the effects of GM food on human health, issues around long-tail liabilities, the possibility of superweeds, issues surrounding access and control, questions around competitiveness, and debates around the power of large corporations. All of these pose challenges to regulators, who must ensure that the disadvantages of the introduction of new technologies are kept to a minimum, whilst simultaneously enabling maximum benefits. For example, if intellectual property and patent law are strongly and universally enforced, then the potential of GM is unlikely to benefit the developing world. Stricter GM regulation in some places than others may also lead to trade disputes, customer concern and a loss of public trust. Also, more stringent food labeling creates higher costs for businesses, which may be passed on to consumers, though arguably this is better for insurers, reducing questions over liability.

Increasing scrutiny over land acquisitions are also likely to lead to increased regulatory risks for businesses. Indeed, it is possible that 'fair use' or 'land grab free' labels could be used on food and non-food products over the next decade<sup>ei</sup>; it is important for businesses to be aware, and alert to this trend. On the one hand, there are some governments and international agencies trying to draw up globally agreed standards for land investments, while on the other hand, the corporate sector is drawing up its own standards, which are also voluntary.

It is likely that businesses will have to adhere to more stringent legislation surrounding food safety, particularly with regard to food-borne diseases, and 'contamination' events. Even if they believe the regulatory risks to be low, businesses may wish to consider the reputational implications of such an event, as the recent horsemeat scandal showed. Four supermarket chains operating in the UK –

Aldi, Iceland, Lidl and Tesco – had to withdraw a number of beef products after horse DNA was found in some of the burgers that they were selling<sup>ciii</sup>. Customers were not only concerned about the direct effects, but also their wider implications, particularly the seeming lack of control over something so integral to their operations. Due to modern communications technologies and social media such as Facebook, issues such as these are easily made public and public pressure builds fast.

#### Case Study: Horsemeat Scandal

On January 16<sup>th</sup> 2013, the Food Safety Authority of Ireland found traces of equine DNA in products supplied to various UK supermarkets and ten million burgers were subsequently taken off the shelves by supermarkets including Tesco, Lidl, Aldi, and Iceland. The European beef-processing industry is, like a lot of today's globalised food chain, dominated by a handful of players (and the implicated meat processing companies supply a number of retailers throughout Europe); consequently, a number of other supermarkets and fast food joints were forced to withdraw certain frozen products<sup>civ</sup>.

On February 4<sup>th</sup>, production at another meat supplier was suspended when equine DNA was again found in raw ingredients. On February 7<sup>th</sup>, Findus beef lasagnes (made by Comigel) were found to contain up to 100% horsemeat; Comigel was making cheap beef meals for supermarkets and branded companies in 16 different countries so the scandal spread rapidly, with ready meals being withdrawn in Germany, Sweden, Belgium, the Netherlands, Switzerland, as well as Ireland and the UK<sup>cv</sup>.

On February 19<sup>th</sup>, Nestle and the world's top beef producer, JBS, were the latest to be caught up in the scandal when Nestle confirmed that horse DNA had been found in products made with meat supplied by German firm H.J.Schypke<sup>cvi</sup>. JBS, which used H.J.Schypke as a subcontractor, said that it would stop buying European meat "until confidence is restored in the European beef supply chain"<sup>cvii</sup>.

Aside from financial and reputational damage (ABP Foods, for example, is estimated to have lost £38 million in contracts), businesses are also likely to be affected by changing consumer behaviours as a result of the scandal. 24% of 2,257 UK adults surveyed by Consumer Intelligence said that they would buy less processed meat, 21% said that they were buying less meat in general, and 62% said that they were more likely to buy meat from independent shops<sup>cvi</sup>.

#### 5.1.5 Societal

Businesses are clearly influenced in a number of ways by the societies in which they operate. They have an interest in population size, composition and economic development, for example, which all have a bearing on the level of disruption that might be caused by a food shortage, and a firm's chances of navigating a crisis. Lack of access to food is a political problem, and could lead to protests, demonstrations, looting and theft should any part of the supply chain fail, depending on other vulnerabilities in that society.

Increasing public interest in food and nutrition will have a direct impact on food producers, manufacturers and retailers. For example, people are more likely to have an open mind about innovation when they can see clear benefits and are assured that there are safeguards. Similarly, cultural changes – in terms of consumer norms, expectations and sense of responsibility – will also influence buying patterns and therefore, for example, organic/fair trade/non 'land grab' businesses. Recent research indicates a positive correlation between corporate social responsibility and firm value for firms in controversial industries. Over recent years, there has also been a step change in attitude to the point where, arguably, in the Western world there is now something of a litigation culture. People can be quick and eager to appoint blame, and claim compensation accordingly.

Additional societal problems involving food include obesity and other diseases. Nutritional deficiency and trends towards less healthy diets, along with more sedentary lifestyles, pose risks for a number of industries. Diet-related illness not only increases the likelihood of work absenteeism, which is a business overhead, but it can also lead to the impairment of performance with implications for productivity and turnover.

Food insecurity can easily trigger the destruction of other human rights such as the right to education, when children are forced to contribute to the family income instead of going to school, or the right to health when malnutrition and unbalanced diets lead to diseases.

## 5.2 OPPORTUNITIES FOR BUSINESSES

Food security and safety issues are likely to lead to a number of opportunities for business. Some examples are:

- > **Innovative ways of preserving the life of foodstuffs:** This would lessen the impact of supply shocks and reduce the incidence of foodborne diseases resulting from eating food which has deteriorated. Preservation is likely to become more important with climate change, as growing seasons change and conditions harshen.
- > **Higher calorie, nutrient-rich foodstuff for developing countries:** This would create underlying conditions which reduce the impacts of a supply shock i.e. a healthier, better-nourished population.
- > **Inexpensive healthy foods:** As above, though applicable globally and should lead to healthier lifestyles.
- > **Risk management opportunities:** For example, microinsurance and other innovative solutions in developing countries. There is already some activity in this regard, but there is still great potential for microinsurance to bridge many risk management gaps. Risk management solutions in developing countries might be achieved through joint ventures, with recognition given to the knowledge and traditions of target countries.
- > **Growing customer base:** Population growth and emerging middle classes with changing tastes present businesses with new target markets and spread and diversify risks. Emerging middle classes bring an opportunity for businesses to win customers early and gain early advantages. In 17 product categories in the United States the market leader in 1925 remained the number-one or number-two market player for the rest of the century<sup>cx</sup>. These companies include Kraft Foods (Nabisco) in biscuits; Del Monte in canned fruit; and Wrigley in chewing gum.
- > **Growth of cities:** Roughly 400 midsize cities in emerging markets are poised to generate nearly 40% of global growth over the next 15 years<sup>cx</sup>. This provides an opportunity for new markets and distribution routes. McKinsey research shows that companies that more readily reallocate budgets towards opportunities tend to outperform their more cautious competitors.
- > **Technology:** There is certainly an opportunity for some kind of technological revolution. GM is arguably one option. Alternatively, British sugar and artificial sweetener maker, Tate & Lyle, are launching a venture capital fund to research and develop a new generation of ingredients that could revolutionise food. Tate & Lyle's Chief Executive wants the fund to invest in businesses involved in food science and technology that might help the company grow its specialist food ingredients division<sup>cx</sup>. They believe that there are major growth opportunities in making food healthier, improving convenience and targeting emerging markets. Similarly, a recent report published by the Royal Society of Chemistry highlights innovative research in soil science as 'fundamental' in overcoming food insecurity. The report draws on input from a wide variety of academic, industry and government experts and promotes the concept of 'precision agriculture', where nutrient are targeted more precisely at soils and crops. In a speech at the Royal Society in November, George Osborne chose agricultural research as one of eight areas in which he sees the UK as a world leader. As with any change to business processes, liability underwriters will need to assess the risks.

## 6 INSURANCE IMPLICATIONS

### 6.1 ROLE OF INSURANCE IN MITIGATING FOOD RISKS

All-encompassing risk management strategies that help to reduce and mitigate various food risks are an important part of ensuring food security and safety. In this respect, insurance is vital, and its role in mitigating the various risks highlighted in this report needs to be better understood. Insurance already plays a significant role in the food industry in helping businesses, from farmers and growers through to retailers and the hospitality industry, manage their risks. However, insurance can play an even more significant role in mitigating and reducing food risks, including food insecurity and the issues around food safety. Indeed, meeting growing demand for food will require huge investments – something fraught with risks during a time of economic recession. Innovative insurance solutions and multi-stakeholder cooperation can play a large role in progressing towards a more food-secure future.

### 6.2 AGRICULTURAL INSURANCE

Agricultural insurance is 'indispensable' for managing agricultural risks as well as being vital to increasing agricultural production<sup>cxii</sup>. It is not only limited to the insurance of crops, although crop insurance represents the majority of premiums, but also includes the insurance of livestock, forestry, aquaculture and greenhouses. The scope of coverage is expanding from pure property to include liability and other financial exposures. Agricultural insurance products range from indemnity-based products (which constitute the bulk of premiums) to innovative solutions including index-based products, microinsurance and public private partnerships (PPP).<sup>cxiii</sup>

It is estimated that half of all countries have some form of agricultural insurance; a large proportion (>80%) of these have mature programmes while the others are piloting new schemes (Mahul & Dutley 2010<sup>cxiv</sup>). In 2009 the global agricultural insurance premium volume was estimated at about \$19.4bn, North America being the largest market (World Bank 2010<sup>cxv</sup>). By 2011 global agricultural insurance premiums had risen slightly to \$23.5bn, around \$5bn of which was generated from emerging markets (primarily China and India)<sup>cxvi</sup>. Agricultural insurance clearly represents an important portion of global insurance, with great potential for growth in emerging markets.

Crop insurance, which functions as a government subsidy to the farming community, has become a very popular risk management tool/financial safeguard in the US. It is much favoured over actual state crop subsidies and farmers and banks are supportive of the insurance industry in opposing any cuts to the program. However, 2012 proved to be a bad year for crop insurance as it was the first time in 10 years that the insurance industry made a loss from such business. The severe drought in summer 2012 means that US taxpayers may have to pay \$15bn to subsidise the privately run crop insurance program. 280 million acres of US crops were insured by the 15 companies that sell crop insurance, including Wells Fargo, QBE, ACE, American Financial Group and Endurance. Agricultural economists believe that companies will pay out \$2bn - \$3bn on top of the \$11bn that they collected in premiums<sup>cxvii</sup>. Currently the government pays approximately 62 cents of every \$1 in crop insurance premiums and bears the brunt of the losses in bad years; this and the consequent burden on taxpayers is likely to put crop insurance under increased scrutiny<sup>cxviii</sup>. Despite these losses, agricultural insurance continues to be considered a lucrative business as highlighted by the recent entrances of Starr International and XL Group into crop insurance. Nevertheless, insurers should be aware of their exposures in this area, especially when taking into account the rising threat of climate change to crop yields, water scarcity issues and the growing severity of extreme weather events, as the 2012 US summer drought has shown.

### 6.3 SUPPLY CHAIN RISK AND BUSINESS INTERRUPTION INSURANCE

All businesses have a supply chain and continuity of supply will be absolutely critical. Supply chain failure may result from a number of causes, ranging from climate-related natural disasters to day-to-day administration. Today's business environment arguably increases these risks, as supply chains are more complex, regulatory requirements increasingly burdensome, and threats more unpredictable. The exposures of food and drinks companies have increased with the growth in global supply chains: the more a company sources its ingredients from around the world, the greater its supply chain risk. Contamination or disruption to one part of the chain can affect a number of downstream companies. Food supply risks include oil price shocks, economic downturns, climate change, loss of fresh water services, natural disasters, pandemics, terrorism, regulatory requirements and even cyber security attacks (as so much business is now conducted online).

Significant food supply chain interruption can cause heavy financial losses and reputational damage to businesses throughout the chain. Natural disasters, for example, have the potential to expose manufacturers, distributors, retailers, contractors and other service providers to devastating income losses. Lack of inputs may mean that businesses are unable to produce and sell certain products, affecting their turnover, cash flow, and ability to pay creditors. It may also force them to negotiate new contracts with suppliers.

Given the importance of processes and timing in the delivery of food products, cover against supply chain risk could be vital for the food industry. Supply chain risk presents an opportunity for the insurance industry to play a bigger role in mitigating food risks and the recent horsemeat scandal only highlights the necessity for businesses to manage risks along their supply chains. This event has prompted numerous companies to review their supply chains; for example, IKEA is enforcing new controls along their meatball supply chain and have vowed that they will shorten the chain to trace all meat back to its origins. Incidents such as like the horsemeat case will most probably encourage companies to be more aware of their suppliers; however, they also demonstrate that businesses still lack awareness of their own supply chains, despite numerous previous cases of food contamination. Experts have said that this scandal may prompt insurers to devise new products to fill certain coverage gaps<sup>cxix</sup>, clearly indicating the potential for new business in this market. Insurance can also help to encourage businesses to understand their supply chain better, particularly their vulnerable supply points, and thereby improve supply chain management and preparedness in the event of a crisis.

Standalone Business Interruption insurance can cover more than most standard property insurance policies, where business interruption is typically provided as an add-on, only where there has been physical damage. Typically, Business Interruption coverage will include lost profits, fixed costs (i.e. costs still being incurred by the property) and any extra reasonable expenses beyond fixed costs<sup>cxix</sup>. Ultimately though, firms and insurers should get to the point of being able to craft the most relevant coverage to any particular company, determining the causes of loss that are able to trigger the policy, territorial scope, what happens in the circumstance that there is no direct physical damage, limits of indemnity and duration of the coverage.

In recent years, particularly following the Thai floods, there has been a significant amount of publicity around the scheduling of Business Interruption/Contingent Business Interruption. CBI exists to provide coverage for the policyholder's lost profits caused by loss to a key customer's or supplier's property, or to other "dependent property" not owned by the policyholder but relied upon for its business operations<sup>cxxi</sup>. Sometimes this coverage is provided only where the dependent property is identified in a schedule and where the cause of loss is identified as covered. But this is not always the case, and most policies define "dependent properties" generally to include contributing locations, recipient locations and manufacturing locations even if they are not specifically identified in the policy<sup>cxvii</sup>. This can obviously lead to potential accumulation issues for insurers. Both the insured and the insurer need to have a clear overview of the schedule for there to be a sensible degree of risk transfer.

## 6.4 PRODUCT LIABILITY AND RECALL

The level of safety and quality of a company's product(s) is a shop window into their brand. Therefore any kind of design fault, internal manufacturing error, malicious tampering, or similar, will have a significant effect on their reputation and ability to win customers. Product recall insurance provides support in this regard, through protecting a company's balance sheet, revenue and contracts. It is becoming more and more important, particularly in the food and drink industry, as a result of new laws, higher safety standards, increasing regulation, more complex supply chains, heightened consumer awareness and instant communication.

It should be emphasised that Product Liability insurance is not a direct substitute for Product Recall insurance, as Product Liability insurance is only triggered if a product enters the supply chain and causes physical damage or bodily injury. Arguably the bigger opportunities and exposure may exist with product liability and general liability cover for commercial organisations, where more extensive cover may be necessary in the future. Product liability exposure should be carefully managed with regards to food safety. With both Product Liability and Product Recall, insurers should be aware of the level of risk and the capital implications. There is a certain amount of overlap between Product Liability and Product Recall as the following example shows.

### Case Study: Peanut Corporation of America

In 2009 the US Food and Drug Administration issued a recall of products distributed from Peanut Corporation of America (PCA)'s Plainview, Texas facility because of suspected salmonella contamination posing a significant threat to food safety. In total almost 4,000 products made with peanut butter and peanut paste produced by the PCA were recalled from just fewer than 400 companies. The contamination resulted in over 700 confirmed infections and at least nine deaths and civil lawsuits were filed across the country. PCA filed for bankruptcy and their CEO was obliged to appear before Congress under Congressional subpoena. The peanut industry suffered losses of \$1bn, sales fell 25%, and companies refocused on their reputations for safety in order to distance themselves from negative press<sup>cxviii</sup>. This case shows how food safety issues can have significant financial and reputational impacts on businesses.

The Peanut Corporation of America case is one of the reasons for closer regulatory scrutiny and highlights the catastrophic effects of a product recall – in this case, one where liability claims also featured. Product recall and liability claims are not only risks for the businesses accused and responsible, but also those across the supply chain and industry. According to JLT in 2010, less than 10% of food manufacturers had product recall insurance, with the majority relying on traditional product liability cover<sup>cxvix</sup>. On the whole, this was not an informed choice; businesses were unclear of the benefits and coverages of both, in many cases mistakenly thinking that their liability policy would pay out in the event of recall when in fact it would not.

In the UK recalls in the food and drink sector doubled from 35 in 2010 to 70 in 2011<sup>cxv</sup>. High profile cases, such as the horsemeat scandal, have also raised concerns and, as industry exposure has grown, requirements surrounding product recall and contamination insurance have become more common in contracts between retailers, suppliers and manufacturers<sup>cxvi</sup>. Product recall insurance reimburses costs associated with a recall and consequent replacement of a product in the marketplace. It protects a company's balance sheet, revenue and contracts with customers, thereby providing financial support as well as protecting the brand. Coverage may include pre-recall expenses (costs of testing and analysis), consultant costs, first party product recall expenses (for example, costs incurred in advertising the recall, the costs of recovering the product, costs of disposal, overtime paid to employees, refunds to purchasers, gross earnings loss), rehabilitation costs i.e. re-establishing the brand and reputation, third party recall liability (financial losses incurred by the third parties of which the insured is liable) and defence/legal costs.

With regards to product liability, the long term impact of Genetically Modified Organisms (GMOs) may pose a number of risks, including environmental risks - which will be dealt with in more depth below – as well as health, economic and broader social, cultural and moral risks. There is still a lot of debate around GMOs and their associated risks, with Europe taking a much more conservative approach to this new technology than the US. It is worth remembering that the long-term effects on human health and the environment are difficult to test<sup>cxvii</sup>. Health risks could include allergic reactions, problems with the immune system and risks associated with malnutrition. Economic risks include the risk of organic farmers losing their accreditation or crops no longer qualifying as organic as a result of pollen flow from GMO crops. Broader social, cultural and moral risks include issues such as the effects of mono-culture (which is believed to be associated with GMO crops), consequences for employment and indigenous people (e.g. displacement of traditional farming) and adverse moral issues related to biotechnology. In order to protect themselves against these risks, businesses need to consider insurance solutions.

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## 6.5 ENVIRONMENTAL LIABILITY

Intensive farming (for example, the increased use of fertilisers, pesticides and irrigation) has a number of detrimental effects, including soil degradation, salination of irrigated areas, over-extraction and pollution of groundwater, resistance to pesticides, and erosion of biodiversity. Agriculture can also damage the environment by means of deforestation and the emission of greenhouse gases or other air pollutants. The above factors coupled with rising demand for food and environmental pressures will have further negative environmental repercussions. The risks associated with intensive farming and agriculture have come under the spotlight in recent years, and led some authorities to take a strict stance on environmental liability.

Environmental liability has become a major issue and will become a growing area of interest. Regulations around this issue, such as the EU Environmental Liability Directive (ELD) and the Environmental Damage (Prevention and Remediation) Regulations, which address agricultural activities' environmental liability, highlight growing public and governmental concern and impose greater demands and increasing pressure on companies. These regulations put the onus on the operator of any potentially polluting or environmentally damaging activity to take proactive action to prevent and, where necessary, remediate any environmental damage caused. Liabilities created by the ELD are unlikely to be covered by a standard third party liability or property insurance policy, and may even be specifically excluded<sup>cxxviii</sup>. As environmental remediation can be extremely costly, companies should assess their potential exposures and consider the use of specialist insurance products to protect themselves against the costs associated with pollution and environmental damage and the clean-up for which they will be liable.

GMOs are another area of concern for European regulators with regards to environmental liability. Environmental risks relating to GMOs may involve the transfer of genetically modified material to other species ('gene transfer'), resulting, for instance, in 'super-weeds' and the risk of displacement or overgrowing of other species ('risk of establishment' or 'displacement'). Given rising public and governmental concern, the ELD, as adopted, imposes strict liability with respect to environmental damage caused by certain activities involving GMOs, while any operator of an occupational activity is subject to a fault liability regime for damage to protected habitats and species. Although the regulatory approach is generally softening, businesses and insurers should bear in mind that GMO technology could become subject to long-tail environmental liabilities

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## 6.6 TERRORISM AND POLITICAL RISK

Food shortages and price volatility can lead to political unrest, strikes, riots and civil commotion – as seen in a number of developing countries recently – and competing land use claims have the potential to be a major driver of conflict. Water scarcity will also have major repercussions for society and businesses. Political risk insurance can protect against many of these risks including; political violence, such as revolution, insurrection, civil unrest, terrorism or war; governmental expropriation or confiscation of assets; governmental frustration or repudiation of contracts; wrongful calling of letters of credit or similar on-demand guarantees; business interruption; and inconvertibility of foreign currency or the inability to repatriate funds. The cover for political risk is extensive and the demand for political risk insurance, driven by rising civil unrest and political violence, has increased in 2012<sup>cxxix</sup>. Considering the potential significance of food insecurity risk and its political repercussions, the market is only likely to see further increases.

The take up rate of contaminated product and crisis response products to address these risks is relatively modest and, too often, viewed as a discretionary purchase<sup>cxxx</sup>. A particular agroterrorism worry is that Al Qaeda and other terrorist groups may develop/maintain an active interest in chemical, biological, radiological and nuclear (CBRN) attacks. Indeed, a low-technology biological attack, such as contamination of the food supply, could be seen as relatively 'easy'. Many companies look to the London (or alternative) market for stand-alone products and tailored coverage in this regard. However, the market is currently fairly limited in size and capacity, with only \$2 or \$3bn available, which suggests that some companies could remain underinsured against a major terrorist event<sup>cxxxi</sup>.

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## 6.7 INSURANCE IN DEVELOPING COUNTRIES

Insurance will not be the sole solution in emerging markets and developing countries, but it can help in raising awareness of the importance of risk mitigation and management and in encouraging investments. Various people could benefit, and at multiple levels; for example, farmers, producers, governments, communities and agribusinesses. Research has shown that in rural areas in developing countries, loss of crops and livestock are considered important risks to low income populations<sup>cxxxii</sup>. These populations highlight the opportunity to develop non-traditional insurance tools, such as microinsurance or index insurance<sup>cxxxiii</sup>. Traditionally, microinsurance has mainly focused on life assurance, but opportunities for agricultural and livestock cover also exist. The opportunity for insurers to tap a new market is there; however, the appetite remains limited. At present, agricultural insurance penetration in emerging markets is very low and far from the level that it has the potential to be. Indeed, by 2025 premiums in emerging markets could reach an estimated \$15-20bn<sup>cxxxiv</sup>. However for these kinds of figures to be realised will require: "Proactive and enabling government policies, supportive infrastructure, innovative products, cost-effective business models, new distribution channels, and advanced technology. Arguably, much of this could be achieved by partnering with insurers"<sup>cxxxv</sup>.

Significant benefits are likely to be gained from establishing an early position in these new markets. Given their potential size, insurers may be wise to quickly develop insurance and microinsurance coverage adapted to the demands of this market.

## 7 CONCLUSIONS AND RECOMMENDATIONS

This report summarises why food safety and security are important issues for businesses, as well as the insurance industry.

Food issues are complex and multifaceted – there are social, cultural, economic and scientific issues – with myriad local, national and global implications for society, business and governance.

The food chain is facing many interrelated challenges – shortages, price rises, diet and health issues, environmental issues and food safety concerns – compounded by the equation of increasing demand and increasing challenges to supply systems.

Globalisation has led to an unprecedented level of interdependence and interconnectivity in the global system, something that brings immense benefits as well as systemic risks.

Many businesses will be exposed either directly or indirectly to risks stemming from food safety or security. There are numerous potential physical, operational, financial, reputational, geopolitical, regulatory and societal risks, which businesses should be aware of and alert to.

Businesses also have an opportunity to mitigate such risks. In this sense, they must proactively address the issues covered in this report. This may not be achievable internally or singlehandedly. In fact, the nature of the issues means that many will require global cooperation.

Food security has a major influence on national and international politics. A globalised world and food system means that it is a system particularly vulnerable to governments and businesses succumbing to panic, hoarding foods or limiting exports. In the past, non-governmental/ intergovernmental organisations have measured and managed the risks faced by vulnerable populations. Now, insurance is well placed to play a large role in progress and in enhancing food production, processing and trading systems – by providing effective risk management advice and expertise, as well as risk transfer.

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- <sup>i</sup> World Health Organisation, 2013, Food Security <http://www.who.int/trade/glossary/story028/en/>
- <sup>ii</sup> Farming First, 2012, What is driving food insecurity in 2012? <http://www.farmingfirst.org/2012/07/what-is-driving-food-insecurity-in-2012/>
- <sup>iii</sup> Chatham House, 2012, Lee, B. et al, Resources Futures, [http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/1212r\\_resourcesfutures.pdf](http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/1212r_resourcesfutures.pdf)
- <sup>iv</sup> World Economic Forum – Global Risks 2012, Seventh Edition (For the latest report please see [www.weforum.org/globalrisks2013](http://www.weforum.org/globalrisks2013))
- <sup>v</sup> The Guardian, 2013, Waughray, D, Davos 2013: Why food security will be on the agenda, <http://www.guardian.co.uk/sustainable-business/food-resource-security-agenda-davos>
- <sup>vi</sup> Maplecroft, 2012, Food security in 75% of African countries at high or extreme risk, [http://maplecroft.com/about/news/food\\_security\\_risk\\_index\\_2013.html](http://maplecroft.com/about/news/food_security_risk_index_2013.html)
- <sup>vii</sup> International Association of Insurance Supervisors, 2007, Issues in Regulation and Supervision of Microinsurance, [www.iaisweb.org/view/element\\_href.cfm?src=1/2495.pdf](http://www.iaisweb.org/view/element_href.cfm?src=1/2495.pdf)
- <sup>viii</sup> Lloyd's. 2009, Insurance in Developing Countries: Exploring Opportunities in Microinsurance <http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Other/InsuranceInDevelopingCountries.pdf>
- <sup>ix</sup> Malthus, T.R. 1798. An essay on the principle of population. J Johnson, London.
- <sup>x</sup> Stutley, C, 2012, Promoting Food Security in a Volatile Climate: The Role of Agricultural Insurance, [http://www.kfw-entwicklungsbank.de/ebank/EN\\_Home/Sectors/Financial\\_system\\_development/Events/Symposium\\_2012/Paper\\_C\\_Stutley\\_Symposium\\_2012.pdf](http://www.kfw-entwicklungsbank.de/ebank/EN_Home/Sectors/Financial_system_development/Events/Symposium_2012/Paper_C_Stutley_Symposium_2012.pdf)
- <sup>xi</sup> PricewaterhouseCoopers, 2012, Food Security: Can APEC feed itself?, <http://www.pwc.com/us/en/apec-ceo-summit/2012/food-security.jhtml>
- <sup>xii</sup> University of Cambridge, 2011, Food Security: Your questions answered, <http://www.cam.ac.uk/research/discussion/food-security-your-questions-answered/>
- <sup>xiii</sup> Stutley. C, 2012, Promoting Food Security in a Volatile Climate: The Role of Agricultural Insurance
- <sup>xiv</sup> Satterthwaite, D. et al, 2010, Urbanization and its implications for food and farming, *Phil. Trans. R. Soc. B* 2010 **365**, 2809-2820, <http://www.bis.gov.uk/assets/foresight/docs/food-and-farming/drivers/dr13-urbanisation-implications-food-and-farming.pdf>
- <sup>xv</sup> The Telegraph, 2012, Grant, G, Why food security is not just a problem for the Third World, <http://www.telegraph.co.uk/news/uknews/9224240/Why-food-security-is-not-just-a-problem-for-the-Third-World.html>
- <sup>xvi</sup> Source: Food and Agriculture Organization of the United Nations, 2013, FAO Food Price Index, <http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/>.
- <sup>xvii</sup> The Telegraph, 2012, Grant, G, Why food security is not just a problem for the Third World
- <sup>xviii</sup> Lloyd's, 2010, Goldin, I, Globalisation and Risks for Business [http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Globalisation/Lloyds\\_360\\_Globalisation.pdf](http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Globalisation/Lloyds_360_Globalisation.pdf)
- <sup>xix</sup> The Financial Times, 2013, Kuchler, H & Lucas, L, Extreme weather to hit consumers and farmers, <http://www.ft.com/cms/s/0/c480ead2-5a82-11e2-b60e-00144feab49a.html#axzz2HZGK7Rli>
- <sup>xx</sup> The Wall Street Journal, 2012, Bomsdorf, C, Denmark scraps much maligned 'fat tax' after a year, <http://online.wsj.com/article/SB10001424127887323894704578113120622763136.html>
- <sup>xxi</sup> The Economist, 2012, Denmark's food chances: A fat chance, <http://www.economist.com/news/europe/21566664-danish-government-rescinds-its-unwieldy-fat-tax-fat-chance>

- <sup>xxii</sup> The Washington Post, 2012, Khazan, O, What the world can learn from Denmark's failed fat tax, <http://www.washingtonpost.com/blogs/worldviews/wp/2012/11/11/what-the-world-can-learn-from-denmarks-failed-fat-tax/>
- <sup>xxiii</sup> The Economist, 2012, Denmark's food chances: A fat chance
- <sup>xxiv</sup> Schroders, 2012, Somers, C, Should investors worry about an 'obesity tax'?, <http://www.schroders.co.uk/staticfiles/Schroders/Sites/Americas/US%20Institutional%202011/pdfs/Talkingpoint-Should-Investors-Worry-About-Fat-Tax.pdf>
- <sup>xxv</sup> Bristol 24-7, 2012, James, R, Fridge contents reflect world on brink of food crisis, <http://www.bristol247.com/2012/08/30/fridge-contents-reflect-world-on-brink-of-food-crisis-27023/>
- <sup>xxvi</sup> United Nations Conference on Trade and Development, 2012, Financial Liberalization and the Financialization of Commodity Markets, <http://dgff.unctad.org/chapter2/2.6.html>
- <sup>xxvii</sup> BBC News, 2012, Q&A: World food and fuel prices, <http://www.bbc.co.uk/news/business-18857765>
- <sup>xxviii</sup> Time, 2011, Schuman, M, A Future of Price Spikes, <http://www.time.com/time/business/article/0,8599,2083276,00.html>
- <sup>xxix</sup> Ibid
- <sup>xxx</sup> Joachim von Braun, 'Supply and Demand of Agricultural Products and Inflation - How to Address the Acute and Long-Run Problem', IFPRI, Prepared for the China Development Forum, Beijing (22 – 24 March 2010), <http://www.ifpri.org/sites/default/files/pubs/pubs/confpapers/20080322jvbchinaforum.pdf>
- <sup>xxxi</sup> Food Standards Agency, 2010, Lake, I, Abdelhamid, A & Hooper, L, Food and Climate Change: A review of the effects of climate change on food within the remit of the Food Standards Agency, [http://www.foodbase.org.uk/admintools/reportdocuments/575-1-1008\\_X02001\\_Climate\\_Change\\_and\\_Food\\_Report\\_28\\_Sept\\_2010.pdf](http://www.foodbase.org.uk/admintools/reportdocuments/575-1-1008_X02001_Climate_Change_and_Food_Report_28_Sept_2010.pdf)
- <sup>xxxii</sup> BBC News, 2011, One third of world's food is wasted, says UN study, <http://www.bbc.co.uk/news/world-europe-13364178>
- <sup>xxxiii</sup> The Independent, 2013, Musoke, R, Over a billion tonnes of food produced goes to waste every year – FAO, <http://www.independent.co.ug/news/news/7303-over-a-billion-tonnes-of-food-produced-goes-to-waste-every-yearfao>
- <sup>xxxiv</sup> Lloyd's, 2009, Dyer, G, Climate Change and Security: Risks and Opportunities for Business, [http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Climate%20reports/Climatechangeandsecurity\\_200904.pdf](http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Climate%20reports/Climatechangeandsecurity_200904.pdf)
- <sup>xxxv</sup> European Environment Agency, 2012, Climate change evident across Europe, confirming urgent need for adaptation, <http://www.eea.europa.eu/pressroom/newsreleases/climate-change-evident-across-europe>
- <sup>xxxvi</sup> Lloyd's, 2009, Dyer, G, Climate Change and Security: Risks and Opportunities for Business
- <sup>xxxvii</sup> The Consultative Group on International Agricultural Research, 2009, Climate, agriculture and food security: A strategy for change, [http://cgiar.bio-mirror.cn/pdf/CCAFS\\_Strategy\\_december2009.pdf](http://cgiar.bio-mirror.cn/pdf/CCAFS_Strategy_december2009.pdf)
- <sup>xxxviii</sup> Inter-Agency Standing Committee, 2009, Submitted by WFP, FAO, IFRC, OXFAM, WHO, WVI, CARE, CARITAS and Save the Children, Climate change, food insecurity and hunger, [www.humanitarianinfo.org/iasc/downloadaddoc.aspx?docID=5031](http://www.humanitarianinfo.org/iasc/downloadaddoc.aspx?docID=5031)
- <sup>xxxix</sup> Overseas Development Institute, 2009, Ludi, E, Climate change, water and food security, <http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/4116.pdf>
- <sup>xlv</sup> The Consultative Group on International Agricultural Research, 2009, Climate, agriculture and food security: A strategy for change
- <sup>xlvi</sup> Food and Agriculture Organization of the United Nations, accessed 2013, Water scarcity, [http://www.fao.org/nr/water/topics\\_scarcity.html](http://www.fao.org/nr/water/topics_scarcity.html)

- 
- <sup>xlvi</sup> Lloyd's, 2010, Pegram, G, Global Water Scarcity: Risks and Challenges for Business, [http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Climate%20reports/7209\\_360\\_Water\\_Scarcity\\_A\\_W.pdf](http://www.lloyds.com/~media/Lloyds/Reports/360/360%20Climate%20reports/7209_360_Water_Scarcity_A_W.pdf)
- <sup>xlvi</sup> Food and Agriculture Organization of the United Nations, accessed 2013, Water scarcity
- <sup>xlvi</sup> Lloyd's, 2010, Pegram, G, Global Water Scarcity: Risks and Challenges for Business
- <sup>l</sup> Food and Agriculture Organization of the United Nations, 2008, Coping with water scarcity: An action framework for agriculture and food security, <http://www.fao.org/docrep/016/i3015e/i3015e.pdf>
- <sup>li</sup> Jägerskog, A, & Jønych Clausen, T (eds.) 2012, Feeding a Thirsty World – Challenges and Opportunities for a Water and Food Secure Future. Report Nr. 31. SIWI, Stockholm, [http://www.siwi.org/documents/Resources/Reports/Feeding\\_a\\_thirsty\\_world\\_2012worldwaterweek\\_report\\_31.pdf](http://www.siwi.org/documents/Resources/Reports/Feeding_a_thirsty_world_2012worldwaterweek_report_31.pdf)
- <sup>lii</sup> Institution of Mechanical Engineers, 2013, Global Food: Waste Not, Want Not, [http://www.imeche.org/Libraries/Reports/Global\\_Food\\_Report.sflb.ashx](http://www.imeche.org/Libraries/Reports/Global_Food_Report.sflb.ashx)
- <sup>liii</sup> Global Food Security, accessed 2013, Future Trends, <http://www.foodsecurity.ac.uk/issue/future.html>
- <sup>liii</sup> Ibid
- <sup>liii</sup> Jones, A. et al. 2013. Resource constraints: The Evidence and Scenarios for the Future
- <sup>liii</sup> United States Department of Agriculture, 2013, US drought 2012: Farm and food impacts, <http://www.ers.usda.gov/topics/in-the-news/us-drought-2012-farm-and-food-impacts.aspx>
- <sup>liii</sup> Food and Agriculture Organization of the United Nations, 2008, The State of Food and Agriculture in Asia and the Pacific Region in 2008, <http://www.fao.org/docrep/010/ai411e/AI411E04.htm>
- <sup>liii</sup> Jones, A. et al. 2013. Resource constraints: The Evidence and Scenarios for the Future
- <sup>liii</sup> The Oakland Institute, 2012, Prateek, G, Land Grabbing: All in the name of Food Security?, <http://www.oaklandinstitute.org/land-grabbing-all-name-food-security>
- <sup>liii</sup> von Braun & Meinzen-Dick (2009) as cited by Jones, A. et al. 2013. Resource constraints: The Evidence and Scenarios for the Future
- <sup>liii</sup> Vidal & Provost 2011 as cited by Jones, A. et al. 2013. Resource constraints: The Evidence and Scenarios for the Future
- <sup>liii</sup> GE Food Alert as cited by Jones, A. et al. 2013. Resource constraints: The Evidence and Scenarios for the Future
- <sup>liii</sup> Science Daily,, 2010, <http://www.sciencedaily.com/releases/2010/03/100311092124.htm>
- <sup>liii</sup> The Telegraph, 2012, Grant, G, Why food security is not just a problem for the Third World
- <sup>liii</sup> Ibid
- <sup>liii</sup> United Nations Chronicle, 2012, Suleri, A, Hunger: A National Security Threat, <http://www.un.org/wcm/content/site/chronicle/home/archive/issues2012/thefuturewewant/hungeranationalsecuritythreat>
- <sup>liii</sup> The Telegraph, 2012, Grant, G, Why food security is not just a problem for the Third World
- <sup>liii</sup> The Council on Foreign Relations, 2013, Johnson, T, Food Price Volatility and Insecurity, <http://www.cfr.org/food-security/food-price-volatility-insecurity/p16662>
- <sup>liii</sup> The Washington Post, 2010, Eunjung Cha, A & Zacharia, J, Russia bans grain exports because of fire and drought, sending prices soaring, <http://www.washingtonpost.com/wp-dyn/content/article/2010/08/05/AR2010080502470.html>
- <sup>liii</sup> The Huffington Post, 2011, Fletcher-Brown, M, Riots: Remember the four meal rule, [http://www.huffingtonpost.co.uk/mark-fletcherbrown/riots-remember-the-four-meal-rule\\_b\\_927882.html](http://www.huffingtonpost.co.uk/mark-fletcherbrown/riots-remember-the-four-meal-rule_b_927882.html)
- <sup>liii</sup> The Guardian, 2009, Mckie, R, Why Britain faces a bleak future of food shortages
- <sup>liii</sup> Ibid

- lxxiii National Intelligence Council, 2012, Global Trends 2030: Alternative Worlds, [http://www.dni.gov/files/documents/GlobalTrends\\_2030.pdf](http://www.dni.gov/files/documents/GlobalTrends_2030.pdf)
- lxxiv World Health Organisation, accessed 2013, 20 questions on genetically modified foods, <http://www.who.int/foodsafety/publications/biotech/20questions/en/>
- lxxv Royal Geographical Society Report
- lxxvi Ibid
- lxxvii Eldis, accessed 2012, <http://www.eldis.org/go/topics/resource-guides/agriculture/key-issues/biotechnology-and-governance/gm-crops-and-food-security>
- lxxviii Royal Geographical Society Report
- lxxix Eldis, accessed 2012, <http://www.eldis.org/go/topics/resource-guides/agriculture/key-issues/biotechnology-and-governance/gm-crops-and-food-security>
- lxxx Royal Geographical Society Report
- lxxxi Food Standards Agency, 2010, Lake, I, Abdelhamid, A & Hooper, L, Food and Climate Change: A review of the effects of climate change on food within the remit of the Food Standards Agency
- lxxxii The Chartered Institute of Environmental Health, accessed 2013, Climate change and food safety, [http://www.cieh.org/policy/climate\\_change\\_and\\_food\\_safety.html](http://www.cieh.org/policy/climate_change_and_food_safety.html)
- lxxxiii Eat Drink Better, 2011, Shulman, R, Climate change is making food less safe, <http://eatdrinkbetter.com/2011/02/23/climate-change-makes-food-less-safe/>
- lxxxiv World Health Organisation, 2012, Initiative to estimate the global burden of foodborne diseases, [http://www.who.int/foodsafety/foodborne\\_disease/ferg/en/](http://www.who.int/foodsafety/foodborne_disease/ferg/en/)
- lxxxv Marsh and McLennan Companies, 2009, Hersh, M & Shaw, H, Food Safety Strategies: How to Protect Your Company and Your Consumers, [http://www.mmc.com/knowledgecenter/viewpoint/Food-Safety\\_Strategies\\_Protect\\_Your\\_Company\\_and\\_Your\\_Consumers.php](http://www.mmc.com/knowledgecenter/viewpoint/Food-Safety_Strategies_Protect_Your_Company_and_Your_Consumers.php)
- lxxxvi King & Spalding Law, 2012, Insurance Coverage for Food and Beverage Contamination Claims and Recalls, <http://www.kslaw.com/imageserver/KSPublic/library/publication/ca090412a.pdf>
- lxxxvii Marsh and McLennan Companies, 2009, Hersh, M & Shaw, H, Food Safety Strategies: How to Protect Your Company and Your Consumers
- lxxxviii Defending Food Safety, 2013, Stevens, S, Ensuring Compliance under the FDA's New Proposed Food Safety Rules, <http://www.defendingfoodsafety.com/articles/food-safety-news/>
- lxxxix Food and Agriculture Organization of the United Nations, 2009, The State of Food and Agriculture, <http://www.fao.org/docrep/012/i0680e/i0680e05.pdf>
- xc International Livestock Research Institute, 2012, Mapping of Poverty and Likely Zoonoses Hotspots <http://www.ilri.org/ilrinews/index.php/archives/9172>
- xci Cornell University Cooperative Extension, accessed 2013, Agrosecurity and Agroterrorism <http://emergencypreparedness.cce.cornell.edu/agrosecurity/Pages/AgrosecurityResources.aspx>
- xcii The Nuclear Threat Initiative, 2011, UK Agency warns of terrorist threat to food supply, <http://www.nti.org/gsn/article/uk-agency-warns-of-terrorist-threat-to-food-supply/>
- xciii Padilla, M, Preparing for the Unknown: The Threat of Agroterrorism, Sustainable Development Law & Policy, Fall 2008, 55-56, 76
- xciv The Federal Bureau of Investigation, 2012, Olson, D, Agroterrorism, <http://www.fbi.gov/stats-services/publications/law-enforcement-bulletin/february-2012/agroterrorism>
- xcv The Royal United Services Institute, 2011, Francis, A, The Gulf's Food Security Dilemma, <http://www.rusi.org/analysis/commentary/a/ref:C4EDDF99D882B5/>
- xcvi Ibid
- xcvii Chatham House, 2012, Lee, B. et al, Resources Futures

- 
- <sup>xcviii</sup> Forbes, 2011, Savitz, E, Agroterrorism: Managing Risk in the Food Supply Chain, <http://www.forbes.com/sites/ciocentral/2011/04/19/agroterrorism-managing-risk-in-the-food-supply-chain/>
- <sup>xcix</sup> Polyak, M, 2004, The Threat of Agroterrorism: Economics of Bioterrorism, Georgetown Journal of International Affairs 2004:31–39  
<http://www12.georgetown.edu/sfs/publications/journal/Issues/sf04/B&F%20Polyak.pdf>
- <sup>c</sup> [http://www.healthcare.philips.com/main/shared/assets/documents/bioshield/ecoandsocialimpactofemerginginfectiousdisease\\_111208.pdf](http://www.healthcare.philips.com/main/shared/assets/documents/bioshield/ecoandsocialimpactofemerginginfectiousdisease_111208.pdf)
- <sup>ci</sup> Virtue Science, accessed 2013, Futehally, I, The Geopolitics of Food  
<http://www.virtuescience.com/geopolitics-of-food.html>
- <sup>cii</sup> Triple Pundit, 2012, Kaye, L, The Global Land Grab, the Next Human Rights Challenge for Business, <http://www.triplepundit.com/2012/08/global-land-grab-human-rights-challenge-business/>
- <sup>ciii</sup> The Guardian, 2013, Quinn, B, Horsemeat discovered in burgers sold by four British supermarkets, <http://www.guardian.co.uk/world/2013/jan/16/horsemeat-burgers-supermarkets>
- <sup>civ</sup> The Guardian, 2013, The Meat Industry, <http://www.guardian.co.uk/environment/meat-industry>
- <sup>cv</sup> The Guardian, 2013, Lawrence, F, The Horsemeat Scandal: The Essential Guide, <http://www.guardian.co.uk/uk/2013/feb/15/horsemeat-scandal-the-essential-guide>
- <sup>cvi</sup> The Global Post, 2013, Agence France-Presse, World's biggest food firms embroiled in Europe horsemeat scandal, <http://www.globalpost.com/dispatch/news/afp/130219/worlds-biggest-food-firms-embroiled-europe-horsemeat-scandal-2>
- <sup>cvii</sup> Ibid
- <sup>cviii</sup> BBC News, 2013, Horsemeat Scandal: Retailers to give regular food test updates, <http://www.bbc.co.uk/news/uk-21495300>
- <sup>cix</sup> Mckinsey Quarterly
- <sup>cx</sup> Ibid
- <sup>cxii</sup> Sugar Online, 2012, UK: Tate & Lyle to invest in revolutionary food technology, [http://www.sugaronline.com/home/website\\_contents/view/1203755](http://www.sugaronline.com/home/website_contents/view/1203755)
- <sup>cxiii</sup> The Post Online, 2013, Parra-Serrano, C, Insurance 'integral' to improving global food security, <http://www.postonline.co.uk/post/news/2236731/insurance-integral-to-improving-global-food-security>
- <sup>cxiiii</sup> The World Bank, 2009, "Agricultural Insurance, primer series on insurance", Issue 12, Nov 2009, p. 3.
- <sup>cxv</sup> Stutley. C, 2012, Promoting Food Security in a Volatile Climate: The Role of Agricultural Insurance
- <sup>cxvi</sup> Ibid
- <sup>cxvii</sup> Insurance Journal, 2013, Swiss Re Study Examines Agricultural Insurance Role in Global Food Production, <http://www.insurancejournal.com/news/international/2013/01/16/277606.htm>
- <sup>cxviii</sup> Reuters, 2012, Abbott, C, Drought brings record US cost for crop insurance subsidy, <http://www.reuters.com/article/2012/10/17/us-usa-agriculture-insurance-idUSBRE89G13420121017>
- <sup>cxix</sup> Ibid
- <sup>cxix</sup> Business Insurance, 2013, [http://www.businessinsurance.com/article/20130224/NEWS06/302249975?tags=\[302|329|338](http://www.businessinsurance.com/article/20130224/NEWS06/302249975?tags=[302|329|338)
- <sup>cxx</sup> The Hanover Insurance Group, 2013, Glossary of Terms, <http://www.hanover.com/glossary.html>
- <sup>xxi</sup> American Bar Association, 2013, Berk, L & Levine, M, Contingent Business Interruption Coverage for Superstorm Sandy Losses, <http://apps.americanbar.org/litigation/committees/insurance/articles/janfeb2013-superstorm-sandy-contingent-business-interruption.html>
- <sup>xxii</sup> Ibid
- <sup>xxiii</sup> The Wall Street Journal, 2009, Peanut Butter Justice, <http://online.wsj.com/article/SB123491912215304853.html>

<sup>cxxiv</sup> Food Manufacture, 2010, Mind the insurance gap on product recall,

<http://www.foodmanufacture.co.uk/Business-News/Mind-the-insurance-gap-on-product-recall>

<sup>cxxv</sup> Jardine Lloyd Thompson, 2013, JLT & Campden BRI launch Food and Drink Industry Research Paper

<http://www.jltgroup.com/risk-and-insurance/news/jlt-and-campdenBRI-launch-food-and-drink-industry-research-paper/>

<sup>cxxvi</sup> Ibid

<sup>cxxvii</sup> Alliance, 2009, [http://knowledge.allianz.com/environment/food\\_water/?502/gmo-insurance-risks-and-rewards](http://knowledge.allianz.com/environment/food_water/?502/gmo-insurance-risks-and-rewards)

<sup>cxxviii</sup> Insurance journal, 2010, <http://www.insurancejournal.com/news/international/2010/03/19/108298.htm>

<sup>cxxix</sup> Insurance Journal, 2012, <http://www.insurancejournal.com/news/international/2012/12/31/275529.htm>

<sup>cxxx</sup> Risk & Insurance, 2012, Reynolds, D, Agroterrorism: The Food Supply Chain Apocalypse,

<http://www.riskandinsurance.com/story.jsp?storyId=533346890>

<sup>cxxxi</sup> Wells Fargo Insurance Services, 2010, Friedl, R, The Terrorism Risk Insurance Act is set to expire in 2014. What's next?,

<https://wfis.wellsfargo.com/NewsIndustryInfo/Industry%20Information/Documents/ManagingTerrorismRisk810.pdf>

<sup>cxxxii</sup> Lloyd's 360 Risk Insight, 2009, Insurance in developing countries: Exploring opportunities in micro insurance.

<sup>cxxxiii</sup> IRI, 2009,

[http://portal.iri.columbia.edu/portal/server.pt/gateway/PTARGS\\_0\\_5024\\_4201\\_0\\_0\\_18/Climate0and0Society0Issue0Number02.pdf](http://portal.iri.columbia.edu/portal/server.pt/gateway/PTARGS_0_5024_4201_0_0_18/Climate0and0Society0Issue0Number02.pdf)

<sup>cxxxiv</sup> Ibid

<sup>cxxxv</sup> Insurance Journal, 2013, Swiss Re Study Examines Agricultural Insurance Role in Global Food Production