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FOOD SECURITY

THE HAGUE CENTRE FOR STRATEGIC STUDIES AND TNO

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FOOD SECURITY

THE HAGUE CENTRE FOR STRATEGIC STUDIES (HCSS) AND TNO

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FOOD SECURITY

STRATEGY & CHANGE VISION PAPER –
THEMATIC AREA: SUSTAINABILITY

THE HAGUE CENTRE FOR STRATEGIC STUDIES AND TNO

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The TNO and *The Hague* Centre for Strategic Studies (HCSS) programme Strategy & Change analyzes global trends in a dynamic world affecting the foundations of our security, welfare and well-being.

The programme attempts to answer the critical question: what are the policies and strategies that must be developed to effectively anticipate on these emerging challenges?

Strategy & Change provides both a better understanding and feeds the agenda for a sustainable future of our society.

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1 INTRODUCTION

In March 2011 the United Nations (UN) Food Price Index hit an all-time global high. The global food crisis of 2006-2008 had already established food scarcity as a major concern for coming decades. This new spike brought renewed warnings from the Food and Agriculture Organization (FAO) concerning the advent of another global food crisis.

Food is becoming an increasingly scarce commodity in many parts of the world due to rising demand from a growing world population and limited agricultural output. According to the FAO, the growing demand will require an increase of global food production of 70% by 2050. Even if this growth in output is met, however, almost 400 million people will still not have access to adequate food.[1] Chronic undernourishment will be most prevalent in Sub-Saharan Africa, where the proportion of malnourished children has been consistently on the rise in recent years and is expected to further increase in the coming decades.[2]

Over the past years, food prices have both increased and have become increasingly volatile. This is partially a result of real, tangible, factors, such as the imbalance between supply and demand, but may also be caused by increased speculation on agricultural commodity markets. In addition, these increases are the result of the growing demand for biofuels, one driven by high oil prices and the objective to reduce greenhouse gas emissions, alongside our dependence on fossil fuels. Subsidies and the

1 FAO, "How to Feed the World in 2050," (Rome: FAO, 2009) 1-14. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

2 Rosegrant, Mark and others, 2020 Global Food Outlook. Trends, Alternatives, and Choices (Washington, DC: International Food Policy Research Institute, 2001), 3-8.

protectionist policies of major agricultural powers also negatively impact global food security.

In the European Union (EU), the Common Agricultural Policy accounts for approximately 48% of the total EU budget, around €50 billion.[3] The Organization for Economic Cooperation and Development (OECD) indicator Total Support Estimate (TSE) reflects the overall value of money transferred through agricultural policies. In 2009 the TSE in the total of OECD countries was € 276.218 billion, accounting for approximately 0.93% of the Gross Domestic Product (GDP).[4] In countries like Egypt and Syria food subsidies, exceed 1 percent of GDP.[5] Food subsidies have improved food security for many households but it has also triggered farmers to produce more than their markets demand.[6] As a consequence, the world faces an incongruous and untenable situation, where the massive food surpluses and the obesity epidemic in the developed world and emerging economies contrast starkly with high levels of food scarcity and famine in the developing world.

Policy makers and the media have directed considerable attention to the issue of food insecurity, which is generally understood as a "complex sustainable development issue, linked to health through malnutrition, but also to sustainable economic development, environment, and trade."[7] By endorsing the Millennium Development Goals, for instance, the international community has pledged to halve, between 1990 and 2015, the proportion of people who suffer from hunger.

However, food scarcity is no longer viewed solely as an issue of sustainable development but increasingly as a geopolitical challenge as well. So far,

3 Public Service Europe, "No Cuts to CAP Budget Insist MEPs," Public Service Europe (2011), http://www.publicserviceeurope.com/article/515/no-cuts-to-cap-budget-insist-meps.

4 OECD, "Total Support Estimate by country," Database, OECD.StatExtracts, n.d.

5 World Bank, "Improving Food Security in Arab Countries," World Bank (January 2009), http://siteresources.worldbank.org/INTMENA/Resources/FoodSecfinal.pdf.

6 Stefan Tangermann, "Farming support: the truth behind the numbers," OECD Observer, May 2004.

7 World Health Organization, Trade, foreign policy, diplomacy and health. Food Security (WHO, 2011), http://www.who.int/trade/glossary/story028/en/.

experts have asserted that no states have yet gone to war over the availability of food, and have deemed it unlikely that they would do so in the future.[8] The Arab Spring, however, has made the security risks of high food prices and food shortages fully apparent. In January 2011, record high food prices resulted in protests in Tunisia, in which over 100 people died and which subsequently led to the spread of the revolutions in other North African and Middle Eastern countries. Stories that prophecied the emergence of food wars in the 21st Century, began to surface in the media.[9] In sum, food security has returned as a top priority on the agenda of policy makers.

This Vision Paper addresses the issue of food security and will look at the different dimensions of the issue both now and in the future. The analysis is complemented with text-mining results and content analysis generated by a sophisticated software program called Leximancer. After discussing this methodology, the paper proceeds in three parts. In the first part, we discuss food security as an emerging issue that increasingly receives attention from academics, policy makers and the media. Second, the paper explores the different themes and concepts that are most dominant in the literature on food security, and offers an analysis of the underlying dynamics of the issue and the main actors involved. Third, the paper discusses some dimensions of food security that may become increasingly important in the future based on current developments and detected changes and in the food security discourse. The paper concludes with remarks about the implications of current and future aspects of food security for policy makers and researchers.

8 Islam Qasem, Resource Scarcity in the 21st Century: Conflict or Cooperation? (The Hague: The Hague Centre for Strategic Studies and TNO, 2010), 22, http://static.hcss.nl/files/uploads/37.pdf.

9 See for example: Brown, Lester R. "The New Geopolitics of Food." *Foreign Policy*, no. May/June (2011). http://www.foreignpolicy.com/articles/2011/04/25/the_new_geopolitics_of_food?page=full.

2 METHODOLOGY

The analysis for this report was the result of a two-step research process. As this paper was written for the HCSS project "Detecting Emerging Issues", the first involved an attempt to determine whether food security is an emerging issue. In order to gauge the salience of 'food security' in the academic literature, we employed a novel bibliometric methodology that compared the number of hits within open access online scholarly archives on a year-by-year basis from 1993 until 2010. To control for the supposed increase in net-based publications over the last decade or so, we employed relatively strict search parameters that excluded news, web-logs and other more fluid forms of publication. We also calculated the proportional increase of hits in relation to the *total* number of results for that year.

Step two involved an analysis of the discourse on food security. To acquire a better understanding of the dominant themes and concepts in the food security literature, content analysis was conducted, using a software program called Leximancer. The program allows researchers to perform text mining and to identify how different concepts relate to one another and how frequently they occur within a given collection of texts. The advantage of such an approach is that it allows the researcher to master a large unknown body of literature quickly. However, since software is no substitute for human judgment, the text-mining results were interpreted on the basis of complementary literature review, desk research and interviews with experts.

3 FOOD SECURITY AS EMERGING ISSUE

The concept of food security has significant historical precedent as an important issue in the field of what is now often referred to as 'human security'. There are indications, however, that the concept of food security is gaining increased attention beyond the human-security domain. The discourse surrounding the food crisis in 2011 appeared to emphasize the security risks of food scarcity and its geopolitical consequences. Commentators have depicted food scarcity as the "hidden driver of world politics"[10] and as a determining factor of geopolitics and international security. This would make food security no longer merely an issue of economic underdevelopment or global health that concerns the developing world, but also a core interest of more advanced economies.

Policy makers are concerned about food security. World leaders discussed food security at the G20 summit in Paris in June 2011. The FAO chose the theme "Food prices- from crisis to stability" as the theme for the World Food Day on the 16th of October 2011 to raise awareness that rising food prices are threatening the food security of developing countries and push millions of people into poverty.

The issue of food security has increasingly received attention from academics. Our results demonstrate that since 1993, the number of hits on Google Scholar containing the term 'food security' in the title of has increased (see Figure 1). The proportion of total hits that contain 'food security' within the text has similarly experienced significant increase, accounting for 1.8% of total hits in 1993, and 9.7% in 2010. The limitations of our methodology are recognized as we limited our search to the Google

10 Lester R. Brown, "The New Geopolitics of Food," Foreign Policy, no. May/June (2011), http://www.foreignpolicy.com/articles/2011/04/25/the_new_geopolitics_of_food?page=full.

Scholar database. Nevertheless, the results provide a rough approximation of the increasing volumes of academic material on food security. It is clear that while the term has significant historical salience, it has achieved increased attention over the past decade.

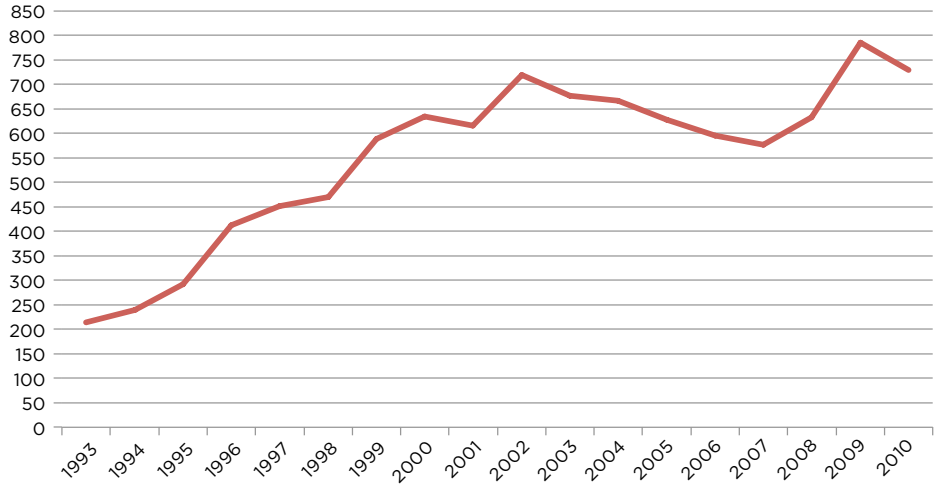

FIGURE 1 NUMBER OF HITS FOR 'FOOD SECURITY' IN THE TITLE OF DOCUMENTS ON GOOGLE SCHOLAR

4 WHAT IS FOOD SECURITY ABOUT?

Food security is commonly understood to include both physical and economic access to food that meets dietary needs and food preferences. Food security was defined at the World Food Summit of 1996 as the condition "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life".[11] Food security involves four dimensions: 1) physical availability of sufficient quantities of food, 2) economic and physical access to nutritious food, 3) adequate knowledge of food utilization, including knowledge about water and sanitation, and 4) stability of access to food over time. When these dimensions become threatened, food security becomes an issue of concern.

Whereas food security was previously foremost an issue of malnutrition in the developing world, the concept of food security is increasingly broadened to include food related issues from the developed world. This means that not only hunger but also dietary excess are considered a threat to food security, as dietary excess is a growing cause of health problems. Although the literature on food security addresses both type of problems, it is obvious that fighting hunger and malnutrition in the developed world requires a different policy approach than fighting obesity in the developed world. This chapter examines the underlying dynamics of food security issues and the main actors involved.

4.1 CONCEPT MAP AND TEXT-MINING RESULTS

To acquire a better understanding of the different themes and concepts that are most dominant in the literature on food security, we used Leximancer to perform a text-mining analysis. For the Leximancer analysis, we used 56 hand picked and verified recent studies on food security to

11 World Health Organization, Trade, foreign policy, diplomacy and health. Food Security.

generate a concept map and text-mining results. We used sources that were published over the past decade by a variety of institutions, including academia, governments, civil society, international organizations and businesses.

First, we used Leximancer to generate a concept map, which shows the importance of different themes in the literature and how they relate to each other (see Figure 2).[12]

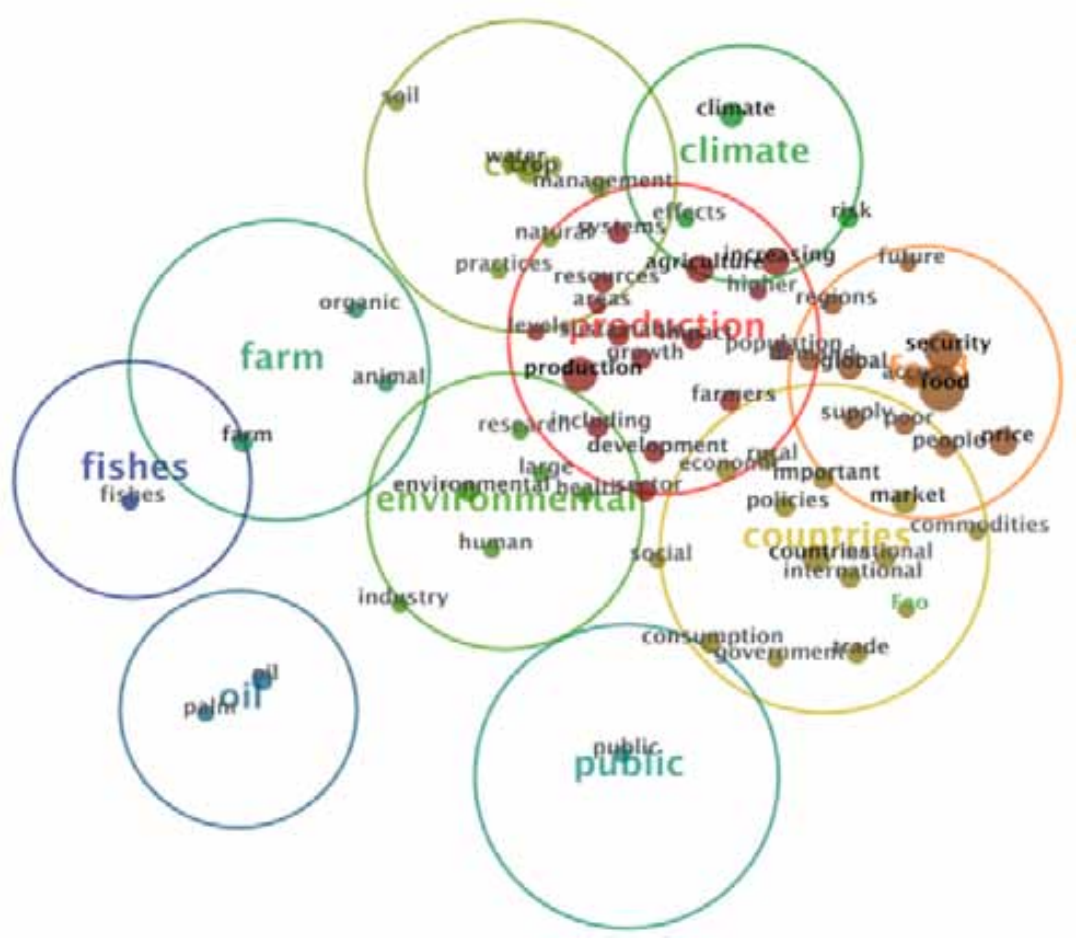

FIGURE 2 CONCEPT MAP OF "FOOD SECURITY"

12 For a full listing of all Leximancer sources, see the Leximancer bibliography.

Next, we generated a table (see Table 2) which displays the concepts according to their absolute and relative frequency of appearance in the literature.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
food	3943	100%	demand	502	13%
security	2838	72%	trade	496	13%
production	2446	62%	population	487	12%
agriculture	1774	45%	sustainable	485	12%
increasing	1735	44%	sector	481	12%
climate	1525	39%	future	481	12%
countries	1469	37%	large	480	12%
price	1441	37%	international	473	12%
market	1208	31%	access	472	12%
global	1016	26%	human	469	12%
crop	1011	26%	animal	457	12%
farm	915	23%	areas	456	12%
important	821	21%	effects	456	12%
impact	801	20%	public	455	12%
environmental	768	19%	national	445	11%
farmers	756	19%	fishes	438	11%
people	748	19%	organic	435	11%
water	739	19%	poor	429	11%
development	710	18%	rural	424	11%
policies	681	17%	palm	424	11%
supply	648	16%	economic	421	11%
risk	630	16%	natural	416	11%
systems	620	16%	levels	414	10%
including	603	15%	government	399	10%
regions	591	15%	data	395	10%
management	583	15%	industry	387	10%

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
growth	540	14%	higher	369	9%
consumption	531	13%	health	364	9%
oil	524	13%	report	361	9%
resources	520	13%	soil	358	9%

TABLE 1 RANKED LIST OF CONCEPTS ASSOCIATED WITH "FOOD SECURITY"

We conducted a Google Scholar search that combined 'food security' with several concepts from Table 1 which Leximancer found to be of high salience, including 'agriculture', 'climate' and 'poverty'. We found that it generated a large number of hits and increase over time, which demonstrated considerable affinity with the results described above (see figure 1). With regards to the concept of 'regions', which also scored high in the text-mining results yielded by Leximancer, a search for 'Africa' generated the greatest share of hits. While the prominence of Africa in the literature is perhaps not surprising, it is notable that that searches for 'Europe' have increased, and are similar to those for 'Asia'.

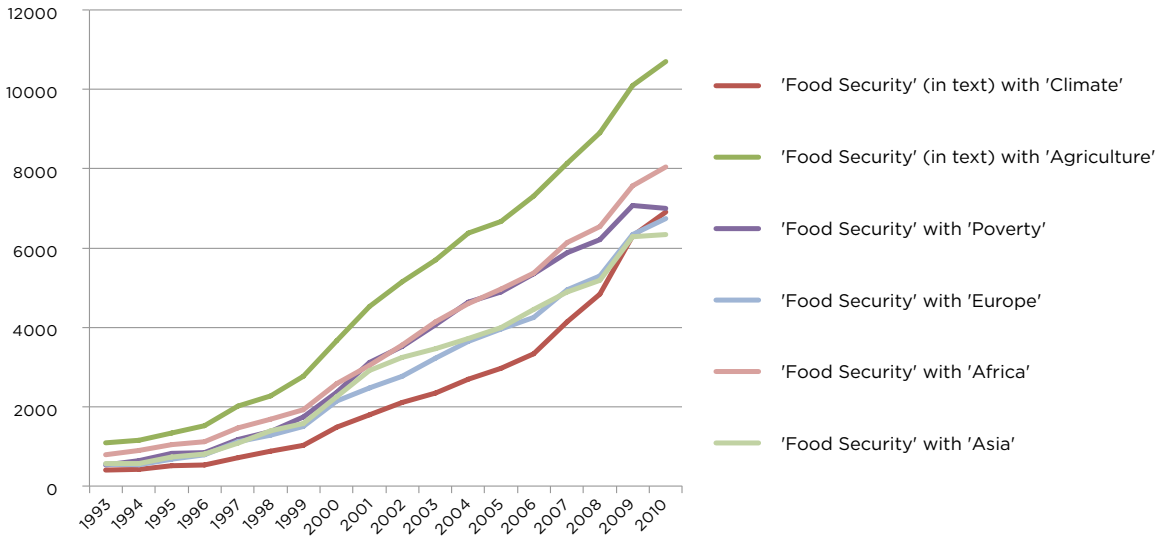

FIGURE 3 NUMBER OF HITS FOR 'FOOD SECURITY' AND VARIOUS SEARCH TERMS IN TEXTS ON GOOGLE SCHOLAR

On the basis of the concepts from the concept map and the text-mining results, the paper will now proceed with an analysis of the different aspects of food security and the main actors that are dealing with this issue.

4.2 DIFFERENT ASPECTS OF FOOD SECURITY

The global food crisis is often referred to as "the perfect storm".[13] This is because food insecurity is often the result of a complex confluence of factors that may mutually reinforce each other, thereby amplifying the scope and intricacy of the problem. The different underlying dynamics causing food insecurity will now further be elaborated.

UNBALANCED SUPPLY AND DEMAND

Food insecurity is mostly caused by imbalances between demand and supply on the global food market rather than an absolute deficit. In the past decades, the world has witnessed an extraordinary explosion in demand. Global food consumption is growing exponentially due to a variety factors, including population growth and changing consumption patterns. Also, the promotion of biofuel has contributed to increased demand for crops like soy and corn.

Whereas the demand explosion is the most significant contributor to food insecurity, supply-side factors have also received mention as contributing to an unbalanced market. Many commentators believe that the supply side has generally struggled to keep pace with this rapid expansion of demand due to insufficient investment in agricultural capital and slowing productivity growth. Many experts from various financial institutions believe slowing productivity growth is an important factor behind high food prices.[14] Others, however, point out that agricultural productivity has increased continuously over the past decades and will continue to do so

13 Aalok Mehta, "'Perfect Storm' in Food Crisis Caused by Many Factors," National Geographic News, 2008, http://news.nationalgeographic.com/news/2008/05/080528-food-crisis.html.

14 Keith Fuglie, "Is a slowdown in agricultural productivity growth contributing to the rise in commodity prices?," Agricultural Economics, no. 39 (2008): 431-441.

due to technological innovation. Since the Green revolution, cereal output in developing countries has grown 2.8 % annually for three decades.[15]

In addition, supply has been affected by rising prices of energy and fertilizer that have put some farmers out of business. Climate change, environmental degradation, soil erosion and unsustainable land use are also negatively affecting food supply. Additionally, the availability of farmland is decreasing due to residential and industrial development, urbanization and a growing population.

The text-mining analysis shows that the concepts related to the unbalanced supply and demand on the global food market are an important dimension of the current food security literature.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
production	2446	62%	consumption	531	13%
supply	648	16%	demand	502	13%
market	1208	31%	price	1441	37%

TABLE 2 CONCEPTS RELATED TO AN UNBALANCED GLOBAL FOOD MARKET

CONSTRAINTS IN FRAGILE STATES

It must be noted that the supply deficit is not absolute. The amount of calories that are being produced globally is enough to feed the world (although the amount of healthy and nutritious micro-nutrients is insufficient).[16] About one third of global food supply is wasted while one

15 Prabhu Pingali, "The Green Revolution Forty Years Later: Lessons Learned and Unfinished Business" (presented at the African Agricultural R&D and Productivity Growth in a Global Setting - FSI Stanford, FSE Symposium, Stanford, October 6, 2011).

16 Foreign Policy Association, Running Out: The Global Food Crisis (Great Decisions, 2009), http://bcove.me/lae7m3t9.

sixth of the world population is hungry.[17] Economist and Nobel-prize winner Amartya Sen points out that hunger is the result of corruption, conflict or marginalization, rather than an issue of absolute scarcity.[18] Corruption, conflict and marginalization are impeding factors to food access that are often present in fragile states. Based on case studies on the food security situation in the Democratic Republic of the Congo (DRC), Somalia and Sudan, the FAO concludes that dysfunctional institutions are at the root of structural food insecurity in these countries.[19] In addition, in protracted crisis, "[t]he governance … is usually very weak, with the state having a limited capacity to respond to, and mitigate, the threats to the population, or provide adequate levels of protection."[20] This weakens the state's capacity to deliver food security and to provide the necessary infrastructure for local food production and to allow local farmer to bring their products to the market in reliable and affordable ways.

RISING FOOD PRICES AND INCREASED PRICE VOLATILITY

Whereas the causes of food insecurity are complex, the consequence of the interplay between buoyant demand and struggling and unevenly allocated supply is easy to pin-point: an unprecedented boom in food prices. Figure 4 shows that food prices have more than doubled since 2000.

17 Cynthia Schweer, "Food and international folly," Blog, The Foreign Affairs Blog Network, June 16, 2011, http://globalhealth.foreignpolicyblogs.com/2011/06/16/food-and-international-folly/.

18 Amartya Sen, "Hunger in the Contemporary World," in Discussion Paper for the Suntory Centre (London School of Economics, 1997), http://eprints.lse.ac.uk/6685/1/Hunger_in_the_Contemporary_World.pdf.

19 Luca Alinova, Günter Hemrich, and Lucha Russo, Addressing Food Insecurity in Fragile States: Case Studies from the Democratic Republic of the Congo, Somalia and Sudan, ESA Working Paper (FAO, July 2007), ftp://ftp.fao.org/docrep/fao/010/ai028e/ai028e00.pdf.

20 A. Harmer and J. Macrae, Beyond the continuum: aid policy in protracted crisis, HPG Report (London: Overseas Development Institute, 2004), 1.

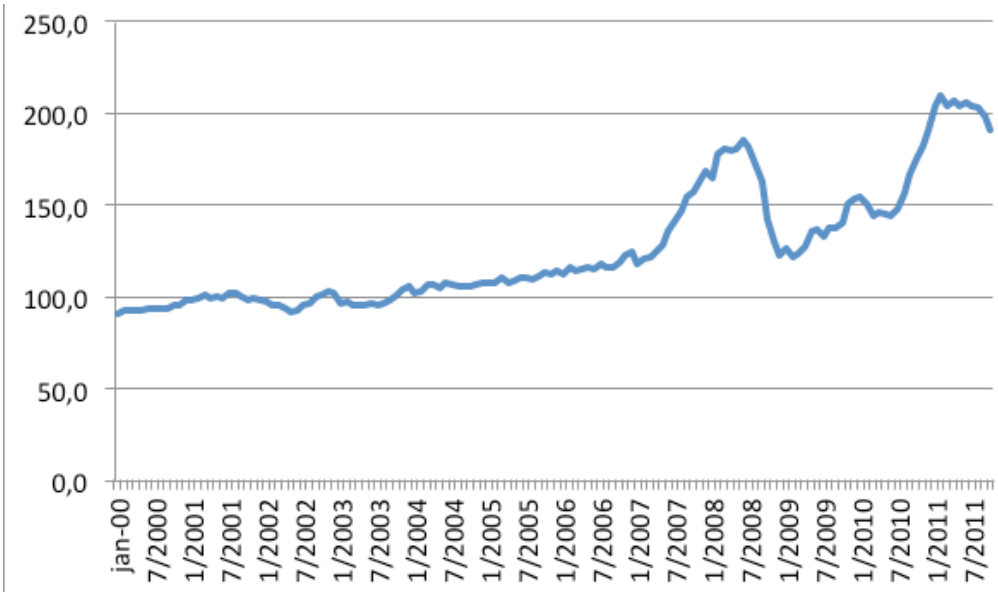

FIGURE 4 FAO FOOD PRICE INDEX (2002-2004=100)

Export restrictions from countries in response to prospects of domestic food insecurity have also contributed to market distortions and price increases.[21] In general, export restrictions are prohibited under the WTO regulation. Article XI on the General Elimination of Quantitative Restrictions of the GATT, however, allows exceptions when export restrictions are applied to "prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party." The use of export restrictions during the food crisis of 2007-2009, however, exacerbated the crisis by driving up food prices.

Speculation is also thought by many to have contributed to rising prices and increased price volatility. Financial firms are increasingly investing in agricultural commodities through futures contracts and other financial instruments, a process labeled by the FAO as the "financialization of commodities".[22] Although it is impossible to determine the exact impact of

21 FAO et al., Price Volatility and Agricultural Markets: Policy Responses, June 2, 2011.

22 FAO, Price Volatility in Agricultural Markets. Evidence, impact on food security and policy responses., Economic and Social Perspectives (FAO, December 2010).

speculation on food prices, there are indications that prices and price volatility have increased due to investments by hedge funds and other investors during the past decade. Some research has shown that commodities that are not traded on futures markets show much less price volatility.[23] Academic research, however, is not conclusive on the relationship between price volatility and the activity of financial institutions on agricultural commodities markets.

Price volatility of agricultural commodities are a threat to food security, particularly in the developing world. Here, people spend as much as 70% of their income on food and often consume less processed foods.[24] As a consequence, rises and fluctuations in commodity prices are felt more strongly. In addition, farmers in developing countries often lack insurance of savings to handle large income fluctuations caused by price volatility. In general, volatility becomes a problem when price fluctuations are large and cannot be anticipated, as they may delay investments and therefore slow food production.[25]

23 HCSS, TNO, and CE Delft, Op weg naar een Grondstoffenstrategie. Quick scan ten behoeve van de Grondstoffennotitie (The Hague: The Hague Centre for Strategic Studies, 2011), 26–27.

24 FAO, Price Volatility in Agricultural Markets. Evidence, impact on food security and policy responses.

25 Ibid.

CLIMATE CHANGE

The concept map and text-mining results also show climate change as an important dimension of food security. Climate change is causing crop damage and failed harvests due to extreme weather events, such as droughts, floods, wildfires and hurricanes. According to the Earth Policy Institute, global warming is an important contributor to food scarcity, for every 1 degree centigrade rise in global temperature, reduces grain yields by 10%.[26]

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
climate	1525	39%	water	739	19%
environmental	768	19%	sustainable	485	12%

TABLE 3 CONCEPTS RELATED TO CLIMATE CHANGE

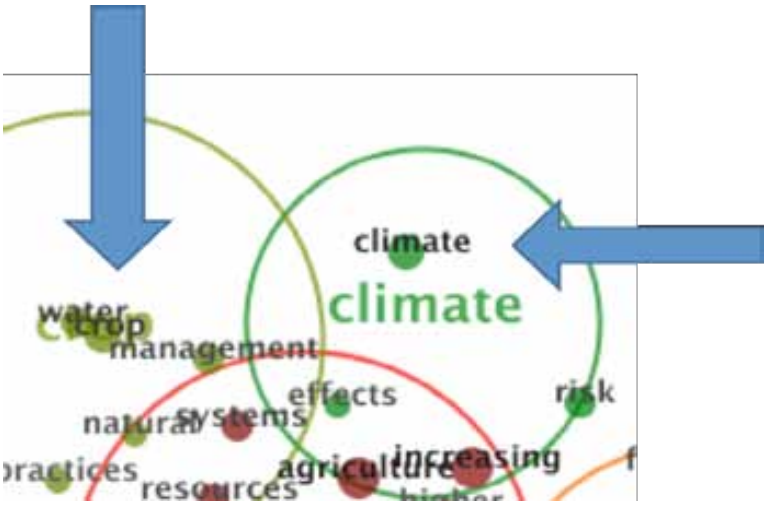

FIGURE 5 'CLIMATE' AND 'WATER' ON THE CONCEPT MAP

26 Ibid.

In addition, water for agriculture becomes increasingly scarce with global warming. In many regions of the world, water tables are falling, which can contribute to a collapse of agricultural production.[27] The Middle East is the first region where grain production has started to fall due to water shortages in Syria and Iraq.[28]

WATER SHORTAGES IN CHINA

In China, exceptional droughts and dust storms destroyed 7 million hectares of farmland in 2010.[29] China is relying heavily on engineering to cope with water shortage, for example by using cloud-seeding shells to create water droplets in clouds that will fall as rain.[30] The director of the Water Research Centre at Peking University has warned, however, that the Chinese government has relied too much on engineering projects.[31] He argues the long-term solution is to adopt a new policy to reduce water consumption and domestic food production, or else aquifers will diminish to unsustainable levels. Agriculture accounts for 60% of water demand in China. To avoid aquifer depletion, countries like China are starting to import food from elsewhere, mainly Africa.

Furthermore, the policy objective to mitigate climate change by reducing greenhouse emissions from fossil fuels has led to promoting the cultivation of crops that can be used as biofuel. The US, for example, has stipulated that biofuel use must reach 36 billion gallons per year by 2022. Likewise,

27 Ibid.

28 Brown, "The New Geopolitics of Food."

29 Reuters, "China Says Drought affecting 50 Million People," Reuters, March 19, 2010, http://www.reuters.com/article/2010/03/19/us-china-drought-idUSTRE62I1O520100319.

30 Jonathan Watts, "Rainmakers of China struggling to cope with country's sever drought," The Guardian, June 28, 2011, http://www.guardian.co.uk/environment/2011/jun/01/china-drought-weather-modifying-yangtze?INTCMP=SRCH.

31 Jonathan Watts, "China told to reduce food production or face 'dire' water levels," The Guardian, June 28, 2011. http://www.guardian.co.uk/environment/2011/jun/28/china-food-water (accessed on June 29, 2011).

the EU has mandated that 10% of transportation fuel must come from biofuel or other renewable energy sources by 2020. Other countries, such as China, India, Indonesia and Thailand have adopted similar targets.[32] This has considerably reduced the amount of farmland for food production.

DEVELOPMENTS ON THE ENERGY MARKET

Food security is related to developments on the energy market in multiple ways, but particularly through price interactions.[33] Rising oil prices make farming more expensive, as farmers need fuel to operate their tractors. Higher natural gas prices increase the price of nitrogen fertilizers. In addition, higher oil and gas prices drive up the transportation costs of food. Figure 6 shows the development of prices of agricultural commodities and energy and displays considerable alignment.

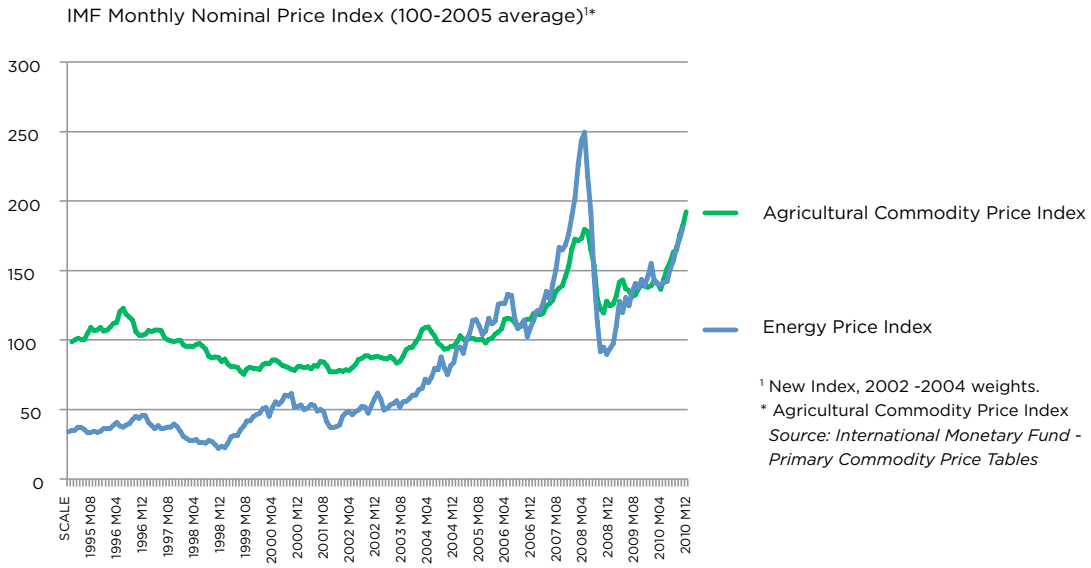

FIGURE 6 RELATION BETWEEN AGRICULTURAL COMMODITY PRICES AND ENERGY PRICES

32 Elisabeth Rosenthal, "Rush to Use Crops as Fuel Raises Food Prices and Hunger Fears," New York Times, April 6, 2011, http://www.nytimes.com/2011/04/07/science/earth/07cassava.html.

33 Qasem, Resource Scarcity in the 21st Century: Conflict or Cooperation?, 32.

At the same time, rising energy prices contribute to growing demand for biofuel. Besides oil price spikes, the growing demand for biofuel is driven by concerns over energy dependence and, as mentioned before, the objective to cut greenhouse gas emissions. Although these are legitimate concerns, the promotion of biofuels by some governments has had an adverse effect on global food supply. Due to government subsidies, it becomes more lucrative to use land for fuel production and as a consequence less and less land is used to grow food. According to the IMF and World Bank, 70% of the increase of global food prices can be attributed to growing demand for crops for biofuel production.[34]

The text-mining analysis shows that palm oil, which is used to create biodiesel, is often mentioned in the debate about food security and fuel vs. food.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
price	1441	37%	demand	502	13%
crop	1011	26%	palm	424	11%
oil	524	13%	industry	387	10%

TABLE 4 CONCEPTS RELATED TO THE ENERGY MARKET

34 Donald Mitchell, A Note on Rising Food Prices, Policy Research Working Paper (The World Bank Development Group, 2008), http://www.ds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2008/07/28/000020439_20080728103002/Rendered/PDF/WP4682.pdf.

FIGURE 7 'PALM OIL' AND 'OIL' ON THE CONCEPT MAP

COMPETING USES

In addition developments on the energy market, the non-food use in the industrial sector has also been a major driving force of the growing demand for agricultural products that compete with food. Especially in China and the EU demand for vegetable oils for non-food industrial purposes has grown.[35] Through processes of bio-refinery, chemical transformation or fermentation, many crops can be turned into materials, chemical substances and other industrial applications. In the European chemical industry, approximately 8% to 10% of the raw material input is based on biomass. This biomass is used to produce bio-plastics, fibers, detergents, cosmetics, paints, coatings, adhesive, and pharmaceuticals.[36] Corn, for example, is widely used as a construction material and its substances are used for a variety of other industries as well (see Figure 8).

35 FAO, World agriculture: towards 2030/2050. Prospects for food, nutrition, agriculture and major commodity groups. Interim report (Global Perspective Studies Unit of the FAO, June 2006), 53.

36 Reinhard Quick, "Competing Uses For Renewable Raw Materials - Some Policy and Trade Aspects" (presented at the Working Group Feedstok, Energy & Logistics meeting, HLG Chemicals, Brussels, February 7, 2008).

SUBSTANCE	USE
Glucose	Food Industry
Bio-ethanol	Energy
Antibiotics	Medicine
Vitamins	Food
Starch	Detergent
PLA	Plastics
Enzymes	Transformation
Citric Acid	Conservative
Colouring Agent	Food, printing,....

Source: Denis Pohl, "Competing uses for biomass: The environmental perspectives," presentation of the Belgian Federal Public Service of Public Health, Food Chain Security and Environment.

FIGURE 8 EXAMPLES OF CORN CONVERSION

As a consequence of the growing demand for agricultural products for non-food purposes, farmers are increasingly growing crops that are used to produce industrial and consumer products, rather than food. The demand for bio-based products, such as paints, lubricants and oleochemicals, is expected to grow faster than the demand for food.[37] As a consequence of market forces, the large scale use of biomass for non-food purposes may decrease the availability of land for food production.

POPULATION GROWTH, GLOBAL PROSPERITY AND CHANGING CONSUMPTION PATTERS

Food security is also emerging as a result of demographic trends and rising global prosperity levels. The fast growing world population is putting increased pressure on the demand side. Farmers must feed 80 million additional people each year.[38] To meet the growing demand for food, farmers will have to increase agricultural output with 50% by 2030 and with 50% by 2050, when the projected world population will be of 9 billion

37 FAO, World agriculture: towards 2030/2050. Prospects for food, nutrition, agriculture and major commodity groups. Interim report, 56.

38 Ibid.

people.[39] Most of the population growth takes place in developing countries, where food supply is already scarcer than in the developed part of the world.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
people	748	19%	demand	502	13%
development	710	18%	population	487	12%
growth	540	14%	human	469	12%
consumption	531	13%	animal	457	12%

TABLE 5 CONCEPTS RELATED TO POPULATION GROWTH, RISING PROSPERITY LEVELS AND CHANGING CONSUMPTION PATTERNS

In addition, economic development is resulting in rising global prosperity and changing consumption patterns. Emerging economies, like China and India, have a growing middle class that wants to eat better. It is estimated that some 3 billon people in the developing world are moving up the food chain, which results in an increased demand for meat, eggs and dairy products[40].

THE IMPACT OF MEAT PRODUCTION

Globally, average meat consumption is expected to increase from 37 kilograms (kg) per capita in 2000 to 48 kg in 2050. The rise of meat consumption is sharpest in East Asia, where meat consumption is expected to double and move towards the same level as OECD countries.[41] To meet the rising demand, meat

39 Qasem, Resource Scarcity in the 21st Century: Conflict or Cooperation?, 21.

40 Brown, "The New Geopolitics of Food."

41 International Water Management Institute (IWMI), Looking ahead to 2050: scenarios of alternative investment approaches (IWMI, February 28, 2007), 94–95, http://www.iwmi.cgiar.org/assessment/Water%20for%20Food%20Water%20for%20Life/Chapters/Chapter%203%20Scenarios.pdf.

production is expected to more than double from 229 million tons in 1999/2001 to 470 million tons in 2050.[42]

Increased meat production has important implications for food security, as it is a highly resource intensive industry requiring large quantities of grain, water and land. The production of 1 kilogram of meat requires on average 8 kilogram of cereals.[43] As a consequence, the demand for corn and soybeans to feed livestock has soared, and so have the prices of these commodities. Figure 9 shows that red meat production has a significantly larger water footprint than other foods. High levels of water consumption in the livestock industry can endanger the production of other foods, especially in times of water shortages and droughts. Livestock production has significant impact on landscapes, soil quality, biodiversity and ecosystems. Depending on the intensity and production method, meat livestock production can have adverse environmental effects, including land degradation, water depletion and pollution, which can negatively affect food security.[44] The grain, water and land resources used for meat production compete with resources for people.

In addition, livestock production contributes to climate change, which can be a threat to food security. It has been estimated by the FAO that livestock production contributes to between 15%-24% of global greenhouse gas emissions. [45]

42 Nigel Scollan et al., The Environmental Impact of Meat Production Systems, July 2, 2010, 3.

43 Europa NU, "Stijgende Voedselprijzen," Europe NU, May 27, 2010, http://www.europa-nu.nl/id/vhubcl2mgsus/stijgende_voedselprijzen.

44 Scollan et al., The Environmental Impact of Meat Production Systems, 3.

45 FAO, Livestock's Long Shadow: Environmental Issues and Options (Rome, 2006), ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf.

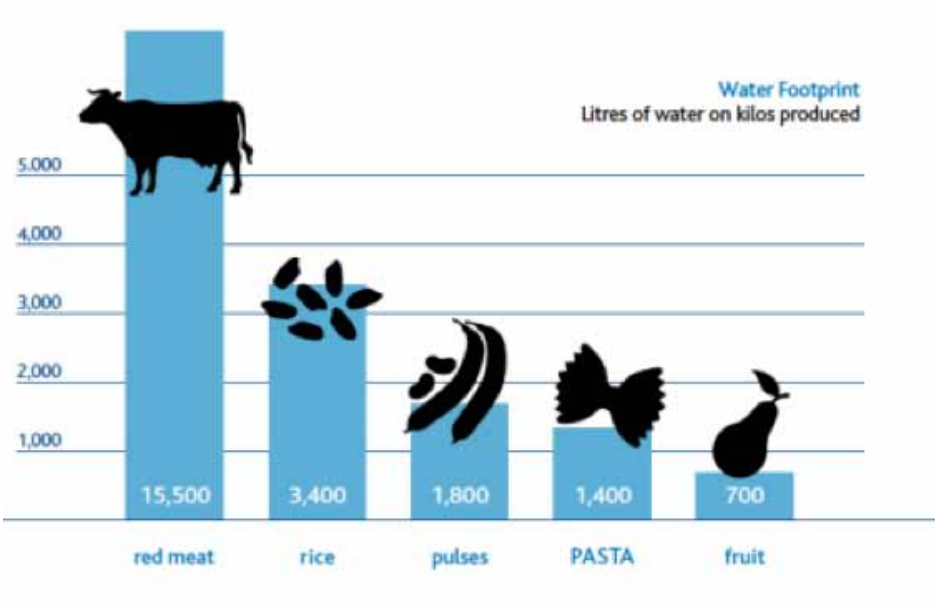

FIGURE 9 WATER FOOTPRINT OF AGRICULTURAL PRODUCTS, SOURCE: WWW.I8NOT.NET/WORDPRESS

SUBSIDIES, PROTECTIONISM AND FOOD SECURITY POLICIES

Various policies are distorting the supply side of the market, including subsidies and protectionist policies. In the US, Europe and Japan, farmers are receiving subsidies from their governments to produce crops, which drives poor farmers in the developing world out of business.[46] The European Common Agricultural Policy, a system of subsidies that was put in place to ensure Europe's food self-sufficiency while guaranteeing an income to European farmers, is heavily criticized internationally. Different interest and lobby groups, such as farmers and large food trading companies, however, play an active role in shaping and keeping these policies in place.

Many countries have responded to growing food scarcity with protectionist policies to enhance their domestic food security. These policies, however, are adversely affecting the availability of food on the global market. Restricting food exports, like Russia did in 2010 after wildfires and droughts destroyed 40% of the Russian grain harvest, is a common example of such

46 Foreign Policy Association, Running Out: The Global Food Crisis.

protectionist policies.[47] Countries can also start stockpiling food, as with rice in the Philippines during 2009.[48] The recent phenomenon of "land grabbing" (see more below) is another mercantilist policy that prevents food from reaching the global market.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
farmers	756	19%	access	472	12%
policies	681	17%	national	445	11%
trade	496	13%	government	399	10%

TABLE 6 CONCEPTS RELATED TO DISTORTING POLICIES

HEALTH

Health is associated with food security in different ways. First, food insecurity can lead to hunger and related health problems. According to statistics from the FAO, hunger continues to be a problem for nearly 1 billion people in the developing world and emerging countries.[49] In addition, at least 2 billion people suffer from so called "hidden hunger", which means they have access to the minimum amount of calories but lack one or more vital micronutrients, which can lead to diseases and health problems.[50] Hunger and malnutrition can lead to problems in children's brain development.

Second, there are the health dangers of unhealthy diets in the developed world. Although these health issues are different from the ones related to hunger in the developing world and require different policy measures, they are a threat to food security in its broadest definition (as discussed above).

47 HCSS, TNO, and CE Delft, Op weg naar een Grondstoffenstrategie. Quick scan ten behoeve van de Grondstoffennotitie, 37.

48 Foreign Policy Association, Running Out: The Global Food Crisis.

49 FAO, The State of Food Insecurity in the World 2010 (Rome: FAO, 2010), http://www.fao.org/docrep/013/i1683e/i1683e.pdf.

50 Francesco Burchi, Jessica Fanzo, and Emile Frison, "The Role of Food and Nutrition System Approaches in Tackling Hidden Hunger," International Journal of Environmental Research and Public Health 8, no. 2 (2011): 359.

Particularly low-income households suffer from increasing rates of obesity and other health diseases associated with poor diets because they have no or limited access to affordable and nutritious food.[51] The food industry has a large impact on poor dietary practices and health.[52] To increase sales, food industries use strategies to make consumers eat more by marketing products as having beneficial health effects while at the same time making food taste better by adding unhealthy amounts of salt, sugar and artificial sweeteners.

Third, there is an indirect relation between food security and the health risks related to agriculture as a professional occupation. Researchers point out that agriculture is a dangerous profession, causing injury and death to millions of workers around the world.[53] Such agricultural accidents heavily hamper agricultural output as the efficiency of the workers is impeded and productivity is reduced. The output of the agricultural sector directly affects global food security in terms of food supply. Agriculture also indirectly affects food security by employing and providing income to purchase food to a large part of the developing world's labor force. Globally, agriculture accounts for 37% of employment.[54] A lack of national health and safety regulations for the agricultural sector in developing nations therefore has important implications for food security.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
health	364	9%

TABLE 7 OCCURRENCE OF THE CONCEPT 'HEALTH'

51 Nadja Boncouer, "Food deserts: Do they exist in the U.S.?," The Foreign Affairs Blog Network, May 5, 2011, http://foodcrisis.foreignpolicyblogs.com/2011/05/05/food-deserts-do-they-exist-in-the-u-s/.

52 Marion Nestle, Food Politics. How the Food Industry Influences Nutrition and Health (Berkeley and Los Angeles: University of California Press, 2007).

53 Samuel Toyin Olowogbon, "Health and Safety in Agriculture and Food Security Nexus," International Journal of Emerging Sciences 1, no. 2 (June 2011): 73.

54 United Nations Conference on Sustainable Development, "The Story of Agriculture and the Green Economy," Rio +20 www.uncsd2012.org, October 26, 2011, http://www.uncsd2012.org/rio20/?page=view&nr=510&type=230&menu=38.

4.3 WHO ARE THE MAIN ACTORS?

The text-mining results give a few indications of the main actors in the food security issue. As food security is an issue with many dimensions, it is not surprising that the results points to many stakeholders, including governments, farmers, the industry and individuals, at the international, national and regional levels, which each have their own perspective on food security.

CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE	CONCEPT	ABSOLUTE OCCURRENCE	RELATIVE OCCURRENCE
countries	1469	37%	international	473	12%
farmers	756	19%	national	445	11%
people	748	19%	poor	429	11%
regions	591	15%	government	399	10%
public	455	12%	industry	387	10%

TABLE 8 CONCEPTS REFLECTING WHO THE MAIN ACTORS ARE

INTERNATIONAL ORGANIZATIONS

At the international level, many organizations are involved in food security. At the Millennium Development Goals summit in 2000, the UN adopted the objective to halve the proportion of people who suffer from hunger by 2015. When the global food crisis of 2006-2008 threatened to reverse the gains made toward achieving this goal, the UN established the High Level Task Force (HLTF) on the Global Food Security Crisis in May 2008.[55] The HLTF is chaired by the UN Secretary General and coordinated by the Special Representative for Food Security and Nutrition. In order to promote a comprehensive and unified approach to achieve global food security, the HLTF brings together the heads of UN specialized agencies, funds and programs and parts of the UN Secretariat. Of the three UN agencies that deal with this issue – the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD) and the World

55 United Nations High Level Task Force, "The Global Food Security Crisis. Background Information", n.d., http://www.un.org/issues/food/taskforce/background.shtml.

Food Program – only the FAO appears on the concept map, suggesting the dominance of this actor in the literature.[56]

FIGURE 10 'FAO' ON THE CONCEPT MAP

It should be noted that the World Bank, the International Monetary Fund, the Organization for Economic Cooperation and Development and the World Trade Organization (WTO) are all part of the HLTF.[57] In coordination with the HLTF, the World Bank articulated the Global Food Crisis Response Program. This program aims to provide immediate relief to countries that are suffering the most from high food prices.[58] The WTO plays an important role in the global distribution of food as it shapes the international frameworks for agricultural trade and serves as the platform for multilateral negotiations on trade liberalization. Protectionist trade policies can be counterproductive to achieving food security. Ongoing negotiations focus

56 N.B. Whilst the potential for a 'skew' in results exists emerging from the inclusion of sources authored by the FAO, it should be noted that FAO published reports accounted for only three of our sources that were used to generate this concept map.

57 United Nations High Level Task Force, "The Global Food Security Crisis. Background Information."

58 World Bank, "Food Crisis: What the World Bank is Doing", April 7, 2011, http://www.worldbank.org/foodcrisis/bankinitiatives.htm.

on reforming agricultural trade by substantially reducing export subsidies, domestic support and import duties on agricultural products.[59]

FARMERS AND AGRI-FOOD COMPANIES

Farmers are the key actors in providing food security, as they are producing food, managing the land and contributing to ecosystem services and biodiversity. During the 20th century, the agriculture sector and the food industry underwent considerable changes. Agricultural mechanization, which "embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting, preparation for storage, storage, and on-farm processing"[60] reduced the number of farmers in the developed world. Today, 97% of agriculture workers live in developing countries, where women farmers produce the majority of the food.[61]

The 20th century also saw the start of an ongoing process of verticalization, mainly in the developed world, in which farmers were replaced by large corporations as the dominant actors in the food industry. [62] These large corporations own stakes in all stages of the food production, ranging from the growing phase, for which they produce seeds and pesticides, to the food processing and marketing phase. Non-governmental organizations (NGOs) have expressed their concerns about this development, which may lead to a monopolistic system in which only a few companies command the global food chain. They have pointed out that currently six multinationals (Monsanto, Cargill, BASF, Syngenta, DuPont, Bayer, and Dow) represent 75-80% of the global pesticides market, and two of these corporations (DuPont and Monsanto) jointly command 65% and 44% of the world's corn

59 World Trade Organization (WTO), Agriculture Negotiations: Backgrounder (WTO, December 1, 2004), http://www.wto.org/english/tratop_e/agric_e/negs_bkgrnd05_intro_e.htm#presentreform.

60 Adrianus Rijk, "Agricultural Mechanization Strategy" (United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM), 1999), http://www.unapcaem.org/publication/CIGR_APCAEM_Website.pdf.

61 United Nations Conference on Sustainable Development, "The Story of Agriculture and the Green Economy."

62 Nestle, Food Politics. How the Food Industry Influences Nutrition and Health, 11.

and soy seed markets respectively.[63] This situation is even more acute in the rapidly expanding bio-technology market, where one corporation, Monsanto, singly controls 87% of the world's genetically modified seed, and accounts for nearly a quarter of the proprietary seed market in general.[64]

The trends towards a monopolistic market has raised concerns about the inequitable effects on farmers and small scale producers in developed and developing countries, as well as for future food security at the global level. The absence of competition allows a handful of multinationals to fix prices for farmers and consumers and to set the rules of the game. Monsanto's policy of producing 'terminator seeds' provides a good case in point. These seeds have a limited fertility span which compels farmers to purchase seeds annually from Monsanto. At the UNEP Convention on Biological Diversity, this policy was heavily criticized in the for entrenching dependency and for negatively affecting biocultural heritage, biodiversity, food systems and livelihoods of farming communities in developing countries.[65]

On the other hand are the advocates of bio-engineering arguing that the research and development conducted by these large companies has made an important positive contribution to increasing global food security. Together with public and private research institutions, these companies are among the main driving forces behind technological innovation which has dramatically increased agricultural output by making it easier to plant and harvest larger areas of land, developing pest resistance, earlier maturity,

63 ActionAid, Power hungry: Six Reasons to Regulate Global Food Corporations (ActionAid, 2004), http://www.actionaid.org.uk/_content/documents/power_hungry.pdf.

64 ETC group, Who Owns Nature: Corporate Power and the FInal Frontier in the Commodification of Life, ETC Communiqué, 2008, http://www.etcgroup.org/en/node/707.

65 United Nations Environment Program (UNEP), "Convention on Biological Diversity" (presented at the Convention on Biological Diversity, UNEP, 2005), http://www.cbd.int/doc/meetings/tk/wg8j-04/information/wg8j-04-inf-06-en.pdf; see also Ronald Herring, "Stealth Seeds: Bioproperty, Biosafety, Biopolitics," Journal of Development Studies 43, no. 1 (2007): 130–157, http://government.arts.cornell.edu/assets/faculty/docs/herring/JDS_HerringStealthSeeds.pdf.

and quality better crops. The FAO's official statement on biotechnology is that it "provides powerful tools for the sustainable development of agriculture, fisheries and forestry, as well as the food industry ...[which]... can be of significant assistance in meeting the needs of an expanding and increasingly urbanized population in the next millennium."[66] The FAO therefore encourages developing countries to *reap the benefits from biotechnologies*. At the same time, the FAO says to be aware of the potential risks posed by certain aspects of biotechnology on the health of humans, animals and the environment, and stresses the importance of minimizing risks.

LOBBY GROUPS

Finally, the literature points to another group of actors that are affecting food security, being lobby groups. First, there is the powerful lobby of the agrifood industry in governments and (international) regulatory organizations, such as the WTO. Civil society organizations have voiced concerns about the influence of large multinational companies over the making of global trade rules. The essence of these concerns is that corporate interests do not necessarily include public goods, such as food security, and that the interests of poor communities are hence being undermined.[67] The lobby of the agrifood industry also allegedly results in the maintenance of forms of indirect support to farmers in the developed world while agricultural subsidies to farmers in developing countries are being outlawed. This is distorting the market and therefore constraining the food security of the world's poorest.

Second, there is the lobby against biotechnology. The anti-biotechnology lobby has raised public concerns about the safety of such technologies and especially in Europe this has resulted in greater restriction of biotechnology

66 FAO, "FAO Statement on Biotechnology," www.fao.org, March 2000, http://www.fao.org/biotech/fao-statement-on-biotechnology/en/.

67 ActionAid, Under the Influence: Exposing Undue Corporate Influence over Policy Making at the WTO (ActionAid, 2006), http://www.actionaid.org.uk/_content/documents/under_the_influence_final.pdf.

research and development.[68] Proponents of these technologies argue that anti-biotechnology lobby is undermining food security due to its influence over public opinion and the decision making process. Researchers from the University of Edinburgh and Warwick University in the United Kingdom, say that Europe's regulation of genetically modified crops has become less democratic and less evidence-based since the 1980s.[69] They argue that Europe is undermining its own effort to enhance global food security as its policy causes developing countries to resist growing genetically modified crops. Even though farmers may benefit from reduced crop losses and increased yields due to biotechnology, they would not be able to sell their produce in Europe.

ACTORS ON AGRICULTURAL COMMODITIES MARKETS

Since the mid-2000, financial derivatives markets for agricultural commodities has strongly increased. Commercial participants, such as food processing companies, use futures contracts to guard against prices rises: they use the increased value of futures contract to offset the higher costs of buying agricultural commodities. However, it is trading by non-commercial actors that increased especially strongly.[70] These non-commercial participants include index funds, swap dealers and money managers. One of the reasons why these investors increasingly started using agricultural commodities in their portfolios is that there seems to be no correlations between the return on agricultural commodities and other assets.[71] Non-commercial investors hold large quantities of futures contracts for many basic commodities, such as wheat, maize, soybeans, cacao, coffee and sugar. Although the participation by non-commercial investors is considered by many to have increased price volatility, these investors also provide the market with liquidity which is necessary for a proper functioning of the market.[72]

68 Les Levidow, "Governing conflicts over sustainability: agricultural biotechnology in Europe," in Agricultural governance: globalization and the new politics of regulation, ed. Vaughan Higgins and Geoffrey Lawrence (London, UK: Routledge, 2005), 98–117.

69 Joyce Tait and Guy Barker, "Global food security and the governance of modern biotechnologies," EMBO Reports 12, no. 8 (2011): 763.

70 FAO, Price Volatility in Agricultural Markets. Evidence, impact on food security and policy responses.

71 Ibid.

72 Ibid.

CONSUMERS

Besides governmental and corporate actors, consumers are important actors in the literature on food security. As stated above, a growing number people has to eat and wants to eat better, contributing to an extraordinary demand explosion. Trends in food production and consumption have also contributed to an increase of food waste over the past years, especially in industrialized countries where food waste per capita is higher than in developing countries. Currently, 40% of food is wasted somewhere in the food chain. In developing countries this occurs mostly at the post-harvest and processing phases, while in industrialized countries this happens at the retail and consumer stages.[73] In the UK, for example, households discard 8.3 million tons of food and drink each year, most of which could be eaten.[74] According to some estimates, "[t]he nearly 1 billion hungry people of the world could be lifted out of malnutrition on less than 1/4 the food that's wasted in the U.S., U.K. and Europe."[75] Consumers are increasingly aware of the negative impact of their food consumption habits. This awareness is resulting in a growing demand for sustainably produced food and initiatives to reduce food waste. Curtailing food waste would reduce the resources, such as land, water and crops, that are needed to produce food. Food waste also undermines future food security by contributing to climate change: it is estimated that food waste is responsible for 10% of greenhouse gasses of industrialized countries.[76]

This chapter has shown that food security is an issue with many dimensions and stakeholders, each contributing their own dynamic and perspective. After having analyzed these different aspects of food security on the basis of the salient concepts in the literature, the paper will now turn to trends that are likely to shape the future of food security.

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73 Renee Cho, "Wasting Food = Wasting Water," State of the Planet - Blogs from the Earth Institute of Colombia University, July 1, 2011, http://blogs.ei.columbia.edu/2011/07/01/wasting-food-wasting-water/.

74 Ashok Chapagain and Keith James, The water and carbon footprint of household food and drink waste in the UK (UK: World Wide Fund (WFF-UK) and Waste & Resources Action Programme (WRAP), March 2011), http://www.wrap.org.uk/downloads/Water_and_Carbon_Footprint_report_22_Aug_11_Final.073c6d59.10610.pdf.

75 Cho, "Wasting Food = Wasting Water."

76 Ibid.

5 TRENDS AND FUTURE OF GLOBAL FOOD SECURITY

On the basis of our analysis of the foresight literature, there are indications that the following aspects of food security are likely to become increasingly important in the future.

5.1 INCREASED GOVERNMENT INTERFERENCE

Growing concerns about food supply and the changing international context have prompted governments to take up an increasingly active role in formulating food security strategies. Import dependent countries are developing policy instruments aimed at acquiring access to food, such as proactively purchasing or leasing land, stockpiling food and encouraging vertical integration of their companies in the food supply chain. Major food producing countries are aiming to use the global demand for food to maximize government revenues while at the same time securing the needs of their own population first. This trend of increased government interference on the global food market has led to increased mercantilist and protectionist policies, such as export restrictions and trade barriers, which have important consequences for the future of international trade relations.[77] The resultant competition between governments, rather than between private companies, is likely to decrease international stability and the capacity for tackling future food insecurity.

5.2 INCREASED INSTABILITY

Food shortages or high food prices can contribute to riots and domestic instability. According to the US State Department, between 2007 and 2009

77 HCSS, TNO, and CE Delft, Op weg naar een Grondstoffenstrategie. Quick scan ten behoeve van de Grondstoffennotitie.

more than 60 food riots occurred worldwide.[78] The consequences of rising food prices are not felt equally around the world, and are particularly a threat to stability in the developing world. People in developing countries on average spend between 50-60% of their income on food, compared to an expenditure of between 15-20% for households in the developed world.[79] This means developing countries are disproportionally affected by high food prices, which have a direct impact on consumption patterns and can make the difference between having one or two meals a day.[80] The Arab Spring is a good example of how rising food prices can contribute to protests and revolutions and potentially regional instability. If prices continue to rise, food is likely to become an ever more important diver of world politics in the future.

5.3 REITERATION OF BIOFUEL POLICIES

As the negative effects of biofuel policies become increasingly apparent, it is likely that we will see a reiteration of biofuel policies in the future. Jeffrey Sachs, the special adviser to UN Secretary-General Ban on anti-poverty goals, argued that "Biofuels were understandable at a time of low food prices and large food stocks but do not make sense now in a condition of global food scarcity." British journalist and commentator George Monbiot argued for a five-year freeze on biofuels to save people form starvation and to avoid the destruction of the environment.[81] EcoNexus, a British NGO, called on the EU for an immediate moratorium on EU incentives for agrofuels, EU imports of agrofuels and EU agro-energy monocultures.[82]

78 Alan Bjerga, "Risk of Riots as Governments Cut Food Subsidies, UN's Sheeran Says," Bloomberg.com, January 25, 2011, http://www.bloomberg.com/news/2011-01-25/risk-of-riots-rising-as-governments-cut-food-subsidies-un-s-sheeran-says.html.

79 Doaa Abdul Motaal, "World Food Security and International Trade", July 5, 2011, http://www.momagri.org/UK/focus-on-issues/World-food-security-and-international-trade_653.html.

80 Brown, "The New Geopolitics of Food."

81 George Monbiot, "If we want to save the planet, we need a five-year freeze on biofuels," The Guardian, March 27, 2007, http://www.guardian.co.uk/commentisfree/2007/mar/27/comment.food.

82 Econexus, "Call for an immediate moratorium on EU incentives for agrofuels, EU imports of agrofuels and EU agroenergy monocultures," econexus.info, June 2007, http://www.econexus.info/call-immediate-moratorium-eu-incentives-agrofuels-eu-imports-agrofuels-and-eu-agroenergy-monocultur-0.

Although it is unlikely that countries will abandon biofuels all together in the future, it is probable that targets for biofuel production may become less rigid, and will be formulated in a way that takes into account the prices of other commodities. As food security becomes an ever pressing issue, biofuel policies are likely to be cut back based on a "food first" principle.

5.4 ONGOING DEBATE ABOUT THE IMPACT OF SPECULATION

Many believe that the upward trend of food prices is partly due to speculation on commodity futures markets. The French President, Nicolas Sarkozy, has been an avid proponent of fighting the perceived negative impact of speculation through more international regulation of commodity markets.[83] European Commissioners Antonio Tajani (Industry), Michel Barnier (Internal market) en Dacian Ciolos (Agriculture) have also formulated a proposal to enforce more price transparency.[84] The FAO on the other hand, points out that policies to limit or ban speculative trading may do more harm than good as government interference can hamper the proper functioning of the market, and that instead, regulation should aim *to improve* and not ban speculative trading.[85] Since there is no consensus on this issue and policy makers are likely to put forward more proposals, debate is expected to continue in the future.

5.5 INCREASED FOOD PRODUCTION IN AFRICA

Although farm land is increasingly scarce, the potential remains to use unexplored agricultural land to increase global food production. Of the world's unused agricultural land 80% is located in Africa, mainly concentrated in Sudan, Democratic Republic of Congo and Angola.[86] It can

83 RTE News, "Sarkozy urges regulation of commodity markets," RTE News, January 24, 2011, http://www.rte.ie/news/2011/0124/sarkozy-business.html.

84 Rudy Ruitenberg, "EU Agriculture Officials Sya More Transparency Needed on Positions in Futures," Bloomberg.com, September 10, 2010, http://www.bloomberg.com/news/2010-09-20/eu-s-dacian-ciolos-says-more-transparency-needed-on-positions-in-futures.html.

85 Easypol, Price Surges in Food Markets: How Should Organized Futures Markets be Regulated?, Policy Brief (FAO, 2010), http://www.fao.org/docs/up/easypol/822/price-surges_food_markets_264EN.pdf.

86 Stephen Ellis, "Seasons of Rains" (Book Presentation, The Hague, Dutch Ministry of Foreign Affairs, June 27, 2011).

therefore be expected that Africa will play an increasingly important role in agricultural production for the world market. Improved farming policies and mechanization can increase agricultural output, especially in places where traditional agriculture is still prevalent. It remains unclear, however, what form the implementation of increased farming in Africa will take. It is uncertain, for example, if this land will be used for food production or whether it may instead be used for the production of biofuel. Another uncertainty is whether this will be done by African farmers or foreigners buying up agricultural land in Africa, a practice known as 'land grabbing'.

5.6 LAND GRABBING

The rise of food prices in 2006-2008 triggered an increase of large scale acquisitions of farmland in Africa, Latin America, Central Asia and Southeast Asia. Governments of emerging and developed economies started to proactively purchase or lease thousands of hectares of farmland in foreign countries as an alternative to buying food on the international food market.[87] The media points to China, South Korea, Saudi Arabia, Qatar, and the United Arab Emirates as the main states involved in land grabbing. These countries use government-to government deals, state owned enterprises, government-private joint ventures, and Sovereign Wealth Funds to back their transactions. Although less attention has been paid to them in the press, private companies from the European Union and the United States are also actively investing in land deals.[88]

Target countries usually welcome this interest, as it brings foreign investment, technology, know how, and infrastructure. Besides obvious opportunities, however, land deals also represent risks to the local population and global food security. The acquisition of land by foreign investors poses a significant risk of compromising access to resources and alienating local people who depend on those resources for livelihood and food security.[89] In addition, these practices can put local farmers who used to deliver to the international market out of business. A recent report

87 Lorenzo Cotula et al., Land grab or development opportunity? Agricultural investment and international land deals in Africa (London/Rome: IIED/FAO/IFAD, 2009).

88 Ibid., 34–35.

89 Ibid., 100.

describes the number of so far known land grab deals as the tip of the iceberg.[90] The perceived abundance of unexploited land in combination with international concern about food supply and rising energy prices are likely to make land grabbing an increasingly important aspect of food security in the future.

5.7 INNOVATION FOR A MORE SUSTAINABLE FOOD SUPPLY

Ongoing technological development and innovation will continue to impact food security and make key contributions to a number of stages of the global food chain. First of all, innovation will help to raise productivity growth and to strengthen the supply side of global agriculture. Innovation can increase the availability of food in various ways, including the development of better quality seeds, improved pest management and farms practices.[91] Funding research remains especially essential in light of the upcoming challenges related to climate change. Developing new varieties of crops that are more resistant to drought, extreme temperatures, salinity, and floods will increase resilience. Recently, a successful experiment to grow plants in the International Space Station yielded important lessons for the cultivation of crops in arid and semi-arid regions on earth.[92] Second, innovation will also increase food security by making agriculture more sustainable. Unsustainable land use undermines food security by causing land degradation and biodiversity loss. Innovation can help to reduce the negative environmental costs of fertilizer use, to improve water management and contribute to better soil conservation. Third, nutrition innovation will enhance global food security by reducing micronutrient deficiencies. By means of biofortification, which is breeding higher levels of micronutrients into crops, malnutrition can be targeted in an effective and way. Biofortification of crops consumed by the world's poorest, such as

90 David Smith, "The food rush: Rising demand in China and West sparks African land grab," The Guardian, July 3, 2009, http://www.guardian.co.uk/environment/2009/jul/03/africa-land-grab.

91 BIAC, "Innovation to Adress Food Security" (OECD, November 2009), http://www.biac.org/statements/agr/FIN09-11_Agriculture_and_Innovation.pdf.

92 Duncan Kennedy, Plants successfully grown in space (BBC.co.uk, 2011), http://www.bbc.co.uk/news/science-environment-13852801.

rice, maize, wheat, cassava, sweet potatoes and beans, is already well advanced.[93]

93 FAO, Price Volatility in Agricultural Markets. Evidence, impact on food security and policy responses.

6 CONCLUDING REMARKS FOR RESEARCHERS AND POLICY MAKERS

This report gave a brief overview of different aspects of food security now and in the future. The underlying dynamics of food security are highly complex, resistant to change and interrelated with many other policy areas besides food alone. This makes it difficult for policy makers to tackle food scarcity. Although enough food is being produced to feed the world, many parts of the world still suffer from hunger as a result of economic underdevelopment and bad policies, such as a lack of investment in environmentally sustainable agriculture and research and development. In addition, there has been insufficient awareness of how policy areas, such as agriculture, energy and climate, interfere with each other. The promotion of biofuels is the most obvious example of how environmental and climate change policy work across purposes with food policy.

Having briefly identified what the future dimensions of food security may be, the question remains what policy makers should focus on in order to anticipate future food crises. One of the main findings from the analysis is that an increase in integrated and inter-disciplinary research is of paramount importance for finding sustainable and equitable solutions to the impending food-security crisis. The literature stresses the exigent need for 'decisive action [...] across a wide front'[94] -action driven by diverse *trans*-disciplinary research[95] that considers the food system as a whole, and

94 Government Office for Science, The Future of Food and Farming: Challenges and Choices for Global Sustainability, Final Report (UK: The UK Government Office for Science, 2011), http://www.bis.gov.uk/assets/bispartners/foresight/docs/food-and-farming/11-546-future-of-food-and-farming-report.pdf.

95 Standing Committee on Agricultural Research (SCAR), Sustainable food consumption and production in a resource-constrained world, Final Report, SCAR Foresight Exercise (EU Commission, February 2011), http://ec.europa.eu/research/agriculture/scar/pdf/scar_feg3_final_report_01_02_2011.pdf.

that implements policy based on broad stakeholder consultation and involvement.[96] This research can focus on the aspects of food security identified as becoming increasingly important but should also take the functioning of the entire food system and all actors involved into consideration. Research is crucial to improve our understanding of the complex issue that food security is and the implications it has beyond the food system itself.

Meanwhile, the potentially severe crisis posed at the local and geopolitical level by future food insecurity requires action at international as well as regional and local levels, and will demand high levels of cooperation between states, and between the public and private sectors. Based on the analysis some general recommendations for policy directions can be made. First, it appears that more investment is needed to improve availability, access and public knowledge of healthy and nutritious food. This includes increasing agricultural output from unexploited areas, such as in Africa. Researchers can make important contributions by looking into the development of methods of food production that are feasible, sustainable and profitable. Governments should also promote healthy, nutritious dietary consumption patterns and improve the protection of consumers against misleading marketing strategies from the food industry. Second, energy policies need to be reviewed. More investments should be made in environmentally friendly energy production that does not compete with food production. Third, a better, and more adaptive alert-system is required. This should not only aim to prevent food crises, but also serve to correct misguided policies, such as the promotion of biofuel, earlier. In addition, an alert-system may help to prevent domestic and international instability.

In order to achieve these objectives, it is imperative that action is taken internationally. The literature emphasizes the inadequacy of single-handed or unilateral measures, either between institutions, nations, or supranational organizations, in responding to the food crisis. By establishing the HLTF, the UN has taken an initial step towards more concerted international action. Experts point out that solving the food crisis requires solving a

96 FAO, How to Feed the World in 2050 (Rome: FAO, 2009), http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf.

political conundrum: how to convince the food secure countries of the world to commit resources to fight hunger elsewhere?[97] The geopolitical consequences of food insecurity, brought to the public's attention by the Arab Spring, may have provided a window of opportunity to overcome this conundrum. It has shown that hunger in fragile states may potentially lead to regional or international insecurity, and is therefore has implications for the developed world. Stressing that food security is ineluctably linked not only with future food provision, but also with global security, environmental integrity, and economic stability is necessary to foster a sense of international solidarity and cooperation.

97 Foreign Policy Association, Running Out: The Global Food Crisis, Film, Great Decisions, 2009. http://bcove.me/lae7m3t9

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