

Resilience of food companies to calamities

– perceptions in the Netherlands

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Abstract

Calamities such as extreme droughts and trade or infrastructure breakdowns potentially hamper the continuity of individual food companies, as well as the continuity of food supply in Europe at large. There is a lack of insight into food companies' resilience in case of cumulative calamities or calamities that did not happen before in recent history. In this context, an expert elicitation study among feed and food companies in the Netherlands was undertaken. Results show that lengthy or structural unavailability of electricity and a lengthy crisis of road transport are perceived as the most threatening calamities. Outcomes also show a relatively limited implementation of BCM (business continuity management) at company level. Complete BCM programs for top-3 calamities perceived to threaten the continuity of food supply in Europe are reported by 0% to 30% of the companies. For calamities perceived to be important for business continuity this is between 20% and 40%. In the field of risk management a leading role is attributed to the public sector for improving international governance and setting up a so-called masterplan with measures such as larger raw-materials stocks and broad sourcing. Findings suggest that further actions are needed, starting with prioritised calamities and the design of a masterplan. Yet, stakeholders are also urged to pro-actively "think the unthinkable".

Keywords: Resilience; Risk perception; Risk management; Business Continuity Management; Masterplan

1. Introduction

Calamities such as extreme droughts, trade or infrastructure breakdowns and pandemics potentially disrupt food companies' continuity, and, as a consequence, the continuity of food supply throughout Europe¹. Although food supply has shown to be rather robust during previous crises such as the 1986 Chernobyl disaster, various severe epizootics, and 2003 droughts (Bindraban *et al.*, 2008)², there is increasing concern about food supply chains' resilience. For instance, Peck (2006) concluded that UK food companies are not well prepared for system-wide disruptions, such as loss of power and loss of water. In addition, Subuh *et al.* (2008) found that feed and food companies operating in the Netherlands lack adequate strategies for responding to food terrorism. In 2008, following the report by Bindraban *et al.* (2008), the Dutch Steering Committee Technology Assessment of the Ministry of Agriculture, Nature and Food Quality, stated that EU food supply is rather robust, but that insufficient knowledge exists on food supply continuity in case multiple disastrous scenarios occur in a short period of time or if scenarios occur that did not happen before in recent history.

To obtain more insight into the resilience of food companies to calamities, the aforementioned Steering Committee in 2009 initiated and commissioned the current study of the resilience of the private sector. More specifically, the objectives are to analyse:

- (i) the perceived impact of calamities on individual business and aggregate food supply continuity; and
- (ii) the perceived relevance of risk management strategies to deal with such calamities.

Business continuity refers to the continuity of individual food companies. Aggregate food supply continuity is the continuity of food supply in Europe as a whole. Specific research questions include:

- What calamities potentially affecting food supply chains have been studied in literature? What has been concluded about companies' risk management strategies and resilience?
- Which calamities are perceived to be threatening for the continuity of individual companies but not for the continuity of food supply at the aggregate level, and vice versa?
- Do companies perceive to need help from others in dealing with calamities?

Results are obtained through expert elicitation. Literature review was used as a basis for developing the questionnaire. In the materials and methods section we first summarise the main findings from literature. Then questionnaire design and sample are elaborated on. Results (section 3) are split into three parts, i.e. perceived impact of calamities on food supply continuity in Europe, perceived impact of calamities on business continuity of individual companies, and perceived relevance of risk management strategies to deal with calamities.

¹ In the paper we do not distinguish between EU and Europe.

² As commissioned by the Dutch Steering Committee Technology Assessment of the Ministry of Agriculture, Nature and Food Quality (now called Platform Agriculture, Innovation & Society).

2. Materials and methods

2.1 Literature review on calamities in food supply chains

Literature yields a longlist of potential calamities and related risk management strategies, as summarised in Table 1.

Table 1: Potential calamities affecting food supply in Europe, possible impacts and proposed risk management strategies.

Source	Calamities	Impact	Risk management
Manning <i>et al.</i> (2005)	Food terrorism with foreign animal disease	Economic disruption, consequential losses, loss of consumer confidence, possible impacts for human health	Public-private strategies; adequate resources; preparedness plans and routine exercises; surveillance systems
Peck (2006)	Large-scale disruptions, i.e. fuel shortages, loss of power, loss of water, and disruptions from sickness and infectious disease	-	Temporary waivers on regulations; implementation of business continuity management; adjusted distribution strategies and stock holdings/locations in advance of foreseeable disruptions; protocols on range reduction between suppliers and customers
Boin and McConnell (2007)	Critical infrastructure breakdowns	-	Contingency planning; promoting societal resilience ¹
Bindraban <i>et al.</i> (2008)	Various, but with focus on collapse of trade affecting EU soybean (meal) imports	Decrease of meat availability in Europe, but no threat for food security. Serious effects for feed and meat industry	Raising stock levels of soybean in Europe; cultivating more protein-rich feed crops within Europe; exploration of dual-purpose crops
Aerts <i>et al.</i> (2008)	Abrupt climate change ²	Many, including food chain disruptions, famines, and infrastructure damage	Some prevention possible; migration south; adjustments ³
Subuh <i>et al.</i> (2008)	Food terrorism ⁴	-	Control actions; information sharing practices; actions enhancing robustness ⁵
DEFRA (2009)	Energy supply disruptions, pandemic flu, extreme weather events and transport disruptions, disruptions to the domestic food chain, economic risks to the food industry	-	Increasing global production in a sustainable way; improving trading and market conditions; managing crises effectively; working together
Meuwissen <i>et al.</i> (2009)	Epizootics	Direct costs, consequential losses	Risk prevention; protective vaccination; culling

¹Among others: preparing first responders, business continuity planning, working with communities, and joint preparation and training.

²Including “little ice age”, “nuclear winter” and “volcanic Aerosol”.

³Among others: focus on local facilities and lifestyle, port de-icing or relocation, increased energy efficiency, increased renewable energy, reliance on food trade with south, stockpiling of freshwater, introduction of resilient crops and techniques, alliance with neighbours for trade and security, and capability to adjust with wealth and health.

⁴Not only from terrorists, but possibly also from supply chain partners with conflicting interests and dissatisfied employees.

⁵More specifically “control actions” include aspects of process strategy, management and technology, infrastructure management, and security metrics. “Information sharing” relates to communication management, management technology, and relationship and public interface management. “Robustness” includes emergency plans and emergency budgets.

Calamities include sudden events such as food terrorism, infrastructure breakdowns, extreme weather events and economic crises. Most extreme scenarios seem to come from Aerts *et al.* (2008), who discuss scenarios of abrupt climate change in Europe, such as “a little ice age” and “a nuclear winter”, potentially leading to food chain disruptions and famines. Table 1 also illustrates the diversity of risk management strategies to deal with such calamities. For instance, some risk management strategies are pro-active, such as stock holding and implementation of business continuity management (BCM) principles, others are more reactive, such as temporary waivers on regulations and culling of diseased livestock. In addition, some strategies are short-term strategies at company level, while other require long-term changes to a system. An example of the latter is given by Bindraban *et al.* (2008), who map the changes of Europe’s food system required to respond to a complete stop of soy imports from America.

With regard to company-level implementation of risk management strategies to deal with calamities, a number of interesting observations were made in literature. For instance, Peck (2006) found that crisis management is often based on reactive actions rather than proactive risk management. In addition, with respect to stock holding, she concluded that “in a perfect world it is to be recommended that redundant capacity and capability should be held by all organisations, just in case. In the present business climate however, this may not be a realistic proposition [...]”. Furthermore, she found that BCM is often regarded as a mechanism to protect the well-being of customers and shareholders, rather than a tool for the public good or to maintain operations in times of national emergency. In the specific area of bio-terrorism, Subuh *et al.* (2008) concluded that many control actions were undertaken but that the majority of food safety managers mistakenly interpret HACCP-based systems to be adequate for dealing with food terrorism. In addition, food companies were found to perceive their own security performance as better than that of their suppliers and the chain as whole.

2.2 Survey design

Calamities in the questionnaire are based on the longlist presented in Table 1, fine-tuned to potential circumstances affecting food companies in the Netherlands:

1. Extreme drought in the EU
2. Extreme drought in EU *and* high oil prices
3. Low stocks *and* extreme drought in EU
4. Extreme cold in Western EU due to changing Gulf Stream
5. Lengthy unavailability of the Rhine for inland shipping
6. Complete stop of soy imports from America
7. Lengthy crisis of road transport in the EU
8. Lengthy or structural non-availability of electricity
9. Pandemic affecting all employees
10. Lengthy unavailability of Rotterdam harbour
11. Lengthy loss of key suppliers due to crisis

Some calamities relate to climate (scenarios 1, 2, 3, 4), other focus on the availability of key inputs (6, 11), labour (9), electricity (8) and transport facilities (5, 7, 10). Two of the climate-related calamities are cumulative scenarios in which multiple disastrous events occur within a short period of time (i.e. scenarios 2 and 3). Underlying causes of the calamities are mostly not specified. For instance, the

unavailability of Rotterdam harbour could be due to extreme weather but also due to terrorist bombing or blockades by ships.

None of these 11 calamities exactly happened in the Netherlands in the recent past. Still, for most there is a link with previous threats, some of which received a lot of media attention. For instance, a stop of soy imports from America (scenario 6) relates to debates on non-allowed genetically modified substances and implications for trade. In addition, a road transport crisis (scenario 7) links to various road blockades in France in the past, some of which lasted 2 to 3 days. Problems with regard to electricity and oil (scenarios 8 and 2 respectively) link to the 2008 disruption of Russian gas exports and peaks in international oil prices. The pandemic scenario associates with global bird flu and Mexican flu concerns in 2006 and 2009 respectively. The stock issue (scenario 3) connects to EU's 2007/8 historically low commodity stocks in combination with high commodity prices on the world market.

In selecting risk management strategies to be included in the questionnaire we focused on private sector measures. For detailing measures from Table 1 we used risk management and BCM literature from Hardaker *et al.* (2004) and Peck (2006), respectively. In total, 16 strategies were included:

1. Larger raw-materials stocks
2. Larger final-goods stocks
3. Own fuel supplies
4. Company energy generation
5. Additional financial reserves
6. Broad sourcing and/or open chains
7. Closed chains
8. Horizontal alliances
9. Alliances with suppliers
10. Local suppliers and customers
11. Scaling down
12. Scaling up
13. Spatial diversification
14. Redundant capacity
15. Process and/or product modification
16. Flexibility of technology

Most risk management strategies are targeted at company level, except for 5 strategies, i.e. 6, 7, 8, 9 and 10, that need to be taken up together with other stages of the supply chain.

The questionnaire consisted of four blocks and started with the perceived impact of calamities on food supply continuity in Europe. We first asked for respondents' interpretation of "continuity of food supply". Two options were given:

- (i) continuously providing a wide variety of products (business as usual); and
- (ii) continuously fulfilling consumers' minimum nutritional needs (possibly with less products on the shelf).

Subsequently, in this context, the perceived impact of the 11 calamities was elicited, using Likert-scales ranging from 1 (not threatened at all) to 5 (very much threatened). It was stressed to only indicate the perceived impact, not the probability of a calamity occurring. Besides predefined calamities, respondents were able to fill in other calamities (open question).

The second part of the questionnaire dealt with the perceived impact of the calamities on the continuity of individual food companies' business. From the list of calamities presented in the previous question, respondents were requested to select the 3 calamities perceived to be most threatening for the continuity of their own food company.

The third, rather extensive, part was on the perceived importance of risk management. We first elicited the degree to which previously mentioned top-3 calamities had already been incorporated in the company's BCM (options: not, not yet, partly, fully). Next, continuing with the business level, the perceived relevance of the 16 risk management strategies was evaluated, again using Likert-scales ranging from 1 (not relevant at all) to 5 (very relevant). Besides predefined strategies, respondents could indicate other strategies perceived to be relevant. We then went beyond the company level and investigated the need for a so-called masterplan to safeguard food supply continuity in Europe at large (options: yes, possible, no), parties perceived to be responsible for such a plan (options: NL-government, EU-government, sector organisations and chain participants) and the top-3 risk management strategies to be included. Top-3 strategies could be selected from the list of 16 strategies previously shown.

The fourth part of the questionnaire was on respondents' interest to participate in follow-up research and on further detailing their companies. Food companies were characterised with regard to stage (supplier, primary producer, processor, wholesaler), type of chain (meat, plant) and turnover.

2.3 Sample

In September 2009, after two pre-tests, the survey was sent to senior management and staff of 20 food companies operating in the Netherlands (and elsewhere) and 20 other stakeholders, including government, and research and sector organisations³. Companies were chosen in such a way that ideally all stages of meat and plant chains would be covered. Questionnaires were sent by email. After 3 months 30 surveys had been returned, mostly by email, implying a response rate of 75%, which can be seen as relatively high. Reasons for non-response are not certain and may range from time constraints to potential shareholder or competitor sensitivity of the topic under consideration.

16 respondents were from food companies and 14 represented other stakeholders. From both groups respondents indeed turned out to be from senior management and high-level staff. Within the category of food companies, there are 3 animal feed companies, 1 large-scale primary producer, 3 processors, 4

³ Questionnaires sent to other stakeholders are different from those to food companies with respect to 4 aspects, i.e. there was no question on BCM, top-3 calamities and relevance of risk management strategies were framed more generally towards "food companies operating in the Netherlands", and we did not ask for further characterisation of the organisation. Both versions of the questionnaire are available upon request.

wholesalers and 5 companies covering multiple stages of the chain. Companies' turnover is between 1 million Euros and 1 billion Euros (n=4), 1-10 billion Euros (n=7) and above 10 billion Euros (n=1). They mostly have a relatively large market share within their sector and both meat and plant chains are about equally represented. From the group of other stakeholders, 4 respondents are from government, 3 from research institutes, 3 from sector organisations and 4 from other organisations such as consultancy companies and certification institutes. In December 2009, 4 respondents (2 from food companies and 2 from research organisations) gave oral feedback to the questionnaire.

3. Results

3.1 Perceived impact of calamities on food supply continuity in Europe

What is actually meant by food supply continuity in Europe? We found that the majority (71%) interpret it as the fulfilment of consumers' minimum nutritional needs, possibly with less products on the shelf. This would imply that even if calamities heavily disrupt food supply chains, this is not regarded as affecting continuity, as long as consumers' minimum nutritional needs are fulfilled. Within the group of food companies (n=16) however views somewhat differ. 50% adheres to the "continuity is business as usual" interpretation, implying that small deviations from normal business would already be regarded as threatening. Along with these interpretations, respondents frequently indicated that continuity is better safeguarded in case food supply chains become more sustainable.

In evaluating which calamities would have the largest impact on food supply continuity in Europe, the following calamities ranked highest (Table 2):

- lengthy or structural unavailability of electricity;
- other calamities (open question), such as food and water contamination, unavailability of drinking water, epizootics and dependence on fossil fuels⁴; and
- lengthy crisis of road transport.

From the various cumulative scenarios, the scenario of low stocks in combination with a drought scored highest (ranked 4th). Standard deviations for the perceived threat of the calamities were found to be relatively low (Appendix Table A.2), indicating that respondents fairly much agree on the severity of threat. In addition, detailed scores show that respondents were generally not very pronounced with regard to their perceptions, i.e. relatively few scored "1" (not threatening at all) and "5" (very much threatening). During feedback it was stated that this might be due to unfamiliarity with the type of calamities included, as companies were said to generally focus risk analyses on known hazards.

⁴ All calamities mentioned in the open question are listed in Table A.1 (Appendix), categorised according to price, production, institutional and other risks.

Table 2: Perceived impact of calamities on food supply continuity and business continuity, and % accounted for in Business Continuity Management (BCM). Top-3 calamities are in bold.

	Threat (rank) for		% in BCM (n=13)		
	food supply Europe ¹ (n=30)	food companies ² (n=15)	Not (yet)	Partly	Yes
Extreme drought in EU	9/10	-	-	-	-
Extreme drought in EU <i>and</i> high oil prices	5	6/7	0	100	0
Low stocks <i>and</i> extreme drought in EU	4	8	0	100	0
Extreme cold in W-EU due to changing Gulf Stream	11	9/10	100	0	0
Lengthy unavailability of Rhine for inland shipping	12	-	-	-	-
Complete stop of soy imports from America	9/10	3/4	25	50	25
Lengthy crisis of road transport in EU	3	3/4	40	40	20
Lengthy or structural unavailability of electricity	1	1	20	50	30
Pandemic affecting all employees	7	5	25	0	75
Lengthy unavailability of Rotterdam harbour	8	9/10	0	0	100
Lengthy loss of key suppliers due to crisis	6	2	40	20	40
Other ³	2	6/7	0	100	0
Overall (%)			25	46	30

¹Measured on a scale from 1 (not threatened at all) to 5 (very much threatened). Table shows ranking.

²Measured as % in “top-3 calamities threatening business continuity”. Table shows ranking.

³Open question. Answers mainly refer to production risks such as food and water contamination, unavailability of drinking water, epizootics and dependence on fossil fuels (Appendix A.1).

The relatively low perceived importance of a complete stop of soy imports from America with respect to food supply continuity in Europe is in line with findings by Bindraban *et al.* (2008), who concluded that a sudden stop of soy imports into the EU would not threaten the fulfilment of consumers’ minimum nutritional needs. The relatively low ranking of pandemics seems to relate to recent government incentives for food companies to implement BCM plans following Mexican flu concerns. Low scores for a lengthy unavailability of Rotterdam harbour likely relate to the frequently stated presumption that other harbours, such as Antwerp, Le Havre and Hamburg, stay accessible.

3.2 Perceived impact of calamities on the continuity of individual food companies

Is the importance of calamities the same when focussing on the company level? Table 2 shows that some differences exist. Company-level continuity is on average perceived to be mostly threatened by:

- lengthy or structural unavailability of electricity;
- lengthy loss of key suppliers;
- lengthy crisis of road transport; and
- complete stop of soy imports from America.

Clearly, electricity and transport crises overlap, while a lengthy loss of key suppliers and a complete stop of soy imports did not show up before. More detailed analyses reveal differences among food companies. For instance, companies with fresh produce generally perceive calamities as more threatening than companies with processed food operating on global markets. The latter seem to trust that sustainable goods and sustainable relationships will also “keep the door open” in case of calamities. Moreover, production companies seem to worry more about the risk of calamities than do wholesalers. For instance,

production companies frequently answered the open question for other types of calamities, while wholesalers did not at all.

3.3 Perceived relevance of risk management strategies to deal with calamities

BCM can be regarded as an integrated way of performing risk management at the company level. Have food companies implemented BCM for top-3 calamities? Table 2 shows that this is not always the case. For instance, lengthy unavailability of electricity is stated to have not (yet) been covered by 20%⁵, it is partly covered by 50% and fully covered by 30% only. More generally, full implementation of BCM is less well organised for top-3 calamities important for food supply continuity in Europe compared to calamities affecting business continuity of individual companies. For the first category, top-3 calamities are stated to be fully incorporated in BCM by 0% to 30% of the food companies, while for calamities threatening business continuity this is between 20% and 40%. Two food companies did not answer the BCM question at all (even though they did fill in their top-3, which included among others electricity and transport crises). During feedback lack of feasible alternative solutions revealed to be the main reason for not answering the BCM question. In addition, it was stated that in general BCM is undertaken for economic reasons, not for reasons of social responsibility.

How did companies detail their BCM, or, otherwise, what risk management strategies are perceived as important to cope with calamities? Table 3 shows that it is not the private strategies that score highest, but open question suggestions, many of which are directed towards public and public-private initiatives. Examples include an increased role of FAO and WHO in crisis management, crisis meetings comparable to summits in the financial world (e.g. between the European Bank and the US Federal Bank), and a check of whether current global food organisations are sufficiently equipped for dealing with potential future calamities. From the predefined private strategies, highest preference was given to solving risks together with other stages of the supply chain (broad sourcing and alliances with suppliers) and company level energy generation. They all equally ranked 2nd/3rd/4th.

⁵ The categories “not” and “not yet” were put together.

Table 3: Perceived relevance of risk management strategies for business continuity and masterplan. Top-3 strategies are in bold.

	Business continuity ¹ (rank) (n=30)	Masterplan (rank) ² (n=25)		Sector and chain
		NL-government	EU-government	
Larger raw-materials stocks	5/6	1	1	1/2
Larger final-goods stocks	14/15	8-11	6-10	6-13
Own fuel supplies	14/15	8-11	6-10	-
Company energy generation	2/3/4	3-7	3/4	6-13
Additional financial reserves	9/10	8-11	3/4	3/4
Broad sourcing / open chains	2/3/4	8-11	2	3/4
Closed chains	13	-	-	6-13
Horizontal alliances	9/10	3-7	5	1/2
Alliances with suppliers	2/3/4	-	6-10	5
Local suppliers and customers	11/12	3-7	11/12	6-13
Scaling down	17	-	-	-
Scaling up	11/12	2	11/12	6-13
Spatial diversification	7/8	-	-	-
Redundant capacity	16	-	-	-
Process/product modification	7/8	3-7	6-10	6-13
Flexibility of technology	5/6	3-7	6-10	6-13
Other ³	1	-	-	6-13
Overall responsibility for masterplan (%)		21	53	26

¹Measured on a scale from 1 (not relevant at all) to 5 (very relevant). Table shows ranking.

²Measured as % in “top-3 strategies for masterplan”. Table shows ranking. Strategies are categorised according to party perceived to be responsible.

³Open question. Answers mainly refer to public and public-private measures, such as improved international governance, increased role for FAO and WHO, risk and crisis training and improved assurance of sustainability (Appendix A.1).

With regard to strategies perceived as not relevant, Table 3 shows that these can be found in the area of costly measures such as larger final-goods stocks, own fuel supplies, scaling down production and investing in redundant capacity. Interestingly, the latter, i.e. redundant capacity, was more or less mentioned in the open question in terms of “provision of latent capacity at farm and processing level” and “emergency plan to allow farming everywhere possible setting aside nature plans and environmental requirements”. Different views on the importance of various risk management strategies are also illustrated by the relatively high standard deviations on the importance of risk management strategies (Appendix Table A.3).

In line with respondents’ preference for public and public-private risk management solutions, the majority see a need for (some form of) a masterplan, i.e. one-third sees a clear need for such a plan and one-third a potential need. Food companies either see a clear need for a masterplan or don’t see a need at all. Other stakeholders are mostly in the “possibly” group. With regard to parties perceived to be responsible for a masterplan, most respondents perceive it as a multiple-party responsibility, but with the largest role for EU-government, i.e. 53% of respondents view the EU-government as (one of) the responsible party(ies)

(Table 3)⁶. Across parties perceived to be responsible, key masterplan strategies are larger raw-materials stocks, broad sourcing, company energy generation and additional financial reserves. In addition, for Dutch governments a role is seen in dealing with scaling up. For sector organisations and supply chains the same is true with regard to setting up horizontal alliances. Overall, masterplan strategies largely differ from company-level business continuity strategies, potentially making them complementary.

⁶ From the group seeing no need for a masterplan, still 5 gave suggestions for parties responsible in this field.

4. Conclusions and discussion

In this study we have analysed the perception of food companies and other stakeholders with regard to the impact of a number of single and cumulative calamities on business and food supply continuity. The following conclusions can be drawn:

- (1) *The topic* of resilience to calamities seems to be of high interest to food companies and related stakeholders, given the high response rate to the questionnaire, the direct involvement of senior management and staff, and a large commitment to participate in follow-up analyses.
- (2) Calamities perceived to be most threatening for *food supply continuity in Europe* are: (i) lengthy or structural unavailability of electricity, and (ii) a lengthy crisis of road transport. In addition, a number of other calamities were perceived as important, such as food and water contamination, unavailability of drinking water, epizootics and dependence on fossil fuels.
- (3) *Business continuity* was perceived to be threatened partly by the same calamities, i.e. unavailability of electricity and road transport crises, but also by some others: lengthy loss of key suppliers and a complete stop of soy imports from America.
- (4) *Business continuity management (BCM)* is relatively better organised with respect to calamities threatening business continuity of individual companies compared to food supply continuity in Europe at large. For the first, top-3 calamities are stated to be fully incorporated in BCM by 20% to 40% of the food companies, while for the latter this is between 0% and 30% only. Important business continuity strategies are company energy generation, broad sourcing and alliances with suppliers.
- (5) With regard to risk management related to calamities an important role is attributed to the *public sector*. This is shown by the high ranking of government strategies, such as improved international governance, crisis training and emergency plans, for safeguarding business continuity. In addition, it follows from the high perceived importance of a masterplan with major roles for Dutch and EU governments. Important masterplan strategies are keeping larger raw-materials stocks, supporting broad sourcing, holding additional financial reserves, and supporting horizontal alliances.

Do the results of this study urge for further actions? Considering the perceived importance of the topic, high impact scores for some of the calamities (even though the majority “only” worried about consumers’ *minimum* nutritional needs), and relatively low implementation figures of BCM, seem to justify a positive answer to this question, i.e. further actions are needed.

For food companies, these behold:

- Improve risk management solutions for calamities which ranked highest, i.e. electricity and road transport crises and loss of key suppliers. Not only because of the relatively limited implementation of BCM for these calamities, but also because some companies did not see any feasible solutions at all.
- Discuss to what degree a number of assumptions made by companies are realistic. For instance, there is a tendency to regard sustainability as panacea for everything, including calamities. In addition, a number of companies seem to rely on sustained open borders, under all circumstances. What if these assumptions do not hold? Furthermore, why are Dutch governments suggested to support scaling up as part of a master plan? Is resilience enhanced by large-scale companies?

- Dear to “think the unthinkable”. Answers reveal that companies focus risk analyses on known hazards. Some calamities may even not have been scored at all for this reason. The high importance of the masterplan strategy of keeping larger raw-materials stocks suggests this might be the case, as raw-materials stocks have little to do with electricity and road transport crises, but much more with shortage of commodities caused by e.g. droughts.

For governments, follow-up aspects include:

- Design an efficient, ethical and feasible mix of masterplan strategies. For instance, what is a proper mix of larger raw-materials stocks, additional financial reserves and broad sourcing? Is it more efficient to foster such strategies at national or at EU level? Is it always ethical to rely on financial reserves to source commodities during a calamity?
- Ensure a proper balance between government and business responsibilities. Although the majority see an important role for governments, BCM scores also show that (some) risk management solutions are feasible at company level. Proper balancing is needed to ensure efficient solutions, including incentives for companies to maintain proper risk and business continuity management.

Issues for further research include:

- Corporate Social Responsibility (CSR). In line with literature, companies stated that BCM is not triggered by CSR policies, but rather by economic considerations. Incorporating so-called “food supply continuity standards” in company-level CSR schemes might enhance awareness and BCM implementation. Similarly, such standards may apply for newly issued government policies and e.g. competition authorities’ assessments in case of mergers and acquisitions. Impact studies would have to reveal feasibility and benefit.
- Knock-on effects. Unavailability of electricity and a road transport crisis were regarded as important threats for both business and food supply continuity. This likely relates to both types of calamities being systemic, i.e. affecting many companies at the same time. If non-systemic risks exist that are also perceived as threatening at both levels this may be due to so-called knock-on effects. We cannot deduce any from our study. Further research would have to reveal if such calamities exist, including implications for company-level and masterplan strategies.
- Consumers’ interpretation of food supply continuity. Food companies and related stakeholders mostly interpreted food supply continuity as fulfilling consumers’ minimum nutritional needs, preferably with a package of more sustainable products. But what is consumers’ interpretation of food supply continuity, e.g. what is their (minimum) demand in terms of choice, availability, price and products once facing a calamity? Consumer studies might be able to elicit consumers’ perceptions on food supply continuity, therewith benefitting decision makers in the resilience arena—and contributing to the already well developed literature in the field of food *safety*.

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Appendix 1: Overview of detailed responses

Table A.1: Categorisation of answers to open questions¹.

	Answers
Calamities (n=10)	
Price risks	- Much higher prices (leading to food wars)
Production risks	- Food and water contamination (due to diseases, pests, disasters, terrorism)
	- ICT problems
	- Epizootics
	- Unavailability of drinking water [2x]
	- Extreme droughts on multiple continents
	- Crisis at plant level
	- Dependence on fossil fuels and power of Middle-East
Institutional risks	- Political issues, e.g. forced adherence to status quo
	- Geopolitical issues, e.g. political instability in the Middle-East
	- Redundant legislation
Other	- Distorting policy, e.g. with respect to bio-energy
	- Economic environment
	- Environmental issues
	- Monopolistic and patent behaviour in food production
Risk management (n=10)	
Private	- Active issue management
	- Research and development
	- Invest in logistical solutions
	- Provision of latent production capacity at farm and processing level
	- Sourcing of alternative raw materials; Increasing chain flexibility
	- Increased valorisation of by-products
Public	- Improved international governance
	- Increased role of e.g. FAO and WHO in crisis management (comparable to top meetings in banking sector between European Bank and FED) [2x]
	- Need for a global masterplan including a check on whether current global organisations are adequate [2x]
	- Risk and crisis training at policy level
	- Emergency plan allowing to farm everywhere possible, i.e. setting aside nature plans and environmental requirements
Public-private	- In the field of assuring sustainability:
	- Consistent implementation of sustainability at policy and business level
	- Less spoilage and more environmental friendly production
	- Link with sustainability and dietary changes, i.e. less and possibly other products on the shelf
	- Assuring transport and electricity facilities
	- Prevention of epizootics
	- A masterplan in which all parties are involved, i.e. NL and EU-governments as well as sector organisations

¹Answers in questionnaire topics “perceived impact of calamities on food supply continuity in Europe”, and “perceived relevance of risk management strategies to assure company’s business continuity”.

Table A.2: Perceived impact of calamities on food supply continuity in Europe on a scale from 1 (not threatened at all) to 5 (very much threatened), n=30.

	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Overall		
						Mean	SD	Rank
Extreme drought in EU	3	33	43	20	0	2.8	0.81	9/10
Extreme drought in EU <i>and</i> high oil prices	0	10	50	37	3	3.3	0.71	5
Low stocks <i>and</i> extreme drought in EU	0	23	30	33	13	3.4	1.00	4
Extreme cold in W-EU ¹	3	41	41	14	0	2.7	0.77	11
Lengthy unavailability of Rhine for inland shipping	34	38	21	7	0	2.0	0.93	12
Complete stop of soy imports from America	20	20	27	23	10	2.8	1.29	9/10
Lengthy crisis of road transport in EU	7	17	17	43	17	3.5	1.17	3
Lengthy or structural non-availability of electricity	0	3	10	45	41	4.2	0.79	1
Pandemic affecting all employees	3	27	37	23	10	3.1	1.03	7
Lengthy unavailability of Rotterdam harbour	7	30	30	30	3	2.9	1.01	8
Lengthy loss of key suppliers due to crisis	7	23	30	23	17	3.2	1.19	6
Other ²	0	0	13	63	25	4.1	0.64	2

¹Due to changing Gulf Stream.

²Open question, see Table A.1.

Table A.3: Perceived relevance of risk management strategies for business continuity on a scale from 1 (not relevant at all) to 5 (very relevant), n=30.

	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Overall		
						Mean	SD	Rank
Larger raw-materials stocks	13	10	20	37	20	3.4	1.30	5/6
Larger final-goods stocks	17	34	24	17	7	2.6	1.18	14/15
Own fuel supplies	24	24	28	17	7	2.6	1.24	14/15
Company energy generation	10	3	31	38	17	3.5	1.15	2/3/4
Additional financial reserves	10	21	28	17	24	3.2	1.33	9/10
Broad sourcing / open chains	10	14	14	38	24	3.5	1.30	2/3/4
Closed chains	17	31	31	10	10	2.7	1.20	13
Horizontal alliances	10	21	24	31	14	3.2	1.23	9/10
Alliances with suppliers	10	10	13	53	13	3.5	1.17	2/3/4
Local suppliers and customers	10	38	24	17	10	2.8	1.18	11/12
Scaling down	41	24	31	3	-	2.0	0.94	17
Scaling up	17	24	31	14	14	2.8	1.28	11/12
Spatial diversification	7	17	28	38	10	3.3	1.10	7/8
Redundant capacity	14	50	25	11	-	2.3	0.86	16
Process/product modification	10	17	14	45	14	3.3	1.23	7/8
Flexibility of technology	7	17	17	45	14	3.4	1.15	5/6
Other ¹	-	-	-	60	40	4.4	0.55	1

¹Open question, see Table A.1.

