Comparative Analysis of Strategies for National Food Stockpiling: A Case Study of Germany and Switzerland

Katharina Eberhardt*
Institute for Industrial Production (IIP),
Karlsruhe Institute of Technology (KIT)
katharina.eberhardt@kit.edu

Simon Stieler
Institute for Industrial Production (IIP),
Karlsruhe Institute of Technology (KIT)

Florian Klaus Kaiser
Institute for Industrial Production (IIP),
Karlsruhe Institute of Technology (KIT)

Frank Schultmann
Institute for Industrial Production (IIP),
Karlsruhe Institute of Technology (KIT)

ABSTRACT

Effective disaster preparedness, including the strategic stockpiling of resources, is crucial to respond quickly and efficiently to unforeseen crises. Therefore, we contribute to understanding effective disaster preparedness by examining the national food stockpiling practices in Germany and Switzerland, nations renowned for their proactive disaster management and high levels of preparedness. Using comparative content analysis, we thoroughly investigate the strategies, stakeholder involvement, and economic aspects these nations employ to ensure food supply. Insights are gained through in-depth interviews with experts in disaster management, food production, and food supply. The analysis reveals significant differences in the approaches, highlighting benefits and drawbacks for policymakers and practitioners. Our research underscores the importance of different strategies to suit national contexts and provides insights into best practices for enhancing food security and supply in the face of disasters.

Keywords

Preparedness, Expert interview, Disaster management, Decision-support

ACKNOWLEDGMENTS

This work/the project is supported by funds of the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE), grant number 2821HS012.

INTRODUCTION AND MOTIVATION

In today's ever-changing world, crises like the 2021 century flood in Germany, the COVID-19 pandemic, and military conflicts consistently impact global supply chains, particularly in the food sector. Given its intricate nature and essential role, food supply chains face an extensive risk landscape due to several factors. Notably, supply chain disruptions are increasing due to the growing frequency of crises and natural disasters, accompanied by changing climate patterns (WEF, 2023). Furthermore, the expanding global population drives increased demand for food, placing significant pressure on supply chains to ensure efficient and timely delivery (Rejeb et al., 2022). Additionally, risks arise from global food supply networks, technological dependencies, regulatory complexities, and growing interconnectedness (Kumar et al., 2022). The COVID-19 pandemic highlighted these vulnerabilities and significantly impacted and disrupted food supply chains. Bottlenecks in production and transport led to a mismatch between demand and supply. They impacted the availability and access to certain food products as described by Mor et al. (2021) and Weersink et al. (2021). The food supply chain relies on a complex and highly

*corresponding author

interconnected structure across various industries. Disruption or failure in any part of this chain can lead to systemic collapse. Dependencies within the food supply chain extend to critical sectors such as energy, water, transport or communication (Brem, 2015). These interdependencies increase the vulnerability of the food sector, with the extent of their impact varying based on the crisis.

As a result, governments, organizations, and private actors are urged to invest in strengthening food production capacities and establishing contingency plans that decision-makers can swiftly activate in times of crisis. One strategy in this regard is the pre-positioning of emergency reserves. For example, Germany and Switzerland have adopted measures to stockpile strategic food reserves and promote collaboration among stakeholders (BMEL, 2023). It is essential to note that both countries' disaster preparedness extends beyond food supplies, acknowledging that crises impact multiple sectors and require diverse relief materials such as energy and healthcare resources (BMWK, 2024; FONES, 2023). Despite their interconnectedness, sectors are usually managed independently, emphasizing unique stockpiling requirements. Notably, storing food presents distinct challenges, including meeting nutrition needs and changing population demands depending on the type of crisis.

Therefore, our paper examines the crucial significance and approaches of food stockpiling. It investigates emergency preparedness and storage strategies in Germany and Switzerland through four expert interviews, gathering valuable insights from professionals with expertise in the field. Based on the focus group interviews, this work provides insights into the following research questions:

- RQ1: What are the distinctions in stockpiling strategies between Germany and Switzerland, considering factors such as stakeholder involvement and economic aspects?
- RQ2: What insights can be derived from the national strategies to enhance preparedness and optimize the efficient distribution of resources in disaster preparedness?

By answering these research questions, our study provides the following contributions: First, by conducting and analyzing four expert interviews, we aim to identify the strategies, motivations, and decision-making processes involved in implementing food reserves in disaster preparedness. This approach allows us to gain valuable insights from experts with practical experience in different sectors and countries. Second, we thoroughly examine the advantages and challenges of the presented food stockpiling strategies, providing a comprehensive perspective on the efficiency and feasibility. Third, utilizing the insights gained from the expert interviews and the analysis of stockpiling strategies, we aim to provide stakeholders with a comprehensive understanding of different approaches to food emergency preparedness, aiding stakeholders in making well-informed and resilient decisions that can shape policies and actions. Fourth, in the discussion section, we highlight the critical importance of adapting to different crises to ensure the effectiveness of systems in diverse settings. These considerations enable decision-makers to tailor their strategies and responses accordingly. Furthermore, we offer recommendations for future work, focusing on understanding the nuances of different crises and leveraging tools such as information systems to manage the resulting complexities and enhance overall crisis resilience by taking on an integrated view.

This study is structured as follows. Initially, a comprehensive overview of the theoretical background is provided, setting the foundation for the subsequent discussion. Next, the research methodology is outlined, detailing the approach for gathering and analyzing data. Subsequently, the research outcomes are presented along with the critical findings. Finally, the study discusses the results and explores potential opportunities for further research.

THEORETICAL BACKGROUND

Pre-Positioning of Relief Supplies and National Stockpiles

Pre-positioning relief supplies is critical in disaster management to strengthen resilience and response operations. It involves strategically placing relief supplies such as food, water, medical supplies, and other essential commodities before a crisis occurs (Sabbaghtorkan et al., 2020).

Numerous studies, including those by Arnette and Zobel (2019), Condeixa et al. (2017), Ni et al. (2018), Rawls and Turnquist (2010), and Verma and Gaukler (2015) have explored the importance and implementation of strategies for stockpiling critical goods. Ongoing research in food emergency preparedness focuses on assessing the unique advantages of collaborative efforts in food supply during emergencies (Edge & Meyer, 2019). These works include studies aiming to enhance the efficiency of logistical processes and ensure the timely distribution of food resources (Özdamar et al., 2004). Furthermore, regulatory frameworks (Manzoor et al., 2014) and technological collaborations (Shrivastav & Bag, 2023) are investigated.

Several countries maintain national stockpiles, incorporating critical goods and food items in line with these considerations. The objective is to safeguard the food supply during crises, encompassing scenarios like natural disasters, wars, or other supply disruptions. The composition and scale of strategic national food stockpiles vary between countries depending on the country's emergency strategy and factors such as self-sufficiency, population size, geographical location, and vulnerability (Caballero et al., 2015). For example, Germany and Switzerland stockpile food for crises, while other countries, such as France or Italy, forego strategic national food reserves (Gerhold et al., 2019).

While the stockpiling of supplies in humanitarian relief operations is a subject of intense discussion, there remains a notable knowledge gap in comprehending how specific strategies can enhance pre-positioning and logistical activities, especially in the context of food-related crises at the national level.

Stockpiling Policies in Germany and Switzerland

German law mandates state emergency food provisions as part of the broader obligation to safeguard every human life (BVerfG, 1977). The Federal Ministry of Food and Agriculture (BMEL) is the primary entity responsible for emergency food provision in Germany. It is mandated to enact sovereign food management during a crisis (BMEL, 2023). Acting on behalf of the BMEL, the Federal Agency for Agriculture and Food (BLE) maintains about 150 warehouses known as the Civil Emergency Reserve and the Federal Grain Reserve, storing essential items such as rice, lentils, condensed milk, wheat, rye, and oats (BLE, 2023b). These stored provisions are intended to ensure a consistent supply of flour and bread and sustain the overall population's needs in urban areas (BMEL, 2023). Over the years, Germany has significantly transformed its approach to food security. The country incorporated military provisions into the constitutional framework in 1956, laying the groundwork for emergency food supply (Menski, 2016). Motivated by Cold War tensions, Germany instituted the Food Security Act (ESG) in 1965 and, in response to the Chornobyl disaster in 1986, introduced the Food Precaution Act (EVG) in 1990 (BLE, 2023a; Menski, 2016). These acts ensure essential provisions for the civilian population and the armed forces during war and other crises. In 2017, these acts were consolidated into the Food Supply and Preparedness Act (ESVG), providing a unified approach to defense and non-defense crises (BLE, 2023a).

In Switzerland, the national economic supply provides the country with essential goods and services in times of shortages (FONES, 2023). The National Economic Supply System (NES) is based on cooperation between businesses and the state. Representatives from the key economic sectors take on management responsibility and contribute their experience (FONES, 2021). Companies that import, manufacture, process, or introduce essential goods for the first time into the market must maintain reserves (Réservesuisse, 2023). Storage requirements for food and feed, including items like sugar, rice, edible oils and fats, coffee, and grains for human consumption, as well as energy and protein carriers for feed purposes, totaling 711,294 tons (FONES, 2022, 2023). The Federal Office for Economic National Supply (FONES), which is subordinate to the Federal Department of Economic Affairs, Education and Research (EAER), is responsible for supervising the process (FONES, 2021). The supply strategy generally consists of two main phases: the preparatory phase and the intervention phase during severe shortages (FONES, 2018). In the preparatory phase, resilience is strengthened through training and collaboration with stakeholders, businesses, and industry associations to develop measures for improving resilience and interventions. According to the FONES (2018), the intervention phase comprises three stages:

1. Stage A (severe shortage less than one year): Stock releases, import promotions, and export restrictions.
2. Stage B (severe shortage up to one year): Stock releases and supply restrictions to distribute the scarce goods evenly to the population.
3. Stage C (severe shortage lasting over a year): Switch to domestic production to ensure a supply of 2,300 calories per person per day.

As the severity of the shortage situation improves, interventions are gradually withdrawn, aiming to return to normal conditions as soon as possible (FONES, 2022). Switzerland's supply policy historically transformed from state interventionism to market-driven approaches in response to changing global dynamics (FONES, 2011). During the First World War, the Swiss Federal Council slowly recognized the importance of food security and strategically intervened in the market to supply the population in crisis (Réservesuisse, 2023). From 1929, companies were first obligated to store grain as part of the non-monopoly grain supply system, a hybrid of free-market economy and state-controlled areas (Willisegger, 2015). In 1955, the mandatory storage of these reserves was more comprehensively regulated by the Federal Act on Economic Preparedness for Wartime (FONES, 2011). 1982 the legal basis was established, allowing the state to intervene subsidiarily even in severe shortages outside of war

(Willisegger, 2015). This shift was prompted by the realization that supply threats could extend beyond wartime scenarios, as demonstrated by events such as the Suez Crisis and OPEC's actions in 1973 (Rickenbacher, 2021; SWI, 2022). This gradual transition led to the Federal Act on National Economic Supply (NESA), which expanded the scope of economic national defense (SE, 1982). Under this act, the federal government can implement state supply measures during war, power-political threats, and scarcity. On March 30, 2022, the Federal Council strengthened further supply measures in response to new requirements influenced by the energy crisis (SE, 2023). The detailed historical development of both stockpiling policies is depicted in Figure 1.

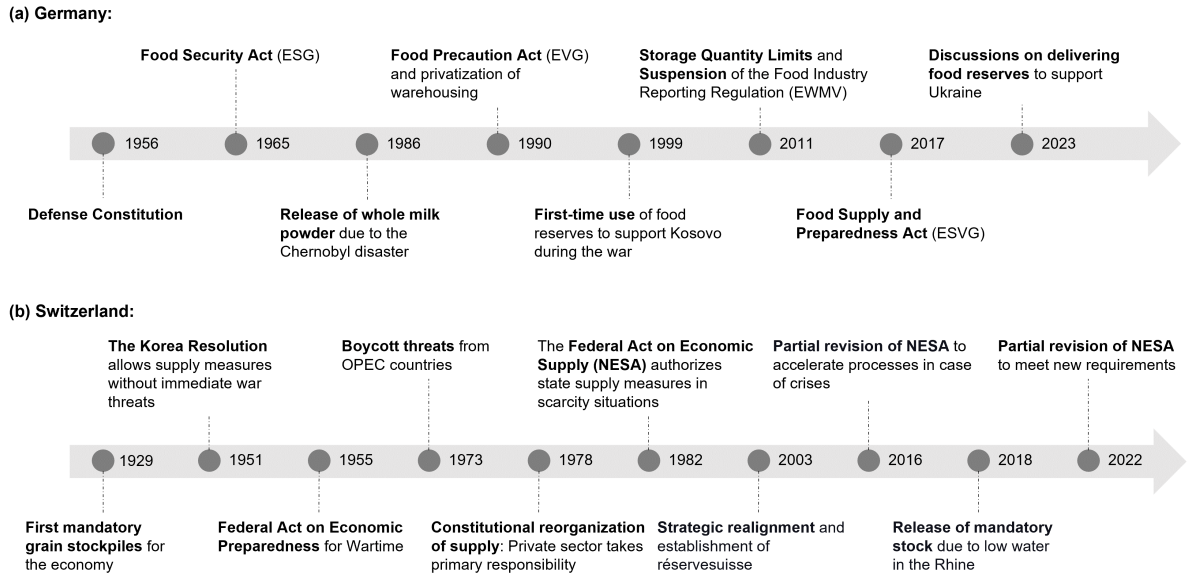

Figure 1. Historical development of stockpiling policies in Germany and Switzerland

METHODOLOGY

Case Description

We selected Germany and Switzerland as case-study countries for food emergency preparedness to further analyze the importance of pre-positioning and the connection between the public and private sectors. The approach offers a comprehensive perspective on various aspects of food security, ranging from economic significance and different governance models to internal and external collaboration.

Germany and Switzerland have established measures for national food stockpiling to prepare for potential crises. However, the approaches differ significantly. While Germany pursues a state-focused approach, Switzerland delegates significant portions of the responsibility to the private sector. Given the notable differences in the approaches of these neighboring nations, it is interesting to highlight their distinct development and strategies and present their advantages and disadvantages, along with the varying viewpoints.

Study Design

A qualitative study was conducted based on in-depth semi-structured interviews with experts in Germany and Switzerland. Expert interviews were chosen as they provide valuable perspectives from professionals specializing in food stockpiling, encompassing food security, logistics, and disaster management. The semi-structured interview method allows interviewees to freely articulate their thoughts on the subject matter, facilitating an open dialogue that can yield important insights beyond the constraints of a predefined question format.

Data Collection

A purposive sampling approach was employed to ensure the inclusion of experts actively engaged in the food supply chain. The sample criteria involved reaching out to individuals from governmental organizations and private companies with institutional and practical knowledge of emergency procedures, strategies, and agencies within the food supply chain. Initial contact was made via email or phone, introducing the research objectives and inviting

them to participate. Participants from Germany and Switzerland were explicitly addressed in the study to ensure comparability between the food emergency systems. However, finding participants proved to be highly challenging due to the sensitive nature of the topic and the limited engagement of the private sector in Germany.

In total, four interviews were conducted during July and August 2023. The selected experts are widely acknowledged for their extensive understanding of the topic within their respective countries, and their expertise is derived from their specific roles and responsibilities, as described in Table 1. The Semi-structured interviews were conducted via MS Teams, using separate interview guides for two stakeholder groups: i) Public authorities (policymakers) and ii) Private companies in the food industry (retailers and producers). The interviews, conducted in German, lasted between 60 to 90 minutes. All interviews were recorded with participant consent and transcribed verbatim for analysis.

Code	Role	Type of Organization		Country	
		Public	Private	DE	CH
DE1	Federal Agency for Agriculture and Food (BLE)	X		X	
DE2	Branch manager of several supermarkets		X	X	
CH1	Federal Office for Economic National Supply (FONES)	X			X
CH2	Head of procurement of a milling company		X		X

Table 1. Overview of expert interviews on food emergency stockpiling

Data Analysis

For thematic data analysis, we employed a qualitative content analysis approach based on Mayring and Gahleitner (2010). The statements obtained from the interviews were systematically structured into categories and coded to identify emerging themes and sub-themes. These provided valuable information about various aspects such as strategies, stakeholders, economic processes, and perceived advantages and disadvantages. To ensure the reliability of findings, different researchers coded the contents independently. After that, the results were compared and discussed until a consensus on the themes and sub-themes was achieved. This collaborative process resulted in a comprehensive coding framework that served as a basis for further interpretation and understanding of the data, as shown in Table 2.

Categories	Subcategories
Stockpiling strategy	Structure
	Development and significance
Stakeholder	Responsibilities
	Collaboration
Economic aspects	Financing
	Costs
System comparison	Strategy
	Stakeholder
	Economic aspects

Table 2. Categorization of interview data

RESULTS: COMPARATIVE ANALYSIS OF FOOD RESERVES IN GERMANY AND SWITZERLAND

Stockpiling Strategy

Germany and Switzerland adopt distinct approaches in implementing their food emergency preparedness systems, although some similarities exist. Both nations prioritize accumulating essential foods like grains due to their convenient storage and prolonged shelf life compared to processed products. Nevertheless, a direct comparison highlights that Switzerland also includes edible oils and coffee in its reserves. The duration for which the state's reserves can sustain the German population during a crisis remains to be determined as no legal supply period is specified. In contrast, stock levels in Switzerland are closely integrated into the regular economic production process and are set at three to four months. Calculations are grounded in import statistics and domestic production over a four-year cycle, automatically adapting to shifts such as immigration or population growth.

According to the expert *DE1*, Germany maintains emergency food reserves and other national reserves to reduce dependence on the food retail sector and fulfill the government's mission to supply the population during crises (DE1,

p. 20, lines 39-45). This state-centric strategy aims to strengthen the national emergency food supply, consistently maintain predetermined quantities of specific food items, and release them in crises. The reserves are allocated across several storage facilities, including the Federal Grain Reserve and the Civil Emergency Reserve, strategically positioned at confidential sites to prevent looting (DE1, p. 4, lines 16-18). The warehouses are contracted to private companies through tenders for storage and related activities, while ownership of the goods and control remains with the government (DE1, p. 20, lines 8-9). In a supply crisis, the federal states can apply for access to goods from the warehouses. The processing, transportation, and distribution of these goods are then the responsibility of the requesting federal state (DE1, p. 15, lines 1-5).

DE1 underscores that initially, the government aimed to avoid entrusting the protective role of food supply to private entities (DE1, p. 20, lines 39-44). This foundational position shifted during the 1990s with a broader reconsideration of the necessity of stockpiling and the government's role. Consequently, by 1995, private entities were operating the warehouses on behalf of the state (DE1, p. 15, lines 39-42). According to *DE1*, this shift is connected to the growing perception that stockpiling is no longer essential, a sentiment that gained momentum during that period (DE1, p. 20, lines 3-15). The overall attitude towards stockpiling has undergone multiple transformations since the conclusion of both World Wars. *DE1* emphasizes that *"there used to be a seriousness"*, backed by the organizational structure (DE1, p. 6, lines 9-10). Formerly, three departments oversaw food stockpiling, whereas today, only one remains (DE1, p. 6, lines 10-15). The peak of the contrasting attitude towards stockpiling occurred in 2016 when the Federal Minister of Agriculture contemplated the complete abolition of emergency food supply (DE1, p. 4, lines 38-44). However, according to *DE1*'s observations, the general attitude has shifted in the opposite direction in recent years. The Ukraine-Russia war has strengthened the current stance where the department overseeing stockpiling is directed to take all necessary measures to enhance supply security (DE1, p. 4, lines 42-44). This change is also emphasized by *DE2*, who deems preparatory measures crucial to mitigate the impact of unforeseen crises (DE2, p. 7, lines 6-14). Despite the significance, *DE1* contends that *"stockpiling has been overlooked in the past"* (DE1, p. 21, line 10), and the awareness of the topic is influenced by global market dynamics and worldwide crises (DE1, p. 21, lines 6-11).

In Switzerland, the State mandates the stockpiling of essential goods, imposing mandatory reserves, the so-called National Economic Supply System (NES). According to *CH1*, specific market players are legally obligated to maintain reserves for three to four months of their typical product processing or importing (CH1, p. 3, lines 42-45). Thereby, the EAER determines the duration for which these mandatory reserves must cover the average demand of the Swiss population (CH1, p. 17, lines 14-16). These mandatory reserves, integrated into companies' production sites, aim for efficient turnover during crises. Approximately 60 companies manage mandatory stocks of essential goods, such as sugar, wheat, rice, oils, fats, yeast, and coffee (CH1, p. 3, lines 45-52 & p. 6, lines 24-25).

According to *CH2*, the organization Rèservesuisse calculates mandatory stock levels for each company on behalf of the FONES based on import volumes and domestic production (CH2, p. 7, lines 39-45). A comprehensive review is conducted every four years, adjusting compulsory stock quantities for all products as needed (CH2, p. 8, lines 3-7). Notably, the stocked quantities remain private and not state-owned. In severe shortages, these stocks can be released to prevent or mitigate disruptions in the supply of essential goods (CH1, p. 14, lines 9-10). *CH2* clarifies that Switzerland's stockpiling strategy is not a response to individual planning failures of specific market participants but rather a macroeconomic assessment to identify and address market-wide crises, determining the need for stock releases (CH2, p. 5, lines 40-49).

In the early stages of the Swiss emergency food system, expert *CH1* notes that the State exclusively managed grain storage from the First World War to the 1970s and 1980s. The Swiss government collected harvested grain at designated points and oversaw its administration (CH1, p. 15, lines 21-23). A shift in the 1980s, driven by economic changes and a decline in self-sufficiency, led to increased imports and a transfer of food supply responsibility to the private sector under state supervision (CH1, p. 15, lines 31-45).

CH1 notes a significant change in Switzerland's perspective on emergency food stockpiling in recent years. Five years ago, many politicians and the population considered the provision system outdated and old-fashioned (CH1, p. 25, lines 49-52). However, the mentality changed with the outbreak of the COVID-19 pandemic in 2020:

> *"It was not necessarily the pandemic itself, but the disruptions that occurred in high-risk supply chains that led to a rethink of the need for reliable emergency food stockpiling."*
> (CH1, p. 16, lines 1-3)

This rethink was further reinforced when the Ukraine-Russia war highlighted the fragility of global supply chains. Today, the focus is no longer on abolishing emergency food preparedness but on analyzing where additional measures and resources are needed (CH1, p. 16, lines 1-13).

Regarding the historical evolution of food emergency preparedness, Germany and Switzerland initially shared common approaches but diverged significantly over time. Both nations maintained complete state control over warehouses and crisis supplies during the World Wars. In the 1980s, Switzerland shifted responsibility to the private sector due to a declining farming population and increased import dependence. Germany underwent a similar change in the 1990s, privatizing warehouses as the perceived necessity of state-controlled food storage diminished.

Today, Germany's strategy still centers mainly on the state's provision of food reserves, aligning with constitutional responsibilities for meeting basic needs. In comparison, Switzerland adopts a collaborative approach between the federal government and businesses. According to the law, companies are primarily responsible for supplying the population and must maintain mandatory stockpiles covering three to four months. The organization Rèservesuisse manages quantity calculations and stock allocations, with private companies owning warehouses and stored goods. In Germany, private companies secure storage spaces through tenders, while the state retains ownership of the stored goods. The quantities stored lack a legal foundation but are based on a 2011 decree that has yet to undergo fundamental adjustments in response to societal changes. Hence, in contrast to Switzerland, quantity requirements are determined by a range rather than a timeframe for supply.

In summary, the two countries exhibit different approaches in their current strategies, diverging from their earlier similarities. Germany emphasizes state control and provision, while Switzerland increasingly relies on collaboration with the private sector. Both nations respond to global events, demonstrating heightened awareness of the importance of food emergency preparedness.

Stakeholder

In Germany, the key public entities regarding emergency food supply are the BMEL and the BLE. According to *DE1*, the BLE is responsible for monitoring food emergency preparedness under the jurisdiction of the BMEL. This responsibility encompasses procuring and managing national crisis reserves (DE1, p. 2, lines 29-33). These reserves are maintained through contracts with private companies responsible for storage services (DE1, p. 20, lines 8-9). However, *DE2* indicates that preparatory measures do not involve private companies from the food retail sector (DE2, p. 7, line 28). During crises, the BLE facilitates the retrieval of stored goods by the federal states. Based on *DE1*, the distribution to grain or hulling mills and the population falls under the jurisdiction of the federal states. *DE1* describes the BLE's role as a facilitator and notes that during wartime, confiscations and government orders are altering the dynamics of private ownership:

> *"In principle, we open the doors and say: 'Now here [...] we have this quantity. You can come by with trucks and pick it up'. [...] At that moment, private ownership ceases to exist. Everyone must be aware of that."*
> (DE1, p. 4, line 53 & p. 9, lines 26-29)

In Switzerland, the relevant public entities are the EAER and the FONES. *CH1* states that the FONES, associated with the EAER, oversees the execution, monitoring, and potential release of mandatory reserves maintained by private companies (CH1, p. 3, lines 22-23). Consequently, according to *CH1*, the FONES assesses whether an inventory release is warranted during a shortage scenario. This assessment includes determining whether the shortage applies to the entire industry or is limited to a specific company that may have miscalculated (CH1, p. 12, lines 15-27). After that, the FONES can release 20% of stocks in the first phase (Stage A) without Federal Council consultation, enabling quick intervention to stabilize the market (CH1, p. 12, lines 28-34). If a severe and prolonged shortage necessitates releasing more than 20% of mandatory stocks, EAER approval through an ordinance is required (CH1, p. 12, lines 16-24). Therefore, as per *CH1*, the FONES collaborates closely with approximately 60 food industry experts within the private-sector cooperative Réservesuisse to influence legislative processes for crisis response. The FONES has delegated the calculation and allocation of storage amounts in the food sector to this cooperative (CH1, p. 18, line 44 – p. 19, line 1). The members include all companies obligated to store mandatory reserves for national economic supply. On behalf of EAER, Réservesuisse issues general import authorizations, monitors mandatory reserve stocks, and acts as an intermediary between the private sector and authorities (CH2, p. 7, line 31-43). The cooperative manages guarantee funds provided by the federal government for financing mandatory reserve storage, compensating members for storage costs, and addressing price fluctuations (CH2, p. 11, lines 41-51). Oversight of guarantee fund use and procurement falls under the responsibility of the FONES (CH1, p. 3, lines 21-23). The concept and interrelationships of the different actors in Germany and Switzerland are shown in detail in Figure 2.

In summary, Germany and Switzerland manage emergency food supply systems through key public entities with lean administrative structures. Despite prior personnel reductions, both nations are recruiting new staff, emphasizing the

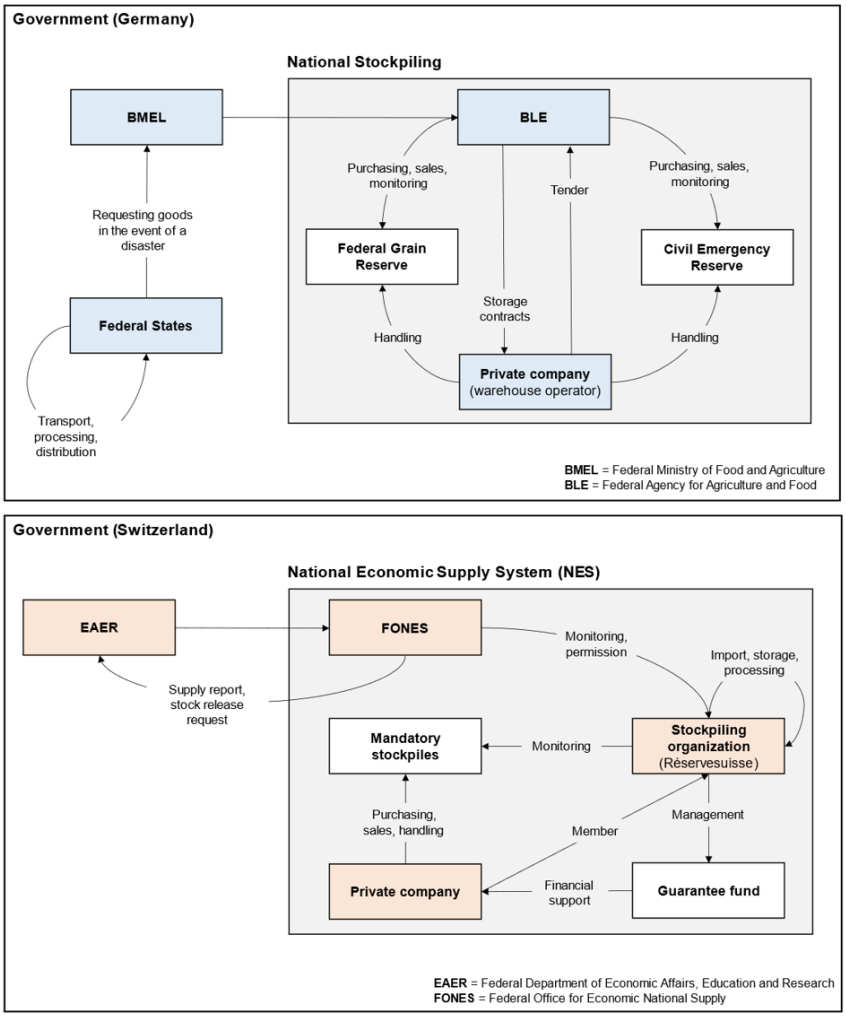

Figure 2. Organizational structure of stockpiling systems in Germany and Switzerland

increasing significance of the topic. In Germany, the BMEL and the BLE play central roles, with private companies responsible for storage services. In case of need, seizing companies' private property is also possible. There is no preventive involvement of logistics companies in this process.

On the other hand, Switzerland's EAER and FONES manage mandatory reserves maintained by private companies, mainly through the cooperative Réservesuisse. Decisions and assessments are coordinated with representatives from the private sector, shaping mandatory storage in alignment with companies' current needs. The objective during a crisis is to maintain operations within the supply chains for as long as possible without government intervention, facilitated by the utilization of mandatory stocks.

While both countries aim to ensure a stable food supply during emergencies, the structures and mechanisms differ, reflecting the variations of governmental and private sector collaboration. Understanding these distinctions is crucial for comprehending the resilience and responsiveness of each nation's emergency food supply system.

Economic Aspects

Based on *DE1*, the federal government covers the costs of Germany's emergency food supply, focusing on crisis preparedness rather than profit generation (DE1, p. 11, lines 4-7). The storage costs, approximately €0.33 per capita, amount to around €27 million for Germany's population of 82 million (DE1, p. 22, lines 28-29). Funding comes from the federal budget, enabling the BLE to cover storage expenses and potential sales losses (DE1, p. 12, lines 24-26). These expenses include storing goods with private companies over an agreed period. The BLE procures and sells the stored goods in a ten-year cycle, with the expenses financed through loans (DE1, p. 10, lines 39-42).

CH1 estimates the Swiss system costs around CHF 20 million, translating to approximately CHF 6 per person per year for the country's nearly nine million inhabitants. The primary cost driver is storage expenses, including

mandatory capacities and administrative efforts, with storage costs being the exclusive expense for companies and the main factor influencing overall system costs (CH1, p. 6, lines 38-39 & p. 8, lines 35-36). As per *CH1*, only some private companies within a sector maintain mandatory stocks due to the considerable administrative burden involved. However, fair competition is ensured, as all companies must pay taxes on goods they import, and those holding compulsory stocks are reimbursed for their associated costs (CH1, p. 16, lines 13-19). *CH2* indicates that this storage method should be *"cost-neutral for mandatory reserve holders"* (CH2, p. 12, line 15). Achieving cost neutrality is crucial for encouraging companies to participate in emergency preparedness. By accessing federally guaranteed bank loans, companies can finance mandatory reserve quantities with reduced interest costs and benefit from higher tax deductions on reserve goods (CH1, p. 8, line 50 – p. 9, line 4). Moreover, *CH2* states that the funding for the system relies on robust border protection safeguarding agricultural prices. When the global market price drops below a specified threshold, customs duties are imposed at the border on imported goods, aligning the import price with the domestic price and increasing the cost of the final product. A portion of import levies, averaging CHF 40 per tonne, contributes to the guarantee fund of Rèservesuisse. This fund reimburses compulsory stockpilers for their incurred costs (CH2, p. 11, line 40- 50 & p. 12, line 6 - 7).

In economic terms, Germany and Switzerland exhibit distinct approaches to funding their emergency food supply systems. In Germany, the federal government assumes financial responsibility, allocating funds from the federal budget to cover the storage costs. A four-year budget plan is created, and the final funding amount is politically determined, influenced by global events affecting potential disposal losses. In addition, the BLE manages procurement and sales in a ten-year cycle, with expenses financed through loans. The emphasis is on crisis preparedness rather than profit generation.

In contrast, Switzerland's system costs are far surpassing Germany's costs. Storage expenses, including mandatory capacities and administrative efforts, constitute the primary cost driver. Financing involves import duties and tax benefits, focusing on cost neutrality and encouraging companies to participate in emergency preparedness. These divergent funding models reflect the unique economic strategies employed by Germany and Switzerland.

System Comparison: Perceived Benefits and Drawbacks

Germany and Switzerland implement fundamentally different approaches to ensure food supply. In Germany, the current strategy prioritizes state-supplied food within the Basic Law's framework of public welfare responsibility without specifying a definite period. In contrast, Switzerland pursues a collaborative approach between the federal government and businesses. According to the law, businesses are primarily responsible for supplying the population and maintaining mandatory stockpiles equivalent to three to four months. The two countries diverge in their current strategies, moving away from their early similarities. Recently, both countries have demonstrated an increased recognition of the significance of emergency food preparedness. Table 3 presents an overview of the comparative analysis of both systems regarding their perceived benefits and drawbacks.

The food emergency system in Germany features a robust infrastructure, ensuring affordable storage quantities to safeguard food security in disaster scenarios supported by transparent legal regulations and a streamlined administrative process. Furthermore, the system clearly defines applicability and decision-making authority while keeping storage locations confidential to mitigate the risk of looting or unfair distribution. The control over the strategy lies with the state, providing centralized oversight. In the view of *DE1*, the food reserves function as insurance for events like the COVID-19 pandemic or an event such as the Ukraine-Russia war, underscoring the rapid emergence of crises with unpredictable magnitudes (DE1, p. 22, line 14-31).

However, Germany's system has challenges. A significant drawback lies in the lack of regular adjustments and the detachment from market dynamics, unlike Switzerland, where quantities are adjusted every four years. *DE1* clarifies that in Germany, there are no regular adjustments in this regard.

> *"The most recent development in 2011 involved receiving a directive from the ministry specifying the quantities to be maintained in the reserves. This directive serves as our basis, and we must implement it annually."*
> (DE1, p. 4, lines 1-13)

Moreover, the reserves are only activated when the market ceases to function. This strategy renders using reserves for market support impractical and may complicate processing and distribution. In addition, the restricted involvement of the private sector and the minimal collaboration with other stakeholders raise questions about the effectiveness of distributing goods in an emergency and the timely availability of adequate human and transport resources. From the perspective of *DE1*, the issue arising from this system is that the BLE can *"only ever draw on the capacities that the*

Country	Category	Benefits	Drawbacks
Germany	Strategy	Food security for crises Low administrative effort Regulation of fair allocation	Lack of regular adjustments Application only in case of market failure Requirement of additional crisis processes Away from the market
	Stakeholder	Control lies with the state Clear responsibilities	Limited private sector collaboration Potential shortage of resources Federalism requires extensive coordination
	Economic	Warehousing at low cost	Strong dependence on state budget Risk of sales losses and quality problems Resource acquisition through confiscations
Switzerland	Strategy	Food security for crises Integration into the supply chain High product variety	High administrative effort Risk of looting and unequal distribution
	Stakeholder	Close collaboration Market participants offer expertise Market situation is known	Moral Hazard
	Economic	Market is protected from collapse Compensation for private sector	Strict controls and sanctions required High costs Entrepreneurial risk and competitive disadvantage

Table 3. Overview of perceived benefits and drawbacks

private sector offers" (DE1, p. 16, lines 41-42). The BLE is solely responsible for facilitating transport to potential production sites, while the actual distribution to the population falls under the jurisdiction of the federal states. In Germany, this decentralized approach presents a significant issue, as federal state jurisdiction hinders direct federal government intervention in state matters. As *DE1* points out, this federalism results in a substantial coordination requirement, which has been historically underestimated and exists only to a partial extent (DE1, p. 21, lines 41-45). Furthermore, *DE2* highlights the significance of a clearly outlined plan for distributing relief items during crises, noting that this information has yet to be communicated to the private sector. The approach entails predetermined contact points, defined responsibilities, and efficient coordination to ensure swift assistance, prioritizing essential food items and hygiene products (DE2, p. 8, lines 20-43). Aside from coordination issues, there is also the matter of whether the state possesses the necessary resources compared to private companies for efficiently managing goods and maintaining quality. While Germany benefits from low-cost warehousing, it faces challenges due to a strong dependence on the state budget and potential sales losses.

On the other hand, Switzerland adopted a decentralized approach to its food emergency system by integrating the stockpiles into the regular supply chain and offering a high product variety. It collaborates with federal and private stakeholders, allowing tailored responses to regional and unique nutrition needs like gluten intolerance. Furthermore, the close collaboration and coordination among stakeholders provide benefits, including transparency, market knowledge, logistical resources, and consideration of the interests of all stakeholders.

CH1 claims that a significant advantage lies in the strategic placement of stocks directly within the producing companies along the value chain rather than in remote locations:

> *"The warehouses are seamlessly integrated into regular production processes, not tucked away in a corner. This integration eliminates issues related to handling, such as spoilage. [...] The benefit of this approach is that all mandatory stockpiles are seamlessly integrated into the established channels. In the event of a shortage, for instance, if a particular type of bread is unavailable, the producer with compulsory stock can source from there and continue production. This process ensures that everything flows through the regular channels without needing modifications, which is a significant advantage."* (CH1, p. 4, lines 36-43 & p. 13, lines 45-51)

Consequently, questions regarding delivery destinations, responsible entities, and processing of goods become irrelevant, as the stocks are conveniently located within the companies engaged in activities like grain milling. *CH2* reinforces this claim by stating that market participants, in his perspective, clearly understand the demand for a product, including where, when, and in what quantity it is required. Moreover, they ensure delivery by established quality standards (CH2, p. 13, lines 21-25). In his view, the federal government faces the potential challenge of

accurately assessing market dynamics. It is possible to be right next to the market and not recognize it, which *CH2* identifies as the most significant risk associated with insufficient collaboration with the private sector (CH2, p. 13, lines 26-33). Furthermore, timely intervention can prevent a complete collapse and, according to *CH1*, also deter panic buying (CH1, p. 12, lines 16-20).

Nonetheless, Switzerland faces some drawbacks. The cost and administrative effort of maintaining strategic food stockpiles can be substantial, and the private nature of its system may lead to challenges like the risk of looting and unequal distribution. Moreover, while product diversity brings advantages, it also results in elevated administrative efforts and, consequently, higher expenses. As stated by *CH1*, the past was characterized by simplicity, with only a few grain variations available. However, numerous other varieties exist today, necessitating multiple silos to store each variety separately (CH1, p. 7, lines 34-52). Additionally, there is a moral hazard for companies to refrain from maintaining extra safety stocks, relying on the government to release reserves in times of scarcity. In this regard, *CH1* states that:

> *"Certain companies may have optimization considerations, questioning the need to maintain an additional month of free stock for their company. Some may argue that one week is sufficient, relying on compulsory stocks in case of emergencies. Evaluating the pain threshold in each case becomes a somewhat challenging task."*
> (CH1, p. 9, lines 46-51)

Thus, strict controls are crucial to prevent unauthorized stock releases during shortages. In 2018, as per *CH2*, his company faced a situation where low water levels on the Rhine prevented them from sourcing additional goods. Meanwhile, another company possessed sizable inventory reserves, leading the federal office to categorize it as non-crisis and refrain from releasing emergency stockpiles:

> *"We faced challenges in the past, especially when the Rhine nearly dried up, causing a prolonged halt in transportation for weeks or even months. The logistics chain was severely disrupted, and we still did not get the go-ahead because other players had larger stocks. Authorities must also establish clear criteria to determine when an economic crisis has occurred."*
> (CH2, p. 8 & 9, lines 50-52, 1-27)

According to *CH2*, the regulation lacks clarity in such cases. The Swiss system, while safeguarding the market against collapse and providing compensation to the private sector, introduces a competitive disadvantage for domestic processing. This issue arises because warehousing costs are passed on to consumers through product pricing, whereas imported goods are subjected to import levies (CH2, p. 8, lines 35-50).

DISCUSSION AND CONCLUSION

In conclusion, examining food emergency preparedness in Germany and Switzerland has highlighted significant distinctions in incorporating public and private actors, particularly concerning their stockpiling strategy, structural frameworks, stakeholder engagement, and economic approach. Germany emphasizes centralized control by the state and cost efficiency, while Switzerland focuses on collaboration and integration into the supply chain. The simplicity of Germany's approach contrasts with Switzerland's more complex and interconnected strategy involving various stakeholders. The strengths and weaknesses underscore the ongoing challenge of balancing efficiency, coordination, and adaptability in disaster management and preparedness.

Germany's system demonstrates a robust infrastructure with low administrative effort and costs. However, it raises the concern of whether ample resources and production capacity would be accessible for efficient processing and distribution during a crisis. On the contrary, Switzerland follows a decentralized approach that promotes adaptability but carries the risk of economic challenges and ambiguity regarding responsibilities. The ability to ensure equitable distribution of goods during a crisis remains to be determined.

In this comparative study, our exploration of Germany and Switzerland's diverse approaches to stockpiling critical goods and engaging with public and private stakeholders reveals valuable lessons for enhancing emergency food preparedness and addressing crisis-related challenges. While the private sector plays a crucial role in Switzerland, the interview with *DE2* sheds light on the opportunities for increased communication and awareness within the private sector in Germany. There is a clear interest in greater private sector involvement with well-defined guidelines and recognizing the benefits of integrating stored goods into the supply chain. However, *DE1* maintains that increased private sector involvement is not essential, emphasizing the state's primary role.

In Switzerland, both stakeholders are satisfied with their system but express minor requests for adjustments. These adjustments include more precise regulations during crises, fair compensation for warehouse keepers in light of rising costs, and a general preference for reduced administrative effort. Furthermore, during the interviews, when asking the experts about their "ideal vision" for food emergency preparedness, a unanimous emphasis was placed on the importance of stockpiling and maintaining national reserves. The statements highlighted the significance of close collaboration and underscored the necessity for increased investments in the underlying system and preparedness efforts. Notably, authorities in Germany and Switzerland advocate for expanding stored quantities and preparedness investments, with Switzerland proposing an extension of the potential supply period from four to six months. Furthermore, expert *CH1* suggested a hybrid approach that combines elements of both strategies, involving the private sector to use existing infrastructures and knowledge while having the government handle financing to address potential economic inequalities.

Nevertheless, it is essential to recognize the study's limitations. Most data is available in German, which could restrict the depth of our exploration. The study's scope, encompassing four interviews, might only partially capture the diverse spectrum of perspectives in both countries. Furthermore, Switzerland, less populated and smaller than Germany, operates with a unique system. Therefore, the transferability of structural elements, particularly legal aspects, might pose a challenge and necessitate further consideration in future analyses.

In addition, given the complex interconnections of critical sectors supporting food storage and supply, it is essential to consider specific crisis scenarios with greater depth, enabling the thorough identification of challenges and actionable strategies to enhance crisis management. For instance, a blackout scenario significantly affects various processes within the food supply chain, ranging from production to distribution and consumption. In Germany, logistical challenges may arise in extracting and distributing goods from storage facilities. Moreover, disruptions could occur in processing the goods at mills, bakeries, and communal facilities. Similarly, in Switzerland, it is necessary to assess how local supply chains and companies would navigate such a scenario and whether critical crisis resources like power generators are available to uphold production. Conversely, in the context of a pandemic, it is crucial to prioritize the mitigation of personnel shortages due to illness and implement suitable operational measures. Furthermore, diseases that affect digestion may influence the suitability of stored food. In other crisis scenarios like large-scale floods or earthquakes, decision-makers should focus on infrastructure functionality instead, considering potential blockages or destruction of roads and warehouses.

These diverse contexts underscore the imperative need for further detailed examination of the impact of different crisis scenarios on the systems and their performance. Moreover, investigating the integration of technology solutions or information systems for resource monitoring, enhancing communication, and fostering collaboration among various stakeholders present valuable approaches to mitigate risks and strengthen the resilience of food supply chains. Therefore, our study serves as a basis for future research and emphasizes the value of examining diverse strategic approaches and technologies in national food emergency preparedness.

REFERENCES

Arnette, A. N., & Zobel, C. W. (2019). A risk-based approach to improving disaster relief asset pre-positioning. *Production and Operations Management*, *28*(2), 457–478. https://doi.org/10.1111/poms.12934

BLE. (2023a). Kritische Infrastrukturen Landwirtschaft. https://www.ble.de/DE/Themen/Landwirtschaft/Kritische-Infrastruktur/Hintergruende/hintergruende_node.html

BLE. (2023b). Staatliche Vorsorge: Lagerhaltung. Retrieved November 30, 2023, from https://www.ernaehrungsvorsorge.de/staatliche-vorsorge/lagerhaltung

BMEL. (2023). Staatliche Vorsorge. Retrieved November 30, 2023, from https://www.ernaehrungsvorsorge.de/staatliche-vorsorge

BMWK. (2024). Ölkrisenvorsorge und -management (Bundesministerium für Wirtschaft und Klimaschutz, Ed.). Retrieved February 21, 2024, from https://www.bmwk.de/Redaktion/DE/Artikel/Energie/mineraloel-oelbevorratung-transport-oelreserven.html

Brem, S. (2015). Critical infrastructure protection from a national perspective. *European Journal of Risk Regulation*, *6*(2), 191–199. https://doi.org/10.1017/S1867299X00004499

BVerfG. (1977). Urteil des ersten senats vom 16. oktober 1977: 1 bvq 5/77 -, rn. 1-18, (BVerfG, Ed.). Retrieved December 5, 2023, from https://www.bundesverfassungsgericht.de/SharedDocs/Entscheidungen/DE/1977/10/qs19771016_1bvq000577.html

Caballero, A. M., Teng, P. P. S., & Shrestha, M. (2015). Public stockpiling and food security (S. Rajaratnam School of International Studies, Ed.). Retrieved December 5, 2023, from https://www.files.ethz.ch/isn/191682/PB150603_Public-Stockpiling.pdf

Condeixa, L. D., Leiras, A., Oliveira, F., & de Brito, I. (2017). Disaster relief supply pre-positioning optimization: A risk analysis via shortage mitigation. *International Journal of Disaster Risk Reduction*, *25*, 238–247. https://doi.org/10.1016/j.ijdrr.2017.09.007

Edge, S., & Meyer, S. B. (2019). Pursuing dignified food security through novel collaborative governance initiatives: Perceived benefits, tensions and lessons learned. *Social science & medicine (1982)*, *232*, 77–85. https://doi.org/10.1016/j.socscimed.2019.04.038

FONES. (2011). Geschichte der wirtschaftlichen landesversorgung: Seit gründung des bundesstaates. Retrieved July 26, 2023, from https://www.bwl.admin.ch/bwl/de/home/wirtschaftliche_landesversorgung/prasentation_wl/geschichte.html

FONES. (2018). Strategische Ausrichtung Strategische Ausrichtung der wirtschaftlichen Landesversorgung. Retrieved December 5, 2023, from https://www.bwl.admin.ch/dam/bwl/de/dokumente/dokumentation/publikationen/strategie_2018.pdf.download.pdf/Strategie_WL_D_2018.pdf

FONES. (2021). Bericht zur wirtschaftlichen Landesversorgung 2017-2020. Retrieved July 26, 2023, from https://www.newsd.admin.ch/newsd/message/attachments/66655.pdf

FONES. (2022). Pflichtlager. Retrieved July 26, 2023, from https://www.bwl.admin.ch/bwl/de/home/bereiche/pflichtlager.html

FONES. (2023). Bericht zur Vorratshaltung 2023. Retrieved November 30, 2023, from https://www.bwl.admin.ch/bwl/de/home/bereiche/pflichtlager.html

Gerhold, L., Cortez Garcia, K., & Guerrero Lara, A. (2019). *Lebensmittelversorgung in Krisen und Katastrophen: Versorgung der Bevölkerung mit Lebensmitteln in OECD-Ländern im Falle von Großschadensereignissen* (Vol. Band 22). Bundesamt für Bevölkerungsschutz und Katastrophenhilfe.

Kumar, M., Raut, R. D., Sharma, M., Choubey, V. K., & Paul, S. K. (2022). Enablers for resilience and pandemic preparedness in food supply chain. *Operations Management Research*, *15*(3), 1198–1223. https://doi.org/10.1007/s12063-022-00272-w

Manzoor, U., Zubair, M., Batool, K., & Zafar, B. (2014). A multi-agent framework for efficient food distribution in disaster areas. *International Journal of Internet Technology and Secured Transactions*, *5*(4), 327. https://doi.org/10.1504/IJITST.2014.068711

Mayring, P., & Gahleitner, S. (2010). Qualitative inhaltsanalyse. https://doi.org/10.2307/j.ctvhktjdr.31

Menski, U. (Ed.). (2016). *Neue Strategien der Ernährungsnotfallvorsorge: Ergebnisse aus dem Forschungsverbund NeuENV* (Vol. Nr. 18). Freie Universität Berlin, Forschungsforum Öffentliche Sicherheit.

Mor, R., Sid, S., Panghal, A., Kumar, D., & Kumar, V. (2021). Agri-food supply chain and disruptions due to covid-19: Effects and strategies. *Brazilian Journal of Operations & Production Management*, *18*, 1–14. https://doi.org/10.14488/BJOPM.2021.031

Ni, W., Shu, J., & Song, M. (2018). Location and emergency inventory pre-positioning for disaster response operations: Min-max robust model and a case study of yushu earthquake. *Production and Operations Management*, *27*(1), 160–183. https://doi.org/10.1111/poms.12789

Özdamar, L., Ekinci, E., & Küçükyazici, B. (2004). Emergency logistics planning in natural disasters. *Annals of Operations Research*, *129*(1-4), 217–245. https://doi.org/10.1023/B:ANOR.0000030690.27939.39

Rawls, C. G., & Turnquist, M. A. (2010). Pre-positioning of emergency supplies for disaster response. *Transportation Research Part B: Methodological*, *44*(4), 521–534. https://doi.org/10.1016/j.trb.2009.08.003

Rejeb, A., Keogh, J. G., & Rejeb, K. (2022). Big data in the food supply chain: A literature review. *Journal of Data, Information and Management*, *4*(1), 33–47. https://doi.org/10.1007/s42488-021-00064-0

Réservesuisse. (2023). Réservesuisse genossenschaft (Réservesuisse, Ed.). Retrieved November 30, 2023, from https://www.reservesuisse.ch/reservesuisse-genossenschaft/

Rickenbacher, D. (2021). Die Schweiz in der Suez-Krise (Schweizerisches Nationalmuseum, Ed.). Retrieved July 26, 2023, from https://blog.nationalmuseum.ch/2021/11/die-schweiz-in-der-suez-krise/

Sabbaghtorkan, M., Batta, R., & He, Q. (2020). Prepositioning of assets and supplies in disaster operations management: Review and research gap identification. *European Journal of Operational Research*, *284*(1), 1–19. https://doi.org/10.1016/j.ejor.2019.06.029

SE. (1982). Bundesgesetz vom 8. Oktober 1982 über die wirtschaftliche Landesversorgung (Landesversorgungsgesetz, LVG. Retrieved July 26, 2023, from https://www.fedlex.admin.ch/eli/cc/1983/931_931_931/de

SE. (2023). Landesversorgungsgesetz-Teilrevision wird Erfahrungen aus der Energiekrise einbeziehen. Retrieved July 26, 2023, from https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-92500.html#:~:text=Der%20Bundesrat%20beschloss%20am%2030,neuen%20und%20gestiegenen%20Anforderungen%20anzupassen.

Shrivastav, S. K., & Bag, S. (2023). Humanitarian supply chain management in the digital age: A hybrid review using published literature and social media data. *Benchmarking: An International Journal*. https://doi.org/10.1108/BIJ-04-2023-0273

SWI. (2022). Wie ging die Schweiz mit der Ölkrise 1973 um? Retrieved July 26, 2023, from https://www.swissinfo.ch/ger/kultur/energiekrise_wie-ging-die-schweiz-mit-der-oelkrise-1973-um--/47920866

Verma, A., & Gaukler, G. M. (2015). Pre-positioning disaster response facilities at safe locations: An evaluation of deterministic and stochastic modeling approaches. *Computers & Operations Research*, *62*, 197–209. https://doi.org/10.1016/j.cor.2014.10.006

Weersink, A., von Massow, M., Bannon, N., Ifft, J., Maples, J., McEwan, K., McKendree, M. G., Nicholson, C., Novakovic, A., Rangarajan, A., Richards, T., Rickard, B., Rude, J., Schipanski, M., Schnitkey, G., Schulz, L., Schuurman, D., Schwartzkopf-Genswein, K., Stephenson, M., ... Wood, K. (2021). Covid-19 and the agri-food system in the united states and canada. *Agricultural Systems*, *188*, 103039. https://doi.org/10.1016/j.agsy.2020.103039

WEF. (2023). The global risks report 2023. Retrieved June 1, 2023, from https://www.weforum.org/reports/global-risks-report-2023/

Willisegger, J. (2015). Liberalismus oder Staatsintervention. Die Geschichte der Versorgungspolitik im Schweizer BundesstaatCottier, MauriceZürich, Verlag Neue Zürcher Zeitung (2014), 216 S., ISBN 978–3–03823–900–0. *Swiss Political Science Review*, *21*(3), 470–474. https://doi.org/10.1111/spsr.12173