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Towards strategies to adapt to pressures on safety of fresh produce due to climate change

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ABSTRACT

This article outlines the findings from a Delphi study aimed to generate insights from a systems perspective about responding to climate change in terms of food safety of fresh produce. The study identified pressures to food safety of fresh produce at primary production, related to contamination of water sources and production environment with microorganisms, pesticide residues, mycotoxins and heavy metals due to heavy rainfalls and floods, droughts, increased temperature and change in seasonality, as results of climate change. First response to these pressures is realised by the core control activities implemented at farm, and depends on their current implementation and actual operation. The experts highlighted the need to strengthen activities, such as water control (including water treatment and quality monitoring), irrigation method, pesticide management (and pre-harvest intervals), personal hygiene requirements and (cold) storage control. Validating the effectiveness of control activities for the changed circumstances, guidance and training to the farmers was emphasized. Moreover, response strategies were proposed for farms to cope with the pressures immediately after occurring and to adapt long-term with support at the community level.

The participating experts represented countries from the global north with industrialised food systems, and from the global south — with structured and traditional food systems. They assessed the likelihood of most pressures as higher for the countries from the global south, which was explained by existing response strategies in the global north. It was proposed that the adaptive and coping capacities of companies, regions and sectors are determined by the currently available adaptation and coping strategies. The pressures to food safety can differ per company, supply chain, region and sector due to variability of current climate vulnerabilities, control activities, and adaptive capacity. This paper argues that future adaptation actions should take into account the context of countries, sectors and companies, thus, focus on improving adaptive capacity from a systems perspective.

1. Introduction

Fruits and vegetables are produced around the globe, in various climate conditions, following different production practices and food safety legislation. Trade with these commodities grew markedly in the last years (EC, 2007). However, an increase was observed in the number of reported microbiological hazards (Lynch, Tauxe, & Hedberg, 2009; Sivapalasingam, Friedman, Cohen, & Tauxe, 2004), pesticide residues (e.g. Hjorth et al., 2011; Winter, 2012) and mycotoxins (e.g. Fernández-Cruz, Mansilla, & Tadeo, 2010; RASFF, 2012), which may indicate inadequacies in the control activities currently implemented in companies. Some of these food safety incidences have been associated with climate events and extremes. For instance, increased occurrence of certain enteric diseases has been linked to seasonality and heat waves (D'Souza, Becker, Hall, & Moodie, 2004; Kovats et al., 2004; Kovats, Edwards, Charron, et al., 2005). Rapid increases in environmental contamination have been documented after heavy rainfalls, storms and floods (Manuel, 2006; Presley et al., 2005; Shehane, Harwood, Whitlock, & Rose, 2005; Stachel et al., 2006; Umlauf et al., 2005). Moreover, application of pesticides and risk of residues are presumed to increase due to climate change and extreme events (Boxall et al., 2009; Koleva, Schneider, & Tol, 2009). Mould growth and mycotoxin formation are also linked to warmer temperatures and more humid conditions (Van de Perre et al., 2013). The risk to food safety and vulnerabilities in the current control activities at primary production are indeed expected to be further exacerbated by climate change (Liu, Hofstra, & Franz, 2013; Miraglia et al., 2009; Tirado, Clarke, Jaykus, McQuatters-Gollop, & Frank, 2010). According to the latest climate change scenarios, the frequencies of climate extremes are predicted to become more common in the future (IPCC, 2007, 2012). Climate adaptation studies discuss the response strategies needed to cope with climate pressures on agriculture, and stress the lack of adaptive capacity due to already existing vulnerabilities in the context of a country and region,

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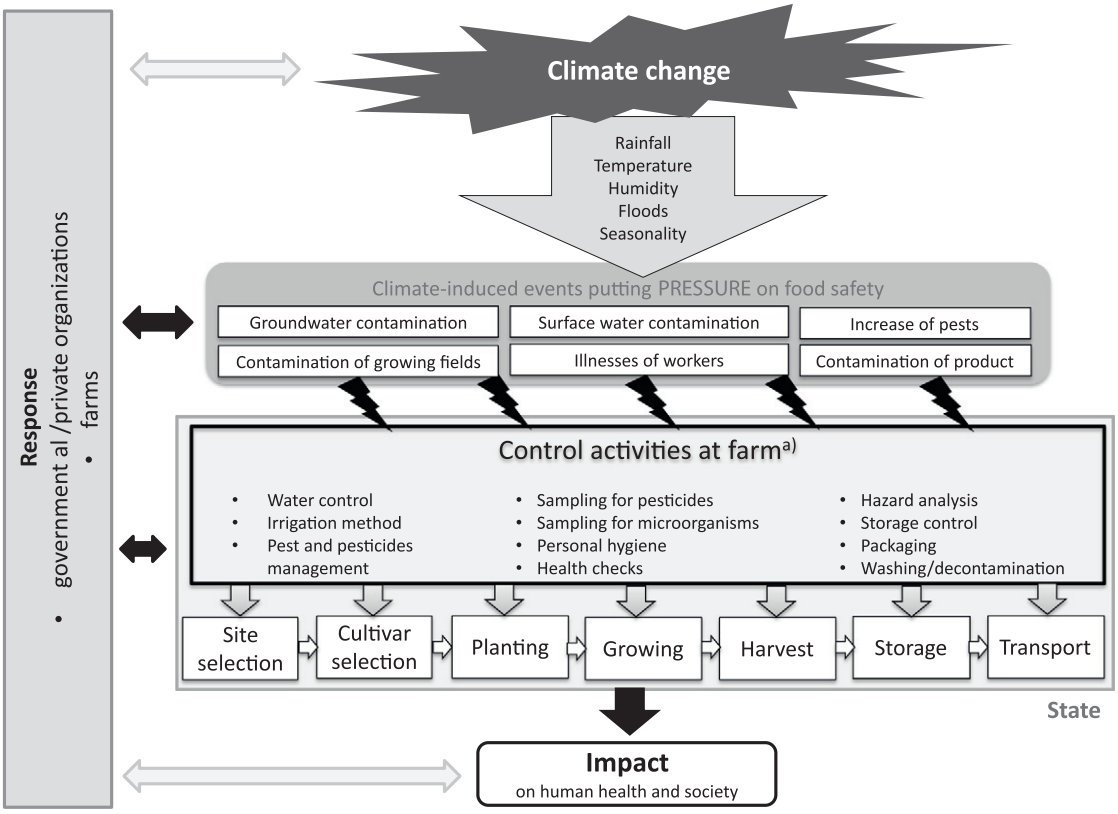

Fig. 1. DPSIR analytical framework used to analyse climate change pressures on for food safety management in fresh produce. a) The major practices shown in the figure are based on previous work (Kirezieva et al., 2013).

particularly in the global south compared to the global north (e.g. Brooks, Neil Adger, & Mick Kelly, 2005). The potential effects of climate change on food safety have been extensively reviewed (Boxall et al., 2009; FAO, 2008; Liu et al., 2013; Miraglia, De Santis, & Brera, 2008; Miraglia et al., 2009; Paterson & Lima, 2010; Semenza et al., 2011). However, only general and scattered evidence exists about how primary producers may respond to the changes in climate in terms of food safety (e.g. Marvin et al., 2013; Tirado et al., 2010). In many cases, response strategies are undermined into few arbitrary measures, the context of their application is not considered, and a systematic approach is lacking.

Therefore, the overall objective of the study was to generate insights from a systems perspective about which climate-induced events can put pressure on safety of fresh produce, and what response strategies can be applied at primary production. The following research questions have been defined: Q1) What changes in climate can be expected to put pressure to food safety of fresh produce in the near future? Q2) Which are the most important and feasible strategies that can be applied to respond to the pressures? Q3) What response strategies can be applied at company and community level? Q4) Which response strategies determine the adaptive capacity of companies and regions, and do they differ globally?

2. Research methodology

2.1. Driving force–pressure–state–impact–response (DPSIR) analytical framework

The DPSIR framework was employed for conceptualisation and definition of the relationships between increasing pressures due to climate change on food safety of fresh produce, and responses needed to adapt. The DPSIR framework, along with its earlier incarnations (i.e. PSR, and DSR), is widely accepted and a commonly used framework for interdisciplinary system and model conceptualization, indicator development and integrated assessments (e.g. Block, Gerven, & Vandecasteele, 2007; OECD, 2003; Walmsley, 2002). The DPSIR framework systemises the relationships between humans and the environment in: *driving forces* that exert *pressures* on the environment, resulting in a certain *state* of the environment, that has an *impact* on humans and society, which may stimulate *responses* on any of the previous four elements (EEA, 1999; OECD, 2003). In the case of food safety and climate change, the framework was modified to address the needs of this study. Climate change is recognised as a *driving force* leading to climate-induced events, which exert *pressure* on the current *state* of food safety management in farms, which ultimately may *impact* human health and society (Fig. 1). Moreover, the framework includes the *response* from society (farms/companies, government or private organisations) through different measures, policies and strategies. A valuable point in this analytical framework is that it recognises the dynamic nature of the processes under investigation. This is especially important in the case of climate change, because it is a process that will gradually change the risks and required responses.

In this study, focus is made on the analysis of the *driving force* of climate change, through its vectors (e.g. temperature, rainfall), which

Table 1
Characteristics of 'coping' and 'adaptation'.
Source: Modified from CARE (2009).

Coping	Adaptations
Short-term and immediate	Practices and results are sustained
Oriented towards instant results	Oriented towards longer-term food safety
Not continuous	A continuous process
Motivated by crisis; reactive	Involves planning
Often leads to destruction of produce	Uses resources efficiently and sustainably
Prompted by a lack of alternatives	Focused on finding alternatives
	Combines old and new strategies and knowledge