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REVIEW

Agricultural pesticide use and food safety: California's model

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Abstract

Pesticides have been an essential part of agriculture to protect crops and livestock from pest infestations and yield reduction for many decades. Despite their usefulness, pesticides could pose potential risks to food safety and the environment as well as human health. This paper reviews the positive benefits of agricultural pesticide use as well as some potential negative impacts on the environment and food safety. In addition, using the case of California, we discuss the need for both residue monitoring and effective pest management to promote food safety. Twenty years' pesticide residue data from California's pesticide residue monitoring program were analyzed. Results showed that more than 95% of food samples were in compliance with US pesticide residue standards (tolerances). However, certain commodities from certain sources had high percentages of residues above tolerance levels. Even when residues above tolerance levels were detected, most were at levels well below 1 mg kg^{-1}, and most posed negligible acute health risk. However, a few detected residues had the potential to cause health effects. Therefore, establishing an effective food residue monitoring program is important to ensure food quality throughout the marketplace.

Keywords: food safety, food security, pesticide use, residue monitoring, environmental impacts, IPM, tolerances, maximum residue limits (MRLs)

1. Introduction

The benefits of pesticide use in agriculture are evident in every agricultural system worldwide (e.g., Popp *et al.* 2013). This is especially true in large-scale commercial agriculture such as the US state of California. At the same time, the negative impacts of pesticides on human health and the environment are well documented. Pesticide residues in food are an important pathway for human exposure. This paper reviews both the benefits and risks of pesticide use with regards to food security and food safety. We present California's program for monitoring pesticide residues in food as a case study for discussing the importance, current practices and future challenges for residue monitoring. Lastly, we discuss how good agricultural practices including integrated pest management can help protect food safety by reducing pesticide use.

Agricultural pesticide use has increased agricultural production worldwide and thereby contributed to food security (Warren 1998; Fisher *et al.* 2012). Pests such as insects, plant diseases, and weeds are an ongoing chal-

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lenge to agricultural producers. Oerke (2006) reported that globally, an average of 35% of potential crop yield is lost to pre-harvest pests. With the expected 30% increase of world population to 9.2 billion by 2050, there is a projected demand to increase food production by 70% according to the calculation by Popp *et al.* (2013). Though non-pesticidal tools have a vital role, there will be a continuing need for pesticide-based solutions to pest control and food security in the future (Webster *et al.* 1999; Fisher *et al.* 2012; Popp *et al.* 2013). Fig. 1 shows average pesticide use intensity (kg ha^{-1} yr^{-1}) on the arable and permanent cropland worldwide. High use intensity countries above 10 kg ha^{-1} yr^{-1} include Surinam, Columbia, Chile, Palestinian, Malta, Korea, Japan, and China (FAO 2015a). Fig. 2 shows that pesticide sales are increasing in Asia, Latin America, and Europe. Africa and the Middle East have far lower sales than any other region (FAO 2015b).

Attention to the impacts of pesticide use on the environment and ecosystems has grown since the book *Silent Spring* was published in 1962. Extensive published literature has well documented the impacts of pesticide use to the ecosystem and human health (Popp *et al.* 2013). Pesticides

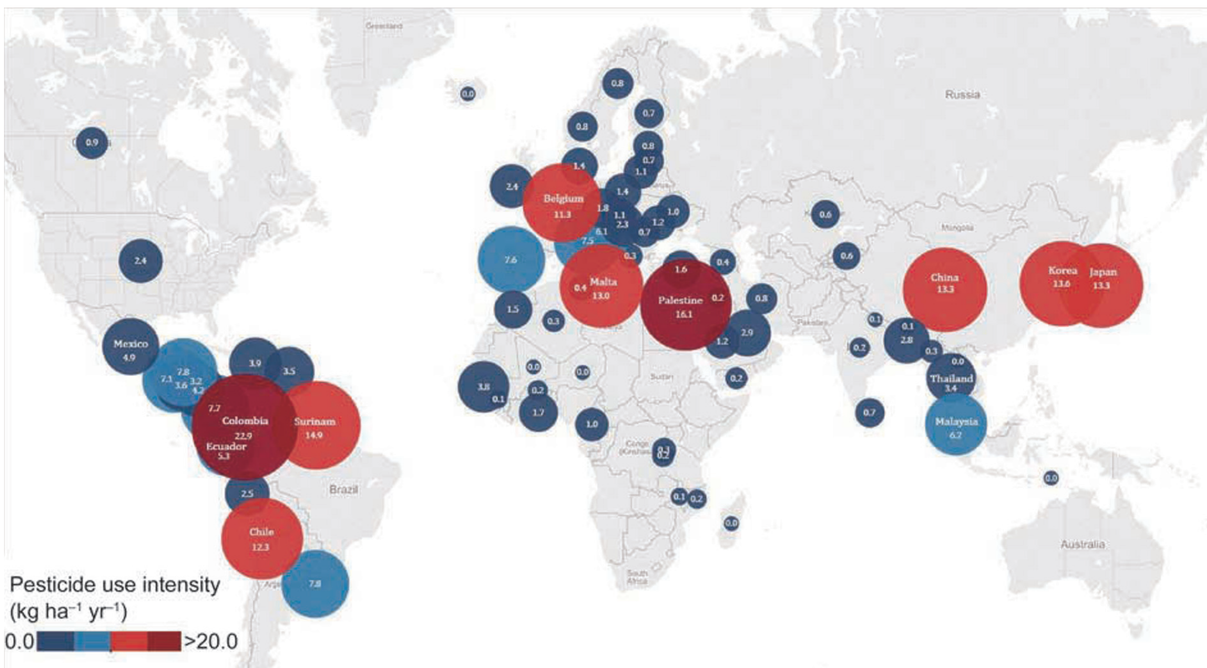

Fig. 1 Average annual pesticide use intensity (kg ha^{-1} yr^{-1}), on arable and permanent cropland from 2005 to 2009. Data are from FAO (2015a).

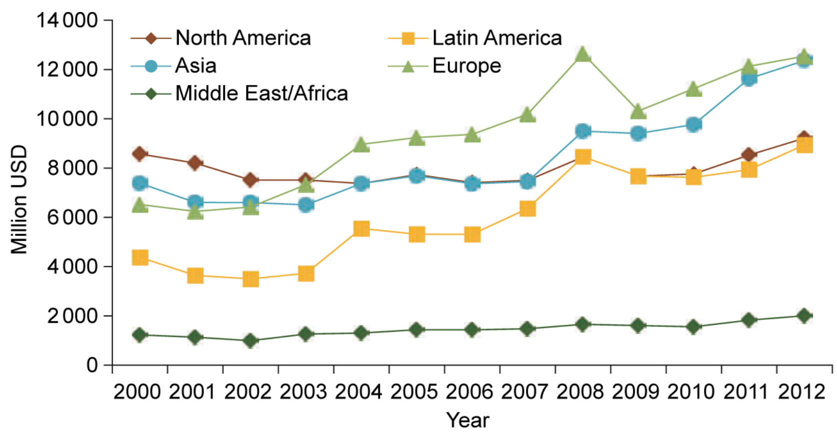

Fig. 2 Annual pesticide sales by geographic regions. Data are from FAO (2015b).