Scientia Horticulturae 125 (2010) 1–15

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Review

Structural change in the international horticultural industry: Some implications for plant health

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ARTICLE INFO

Article history:
Received 28 August 2009
Received in revised form 19 February 2010
Accepted 25 February 2010

Keywords:
Agriculture
Cut flowers
Globalization
Greenhouses
Invasion biology
Network theory
Ornamentals
Phytosanitary regulation

ABSTRACT

The horticultural sector has seen much structural change both nationally and internationally over the last decades, but the implications for plant health have been neglected. We review in the context of the risk of emerging plant diseases recent developments including the movement towards a global horticultural market, the rise of the horticultural industry of many developing countries, and the economic integration of the European Union. North America is typically well ahead of other regions in economic developments, and in horticulture this is shown for example by the growing importance of Mexican growers. Asia is rapidly catching up also in horticulture, with China and India becoming key producers. Australia and New Zealand show the impact of change in horticulture extension services. The Eastern enlargement of the EU is having profound influences on fruit and vegetable growers both in the new and in the old member countries. Similar developments are taking place in South America and Africa. In all continents, there is a general trend towards fewer and larger horticultural growers, an increasing role of supermarkets and a concentration of the retail pathways. These developments have consequences for the control of plant pathogens and invasive species. Technical issues seem to be of lesser consequence in terms of structural change compared with labour and trade aspects. However, examples can be found where technical innovations have opened up new opportunities or provided solutions to pressing problems, as can be seen in the hardy nursery stock and ornamental industry in the UK. Future technical, economic and social impacts on the sector are likely to play a key role for securing a diverse and reliable food supply for the still expanding world's population. Recent advances in modelling disease spread in complex networks representing trade pathways should be used to target control of introductions of new plant pathogens. There is a need for more long-term research on how structural change in the horticultural sector will affect and be affected by climate change.

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1. A global horticultural expansion

The increase of the global human population of the last decades has been accompanied by a rapid rise in horticultural crop pro-

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0304-4238/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.scienta.2010.02.017

duction (vegetables, fruits, wine, etc.), including the production of ornamental plants and flowers (Menini, 1987; Lawson, 1996; Harrison, 2003; Janick, 2007; Hoffmann, 2009). This phenomenon has been made possible by the increased adoption of free market policies and trade agreements, which have reduced trade barriers to plant shipments among different countries of the world, although hurdles in the horticultural trade are in many cases still substantial (Rae, 2004).

At the same time, the global horticultural expansion has been enabled by continuous product improvement. This, in turn, was a consequence of advances in breeding and tissue culture propagation, which have brought lower real product costs and year-round availability. The latter has led to a rapid expansion of horticultural capacities in countries able to supply products during the winter months in the Northern hemisphere. The global horticultural and floricultural expansion has thus been beneficial to many emerging economies, although many challenges still persist (De Groot, 1999; Norman, 2003; Humphrey, 2006). Developing countries are indeed generally trying to develop horticulture industries to increase export revenues and to benefit rural communities (Warrington, 2005; Lumpkin, 2007). Technical innovations in greenhouse horticulture (e.g. soil-less production; Jiang and Yu, 2007) are likely to be essential to maintain sustainability of food production in the face of the predicted widespread water shortages (Elomaa et al., 2008; Van Kooten et al., 2008).

In spite of the many developments in the horticultural production of most countries of the world, there has been insufficient attention to how such international structural change can affect the risk of spreading invasive plants, diseases and pests (McRae and Wilson, 2002; Brasier, 2008; Evans and Waller, 2010; Hulme, 2009; Drew et al., in press). There have been attempts to improve plant inspection policies at countries' borders using probabilistic models (Surkov et al., 2007, 2008a,b, 2009; Mwebaze et al., 2010), but such commendable approaches need to be complemented by modelling how structural change in the importance of producers, wholesalers and retailers in the international trade pathways affects the likelihood of plant epidemics occurring. Moreover, much literature is appearing documenting rapid developments in the horticultural and ornamental industry of many countries and this still needs to be summarized in the context of plant health.

In this review, we summarize selected literature on recent horticultural developments including the emergence of an international horticultural market, the relatively rapid growth of the horticultural industry of many developing countries, and the consequences for this sector of the increasing economic integration of countries belonging to or aspiring to membership of the European Union. We focus on horticulture but include examples from floriculture, the production of ornamentals, or agriculture in general wherever relevant for the issues considered. Whenever possible, we point out consequences of these structural changes for the likelihood of introduction of new plant pathogens and other invasive species. We point out horticultural trends in (i) the Americas, (ii) Africa, (iii), Asia, (iv) Australasia, (v) as well as in European countries. As an example where there has been both structural change and threats from new plant pathogens, we summarize economic and technical developments of the UK hardy nursery sector. Some implications for plant health, research needs and likely future challenges are then discussed.

2. Horticultural trends in individual countries

2.1. The Americas

The horticultural industry in North America is one of the most dynamic of the world. It is thus often a precursor of structural changes which propagate to other countries with a more or less prolonged delay. Consolidation and structural changes have long affected the North American floricultural market (Haines, 1998). This development has been further spurred by several free trade agreements between Canada, the USA and Mexico (Dempster, 1989; Meilke and Van Duren, 1996; Furtan and Van Melle, 2004; Olper and Raimondi, 2008). The large-scale movement of horticultural products and ornamental plants within and from/to outside the North American continent has certainly increased the likelihood of transferring unwanted species (Bandyopadhyay and Frederiksen, 1999; Timmons, 2005; Gullino and Garibaldi, 2007; Gamliel, 2008). New horticultural trends include (i) the entry in the market of publicly traded floriculture companies, (ii) external purchase by growers of main floral products supplying the North American market (Haines, 1998), and (iii) the increased horticultural production in high tunnels; the latter development can have direct impacts on plant disease management, including the enhanced possibility to make use of biological control (Carey et al., 2009; Pickett Pottorff and Panter, 2009).

As with many other states of the USA, Florida's ornamental plant nurseries underwent substantial structural changes in the 1980s/1990s (Hodges et al., 1996). In Florida, as in other states, slower market growth and an increasing competition has led to larger firms. At the same time, horticultural players tried to increase their product diversity. They also expanded their connectivity to distant markets, thus leading to a lower seasonality of sales. Adding long-distance trade connections to a horticultural system is likely to lower the threshold at which a plant disease epidemic may occur thus making it possible for diseases to become out of control – an insight obtained from network theory applied to trade pathways (Pautasso and Jeger, 2008).

An additional trend is the shift in wholesale outlets from landscapers to retailers and other market channels (Andrade and Hinson, 2009). The vegetable greenhouse industry in Florida was surveyed in 1991, 1996, and 2001 (Tyson et al., 2001). A 50% increase in average acreage occurred over the 10 years investigated, together with changes in production media and dominant crops. Generally speaking, the evolution of the vegetable and wholesaler industries in the USA is a very rapid phenomenon (Perez, 1998; Park and McLaughlin, 2000; Hine et al., 2005). This rapidity makes the life of plant health inspectors harder, as measures aimed to counteract shifts and twists of the trade always take some time to be adopted fully.

In Mexico, there is currently a rapid growth of the vegetable greenhouse industry (Steta, 2004). This has grown from 50 ha in 1991 to 350 ha in 1997, and from 1000 ha in 2001 to 2700 (estimated) in 2004. This development has been driven by the demand from the USA and by aggressive promotion of suppliers also from Europe. Increased links from Mexico to Europe and the USA could become a major pathway of plant pathogen introductions, especially in an age of climate warming. The vegetable greenhouse industry is seen as a key factor for creating technological innovation in the Mexican agriculture. There has also been a key role of the rapid development of the supermarket sector in Mexico in the 1990s for shaping the fruit and vegetable supply chain, with a shift away from traditional wholesalers (Schwentesius and Gomez, 2002).

Structural change is affecting also the horticultural industry of South American countries (e.g. Faiguenbaum et al., 2002). Horticultural exports from Central and South America are increasing (Rae, 2004), particularly from countries such as Ecuador, Chile and, to some extent, Colombia (Lawson, 1996; del Banco Mundial, 2004; Pizarro Yanez, 2007). Increasing horticultural trade among South American countries and towards other continents will increase the likelihood that known and unknown pathogens from these regions will be introduced to and become established in previously unaffected cropland (Hodgetts et al., 2009).