



# > Horticultural science in crisis: where are the graduates required to assure its future?

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## Horticulture is in a crisis

Horticulture is facing a crisis in many countries. There are simply not enough well-trained people being produced in local institutions to service the broad range of careers that comprise the horticulture sector. Sectors within the horticultural industry are becoming very concerned at the reduction in the number of young people undertaking post-high school education in horticulture and/or horticultural science. Headlines such as those indicated below have become increasingly common in many countries over the past few years.

*“Horticulture is under siege in the USA”.*

*“Is horticulture a withering field in the USA?”*

*“Careers in agriculture fail to win hearts and minds of the young”.*

*“Concerns over shortage of agriculture graduates in Australia”.*

*“Uganda’s flower sector faces an imminent shortage of qualified managers and supervisors in flower firms”.*

*“Horticulture is facing a crisis in the United Kingdom”.*

*“Kenya has a shortage of competent horticultural staff at institutional and commercial levels”.*

*“New Zealand horticulture requires a net increase of 7,800 qualified people by 2025 with an additional 26,300 people needed to cover natural attrition”.*

A recent Royal Horticultural Society (RHS, 2014) publication highlighted the fact that 70% of horticultural businesses surveyed in the United Kingdom struggled to fill skilled vacancies, with 90% of respondents saying horticulture lacked career appeal. In Australia in 2010, there were just 743 graduates in agricultural science but over 4,500 agricultural science jobs were advertised. It is estimated that the horticulture sector will require about 2,000 new jobs each year for the next decade in order to retain its current position (J.E. Pratley, Charles Sturt University, pers. commun.) let alone achieve the growth targets being set by the sector. The decline

in horticultural graduates in Australia during the last 11 years, from about 150 to about 40 per year, has been dramatic and is inadequate to meet sector needs. A serious and inevitable consequence of this decline in enrolments has been the disappearance of horticultural degrees from technical and university programmes in all Australian universities apart from Charles Sturt University and the University of Melbourne. This trend of disappearing Departments of Horticulture is mirrored in many European, American and Oceanic countries. The USA is not producing the number of scientists required to sustain its high value specialty crop (horticultural) sector.

There is no doubt that science underpins successful horticultural development throughout the world, whether it is on large corporate farms in developed countries or small subsistence units in developing countries. In a recent study the Coalition for Sustainable Agriculture in the USA indicated that too few scientists are being trained in agriculture (including horticulture) areas of science (Enoch, 2014).

## World population and horticulture

World population increased by nearly 1 billion people between 2000 and 2012, a 16% increase (Table 1). The largest percentage increases were in Africa (35%), Oceania (17%) and Asia (15%).

World production of vegetables and fruit increased by about 32% over the 12 years 2000 to 2012, with the largest increases occurring in Africa and Asia, regions where population growth has been greatest (Table 1). There was a 62% increase of vegetable production in Africa and 73% increase in fruit production in Asia. This major increase in production of vegetables and fruit would not have occurred without the concerted efforts of horticultural scientists and producers worldwide. There is no doubt that these increases in vegetable and fruit production contributed to the Millennium Development Goals (MDGs) of reducing extreme poverty, improv-

ing nutrition and reducing child mortality rates in developing countries. In contrast, fruit and vegetable production in Europe decreased by 13% for vegetables and 36% for fruit. Europe’s population growth was lowest of all continents with a change of only 1.6% between 2000 and 2012.

## What is Horticulture?

Horticulture is difficult to define precisely and is often subsumed and regarded as a sub-section of agriculture. Too often, the public perception of horticulture is that it is a poor-paying job, requiring few if any skills, working long hours in menial laboring tasks in all weathers and seasons, and requiring no tertiary education. This is far from the truth. Horticulture is a knowledge-intensive, high-tech industry, which is vitally important internationally and deserving of its own place in the sun.

Farr (2014) stated that *“Horticulture is a synthesis of science, technology, art and society; implementing it requires technical appreciation of engineering, plant sciences, ecology, – including marketing, strategic management, human resources and financial planning”*.

The Eden Project in the United Kingdom believes that *“Horticulturists help ensure the survival of the human race by combining the energy of the sun with soil, seeds, water and ingenuity”* (Anon., 2014a).

In Wikipedia **horticulture** is defined as the *“branch of agriculture that deals with the art, science, technology, and business of plant cultivation. It includes the cultivation of fruits, vegetables, nuts, seeds, herbs, sprouts, mushrooms, algae, flowers, seaweeds and non-food crops such as grass and ornamental trees and plants. It also includes plant conservation, landscape restoration, landscape and garden design, construction, and maintenance, and arboriculture”* (Anon., 2014b).

Because of its unique attributes, horticulture must be considered an integrative discipline in its own right and should develop its own specific ‘brand’ standing apart from agriculture. According to Kahane and Pilot (2012),

in many countries horticulture is rapidly decreasing in recognition as an academic science in its own right. Rather, it is being included in less distinctive entities such as Natural Resources or Plant and Environmental Sciences that have little, if any, direct impact or relationship with the richness and diversity that is horticulture. Specific disciplines that are essential contributors to, and often associated with, horticulture include: Agronomy, Agriculture, Botany, Crop Science, Plant Pathology, Plant Science Management, Soil Science, Entomology, Plant Ecology, Environmental Science, Natural Science and Agribusiness Management. Horticultural careers exist in plant breeding; fruit, vegetable and cut flower production; protected cultivation in green and plastic houses; landscape, nursery, public botanic gardens; sports turf and community businesses; private and public extension (outreach) services; postharvest quality and supply chain management; consultancies in plant production; plant science; plant genetic technology; pests and diseases; food safety and security; as well as the physiological and psychological benefits of plants. Successful horticultural industries depend on the integration of some or all of these disciplines into coherent and synergistic systems for optimal outputs.

Horticulture is an intensive productive sector and is of growing importance in contributing to poverty alleviation, nutritional enhancement, environmental sustainability and beautification and economic growth. Fruit, vegetables and cut flowers are generally more profitable to small farmers than staple or arable crops as they are high-value with value-added income generation potential (Weinberger and Lumpkin, 2005). Most staple agronomic crops, including cassava, maize, sorghum and rice, do not fall within the normal definition of horticultural crops. However, these staple crops are grown by smallholder farmers in developing countries and will continue to be important sources of carbohydrates and income at the household level. For this reason, their production should be integrated with horticultural crops and also require the attention of the scientific community.

Other positive attributes of horticulture include increased employment opportunities, increased commercial (servicing) opportunities in the rural sector and the potential for urban and periurban plant production for personal consumption (food security, health and nutrition) and local sales (income generation).

Vegetables and fruit are essential components of a well-balanced, healthy and nutritious diet. This is well recognised worldwide. The World Health Organisation (WHO) and the Food and Agricultural Organisation (FAO) advocate a minimum daily intake of 400 g of

■ Table 1. World vegetable and fruit production and population change between 2000 and 2012. Source: FAOSTATS: Accessed October 2014.

		Tonnes (million)		% change	Population % change
		2000	2012		
World	Vegetables	1,390	1,792	28.9	16.2
	Fruit	625	839	34.2	
Africa	Vegetables	175	283	61.8	34.6
	Fruit	77	113	47.2	
Asia	Vegetables	804	1,120	39.3	14.6
	Fruit	279	481	72.5	
Americas	Vegetables	153	161	5.2	12.0
	Fruit	142	158	11.1	
Europe	Vegetables	242	210	-13.3	1.6
	Fruit	125	76	-36.2	
Oceania	Vegetables	7	8	16.4	17.2
	Fruit	5	7	25.9	

fruit and vegetables. Programmes such as “5 + a Day” are proving very useful in educating consumers about the nutritional and health benefits provided by horticultural products. Many dieticians and health professionals advocate a greater range and daily intake of vegetables and fruit (Slavin and Lloyd, 2012). Horticultural foods provide a range of nutrients and different bioactive compounds including phytochemicals (phenolics, flavonoids and carotenoids), vitamins, (vitamin C, folate and pro-vitamin A), minerals (potassium, calcium and magnesium) and fibre (Liu, 2013). New technological knowledge is needed to produce enhanced yields of quality products. This will be generated by scientists and implemented by growers and others in the value chain. The products will be harvested, processed, packaged, stored and transported using modern postharvest and processing technologies. Production of such knowledge requires well-educated and trained horticultural professionals, whether they are specialised plant breeders, plant physiologists, plant pathologists, entomologists, soil scientists, horticultural engineers, agribusiness managers, consultants or combinations of the above. There is an international paucity of such horticultural professionals. The problem is exacerbated by the aging of existing professionals and compounded by the lack of young people choosing to study horticulture at tertiary level in many countries.

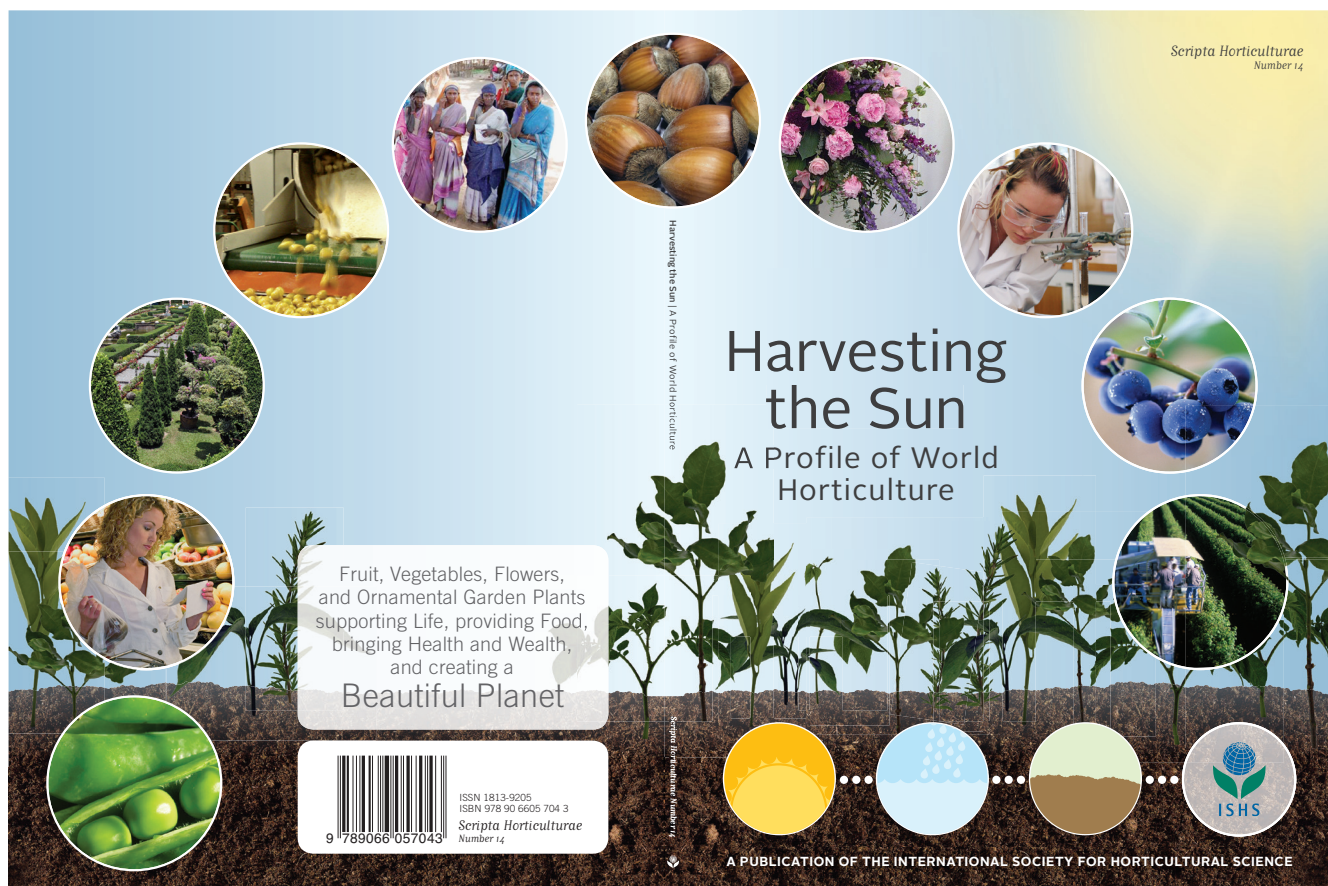
Horticulture is not only about production of food. It contributes to quality of life and lifestyles, to the beauty and sustainability of the human environment through local and

national parks, reserves and gardens, and to enhancement of community economic value. Amenity or community horticulture creates places that contribute to improved mental and community health as well as contributing to the local and national economy. Aldous and Johnston (2012) stated that the global urban horticulture market was worth US\$287.5 billion. A report of the economic value of protected open spaces in S.E. Pennsylvania (Anon., 2011) showed that the following benefits could be attributed to the open spaces: \$16.3 billion added to the value of housing stock, \$240 million gain in annual property and transfer tax revenue for the local government, \$133 million reduction in costs avoided as a result of the natural provision of environment services, \$577 million in annual benefit to residents who recreate in open spaces, \$795 million annually in avoided medical costs, plus the creation of 6,900 jobs.

### Why does horticulture lack appeal to young people?

Regrettably, the general perception of horticulture by the general public, including prospective students and their parents, is negative and ill informed. For horticulture and horticultural science to prosper in the future, this negative perception must be changed through an active advocacy and marketing programme.

There is a perception that horticulture is low-tech and boring. This is not so. Horticultural producers are among the initiators and first users of any new technology. They are avid users and rapid adopters of new ideas, new varieties and new high-tech inno-



> Harvesting the Sun is freely available for ISHS members to view, use and share.

ventions, especially those that enable more sustainable and productive systems. There is a perception that horticulture is low paid with poor career prospects. That need not be so. New horticultural graduates in New Zealand and Australia can receive more than \$70,000 p.a. on initial recruitment into selective, highly responsible roles with great opportunities for rapid advancement and income increases.

A very wide and varied range of careers exists for horticultural graduates. Well-trained and educated people are required to ensure that nutritious fruit and vegetables are on tables 365 days a year, parks and gardens are available to people in urban and rural environments and sustainable production, postharvest and amenity horticultural systems are universally practiced through the entire supply chain from farm to consumer. In many cases, employment in horticulture enables working outside in pleasant surroundings, provides opportunities for international travel and chances to provide updated advice and assistance in developing countries.

And yet there is a huge actual and projected deficit in well-trained horticultural graduates in many countries – insufficient numbers to meet future needs. Kenya has a shortage of competent horticultural staff at institutional and commercial levels. New Zealand horticulture will require a net increase of 7,800

qualified people by 2025 with an additional 26,300 people to cover natural attrition. In Australia there are 60,000 unfilled jobs in the agriculture/horticulture sector but only 500 graduates every year to fill them. Seventy percent of horticultural businesses surveyed in the United Kingdom struggled to fill skilled vacancies, with 90% saying horticulture lacked career appeal.

The International Society for Horticultural Science (ISHS) has commenced a campaign of advocacy about horticulture. A book (ISHS, 2012) and a video (on YouTube – <https://www.youtube.com/watch?v=MvIFcEyAezA>) titled: “Harvesting the Sun” has been produced in an attempt to demonstrate the breadth, range and diversity of horticulture, its nutritional, health, economic, community and social importance. It is written in a simple text with many colourful pictures that show a wide spectrum of horticultural aspects including potential careers. This book has been translated into several languages to date. Hopefully, appropriate volunteers can be found to translate the book into other languages.

The Royal Society for Horticultural Science (RHS, 2014) in the United Kingdom has produced “Horticulture Matters”, a report on the state of horticulture in the UK. Its main objectives include: promoting horticulture across government, improving the perception of horticulture in society and to government,

embedding horticulture in education, promoting and supporting training, and safeguarding the health of UK horticulture. A varied number of initiatives have been launched across the sector, with a focused attention on youth, and initial results appear promising.

In the White Paper “Promoting Horticulture in the United States” (Anon., 2014c), the authors encapsulated the issue concisely: “Today our world is highly dependent on horticultural expertise to provide the technology and people necessary to meet the rapidly increasing global demand for fruits, vegetables, nuts, herbs and ornamentals in the face of the changing global environment and limited natural and financial resources. Horticultural Science is critical in improving the nutritional content of food, enhancing the safety of our produce supply, and increasing the supply of healthy, local and sustainably produced foods. Expertise in environmental horticulture is necessary to address the global issues of climate change; water quality, availability, storm water runoff, and retention; and energy production through biofuels. Additionally, the role that horticulture plays in promoting positive mental well-being, on a large scale from public botanic gardens, parks, and sports fields, to small scale individual home gardens is critical to our life today.” The issue in the USA is exactly the same as in many other countries.

The USA programme focuses on young people. It intends to raise funds for integrating horticulture firmly into core curricula at schools, to develop marketing programmes for universities and colleges to reach parents and potential students, and to promote knowledge about the importance of horticulture to the general public (Anon., 2014c).

### Can the declining trend be reversed?

It is critically important that more young people are encouraged to undertake advanced education and training as the horticulture sector requires an adequate and skilled workforce to fulfill its undoubted potential. There have been a number of suggestions made by a range of people and organisations to reverse the decline in available personnel needed by the horticulture sector.

#### Marketing and advocacy

- (i) Make horticulture an appealing and relevant subject at school. Give it a WOW factor and stress its national and international importance. It is widely accepted that a comprehensive marketing or advocacy programme will be required to change the image of horticulture in the broader community. Most people are ignorant about the nature and essential importance of the sector to their health, nutrition and wellbeing. The key to such messages would include:
  - modern horticulture is a high-tech, diverse and interesting topic of study;
  - horticulture will be essential to help solve the big problems facing humanity, such as food security and global warming;
  - horticulture has a wide range of well-paid, interesting jobs that should be demonstrated through case studies;
  - horticulture is international and employment opportunities are available throughout the world for horticultural graduates in private, public and international businesses and institutions.
- (ii) Should the sector consider changing its name from horticulture to something that most people will recognise immediately? Horticulture encompasses food, nutrition, health and wellbeing and uses sciences from all disciplines to generate economic, social and community outputs for people. In the USA, government (through the US Department of Agriculture) no longer funds horticultural research. Instead increased funding for R&D is being allocated to the Specialty Crops programme that is defined as “fruit, vegetables, tree nuts, dried fruit, horticulture, and nursery crops (including floriculture).”

(iii) Obtain data that can be used to demonstrate to policy makers the implications of the decline in horticulture graduates. Hopefully this would persuade them to invest more in horticultural education and R&D. To some extent this has occurred in Africa where heads of government, through the Comprehensive Africa Agriculture Development Programme (CAADP), have agreed to allocate 10% of budget allocations to achieve a 6% growth rate target in agriculture. Such success will undoubtedly lead to increased funding in agricultural education that also includes horticulture. Creation of six regional hubs of excellence, strategically located throughout the continent, would facilitate research on local and regional problems and could develop into a network of scientific and educational centres for advanced horticultural education and training (Kahane and Pilot, 2012).

- (iv) Individual horticultural sectors must become involved in helping solve the shortage of well-educated, well-trained and committed young people by integrated inclusion in any marketing endeavours. Funding and enthusiastic advocacy is expected from the industry itself in cooperation with other committed agencies.
- (v) A sharpening of the marketing focus to educate children about the source of products and the journey they follow from the farm to the mouth, would be valuable. The 2014 Produce Marketing Association (PMA) meeting was particularly interesting because of the marked increase in advertising of products with a focus on children. Significant efforts were made by many companies to use dramatic colours, cartoon characters and catchy tunes and phrases to attract children to purchase their products (Anon., 2014d).

#### Educate and encourage youth

- (i) Start advocacy early. All three major advocacy programmes above have a very strong commitment towards young children and youth. Generating knowledge, understanding and interest about horticulture in youngsters during early school years will have major outcomes relating to education and career choices later.
- (ii) Adjust curricula. Appropriate and relevant adjustments should be made to national curricula at both primary and secondary levels to ensure that students are made aware of the economic, social, environmental, nutritional, health and wellbeing benefits that are contributed by horticulture to humankind. At the very least, primary school students should gain an understanding of plants, their

growth and care, and their importance to them and their families. At the tertiary level, a balanced combination of lectures, laboratory and practical fieldwork under enthusiastic mentors who would bring an international perspective is important.

- (iii) Enthusiastic teachers. It is critically important that teachers of biological and horticultural sciences are knowledgeable and genuinely enthusiastic about their subject. Too often, teachers at both primary and secondary level have no background in or experience of horticulture so their knowledge is also inadequate. An increase in horticultural science graduates would provide a larger pool of teachers with both scientific and horticultural expertise.
- (iv) Encourage educational and career pathways. Ensure that the path from school to tertiary education to employment is clear, direct and unimpeded. At the same time it should retain flexibility to enable individuals to enter, leave and re-enter to fit personal circumstances. Students, parents and career advisory officers need accurate and constantly updated information about employment and remuneration options for horticultural graduates. Horticultural science is for the best and brightest of our youth.
- (v) New pedagogical models. Wals et al. (2013) suggested that traditional tertiary agricultural and horticultural education programmes were inadequate for meeting the global challenges of the next 50 years. Most existing agricultural/horticultural curricula do not include major global issues that are of real interest to the current generation of young people. Climate change, loss of biodiversity, global economic trends, over-exploitation of natural resources of land, water and energy (Anon., 2012), food losses and waste (Gustavsson et al., 2011), the social importance of transforming individual poverty to community wealth, the power of social media to spread knowledge and ideas at lightning speed, and the globalisation of trade, are rarely incorporated into horticulture and agriculture curricula. Many young people are idealists who relish the opportunity to use their knowledge and skills to help others less fortunate than themselves in environments away from the comforts of home. Horticulture enables graduates to do this!
- (vi) Meeting society demands. The societal benefits should be highlighted and promoted through multiple media sources with wide circulation. There are signs emerging that more students are enrolling for tertiary education in horticulture in some countries. The impact of the

global economic crisis has resulted in huge loss of traditional jobs and unemployment; one outcome in some countries is an increase in young people enrolling in horticultural courses with the intention of producing food at home, in developing countries or improving the environment.

## Conclusion

Production of fruit and vegetables has increased faster than the increase in the rate of world population from 2000 to 2012. This is especially evident in Africa and Asia. Considerable progress has been made in meeting MDG goals: poverty has been reduced by 50%; hunger continues to decline; chronic child undernutrition and child mortality have almost halved. However, much more has to be done. It is certain that horticulture has contributed significantly to some of these successes through increases in high value, highly nutritious horticultural foods, as well as the generation of additional incomes by adding value through postharvest storage and processing.



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However, this contribution was underpinned by enhanced horticultural extension, research and development programmes in many countries. To ensure that production and availability of fruit and vegetables continue to increase faster than population through to 2050, it is imperative that a highly qualified, well-skilled and educated horticultural workforce, from producer through the supply chain to the market, is maintained or increased immediately. A major shortfall in horticultural graduates has the potential to threaten their industries over the next two decades. A few national and international agencies have embarked on advocacy programmes to change the perspective of families, students and communities to the important realities of horticulture and the myriad of career opportu-

nities in the sector. A worldwide cooperative, collaborative and coordination effort involving international agencies, industry groups and tertiary institutions must become part of this movement. National and international agencies must work together to increase the number of scientists, extension specialists and consultants who will be crucial for the future success and prosperity of horticulture as it contributes to feeding, nourishing and beautifying our world.

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