

A publication of the International Society for Horticultural Science

Chronica Horticulturae



Horticultural highlights

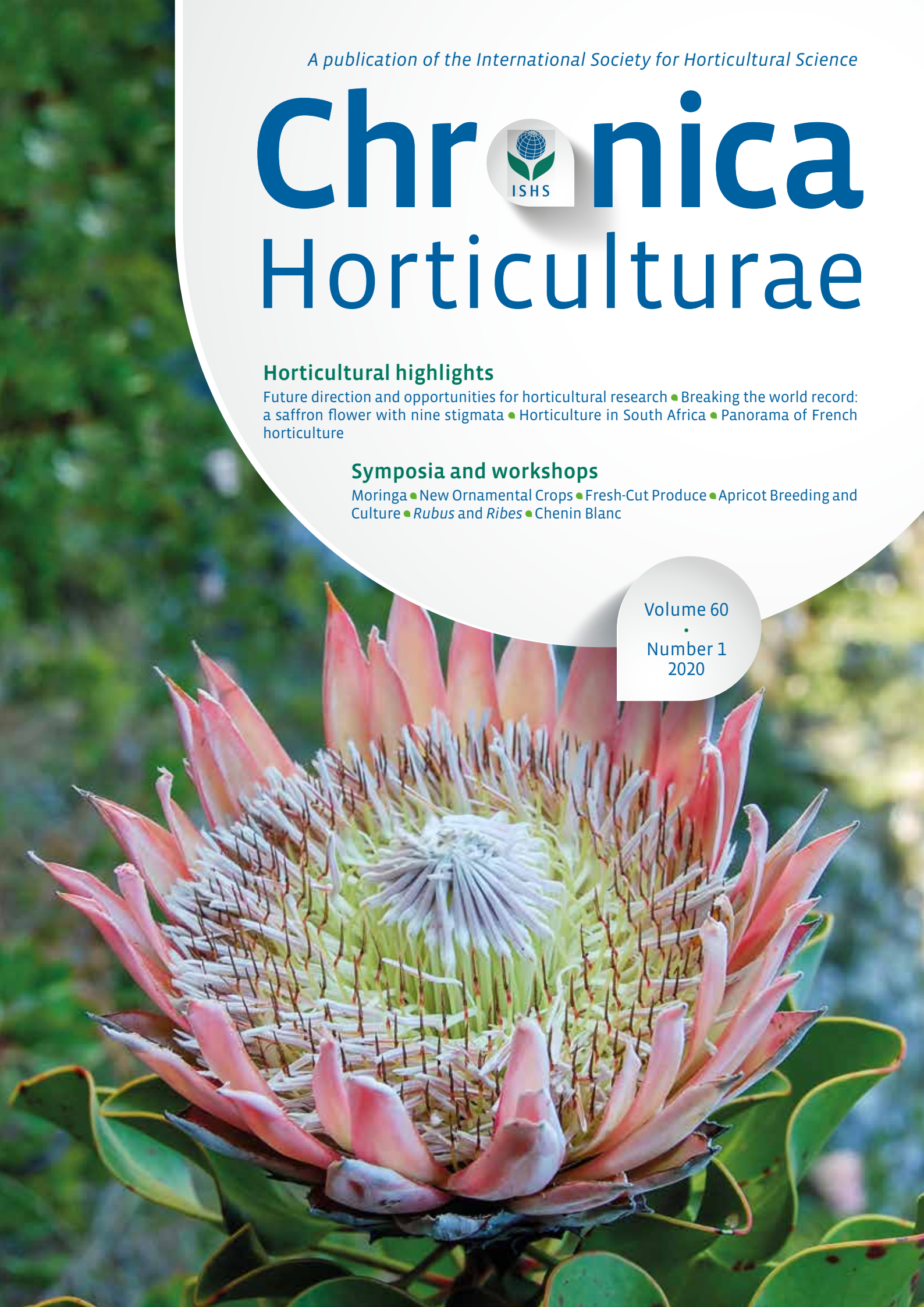
Future direction and opportunities for horticultural research • Breaking the world record: a saffron flower with nine stigmata • Horticulture in South Africa • Panorama of French horticulture

Symposia and workshops

Moringa • New Ornamental Crops • Fresh-Cut Produce • Apricot Breeding and Culture • *Rubus* and *Ribes* • Chenin Blanc

Volume 60

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Number 1
2020



Chronica Horticulturae



Chronica Horticulturae © Volume 60 – Number 1; March 2020;
ISSN: 0578-039X (print), 2506-9772 (electronic).

Published quarterly by the International Society for Horticultural Science, Leuven, Belgium. Lay-out and printing by Drukkerij Graphius, Gent, Belgium. ISHS © 2020. All rights reserved. No part of this magazine may be reproduced and/or published in any form, photocopy, microfilm or any other means without written permission from the publisher. All previous issues are also available online at www.ishs.org. Contact the ISHS Secretariat for details on full colour advertisements (1/1, 1/2, 1/4 page) and/or mailing list options.

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PubHort is a service of ISHS as part of its mission to promote and to encourage research in all branches of horticulture, and to efficiently transfer knowledge on a global scale. The PubHort platform aims to provide opportunities not only to ISHS publications but also to other important series of related societies and organizations. The ISHS and its partners welcome their members to use this valuable tool and invite others to share their commitment to our profession. The PubHort eLibrary portal contains over 78,000 downloadable full text scientific articles in pdf format, and includes The Horticulture Journal, Journal of the American Pomological Society, Journal of the International Society for Mushroom Science, Proceedings of the International Plant Propagators' Society, Journal of the Interamerican Society for Tropical Horticulture, etc.

Additional information can be viewed on the PubHort website www.pubhort.org.

A publication of the International Society for Horticultural Science, a society of individuals, organizations, and government agencies devoted to horticultural research, education, industry, and human well-being.



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Cover photograph: *Protea cyanaroides*.
Photo: Mark Schaffner. See article p.25.



News & Views
from the Board

> Publications: a key role in horticultural innovation



> Sisir Mitra

Sisir Mitra, ISHS Board Member Responsible for Publications

The two most important methods for knowledge transfer are: i) traditional published academic outputs such as journal articles, conference proceedings and books; and ii) informal interactions including personal contacts at conferences, symposia, seminars, and workshops via professional associations (Arnold et al., 2012). Today, ISHS is working with these methods of knowledge transfer and is a major publishing house in its own right with a specialist niche market in all aspects of horticultural science and technology.

The first publication undertaken by ISHS was *Chronica Horticulturae*, which started in 1961, to serve as a magazine for informing the members of the professional activities of the Society. It provided the opportunity for correspondents in member countries to report on recent news of general interest to members, included articles on the horticultural industry, universities and research institutions in various countries and, carried general articles on horticulture. Recent ISHS Boards have transformed *Chronica* into a completely new format, incorporating the use of colour photographs on the cover and throughout the articles inside, and including feature articles that are relevant to horticultural science. Along with the Society's website, it is an important vehicle for liaison with

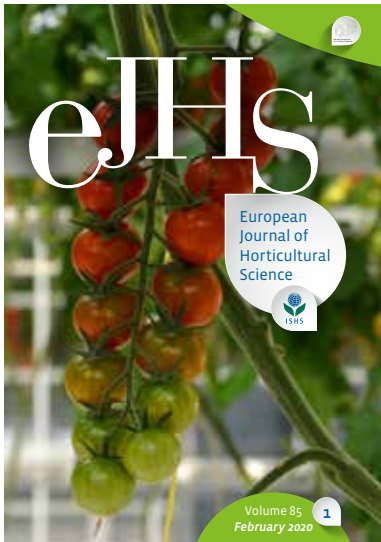
members. Presently Kim Hummer, Board member, serves as Editor, and Kelly Van Dijck and Peter Vanderborgh of the Secretariat are Associate Editors. *Chronica Horticulturae* is available on-line and in electronic and printed formats.

Acta Horticulturae has been the flagship of the Society's publication portfolio since the first volume was published in 1963. Volumes of *Acta Horticulturae* serve as a record of the proceedings of the ISHS symposia that are held around the world each year. Over 1260 *Acta* volumes have now been published with the number of volumes increasing progressively over the past six decades. The contents of *Acta* are diverse, covering all research, production and marketing for different crops or focusing on specific discipline topics. Thanks to the work and vision of past Boards, and especially of the Publication Chairs, Dr. Jules Janick and Dr. Yves Desjardins, the presentation of *Acta* has improved considerably over the last two decades. Each manuscript of *Acta* has a DOI (digital object identifier), allowing unique searching and renewed citation capability. Cross-referencing is also available, allowing for easy navigation through electronic enhanced PDF. More than 69,000 full text articles have been posted at www.actahort.org and an impressive number of viewers (>20,000 page-views per day) utilize

this important record of achievements and discoveries in horticultural science. *Acta* is referenced by Scopus and is thus used in the calculation of the H-Index and in altmetrics. *Acta* is widely cited because it reports the latest findings and/or thinking of researchers from their presentations at symposia and congresses. Often it summarises preliminary results from a longer-term trial or reports on smaller trials that might not otherwise be published.

A specialized publication series, named *Scripta Horticulturae*, has been published by ISHS since 2005. It covers extensive articles on specific horticultural issues, position papers, monographs on individual crops or particular technologies, and the proceedings of specific conferences or workshops. Twenty issues have been published to date and one *Scripta* volume on bonsai is in preparation. Considering the diverse interests, origins and demands of close to 6000 ISHS members, the past and recent Boards felt the need to provide members with the option of publishing their research in peer-reviewed scientific journals that are managed within the ISHS and which include an impact factor (IF). With that goal, ISHS acquired *eJHS*, the European Journal of Horticultural Science (www.ishs.org/ejhs) from the German Society for Horticultural Science, and *Fruits*





(www.ishs.org/fruits) from the Centre de Cooperation Internationale en Recherche Agronomique pour le Development (CIRAD) in France. Both journals were acquired between 2015 and 2017, and have shown a progressive increase in their IF since incorporation in the ISHS. These two journals publish original research papers and scientific reviews and are often organized into thematic issues. The editorial policy and scope of *Fruits* has recently been broadened to encompass tropical and subtropical horticulture – hence the name of this journal has been changed to become *The International Journal of Tropical and Subtropical Horticulture*. Both of these journals are available in either print or electronic formats. *eJHS* is Open Access. The Society is also involved in book publishing. The book, *Principles of Modern Fruit Science*, was published in 2019. It is a translation of the previous Italian version of *Arboricoltura Generale* edited by Professor Dr. Silvano Sansavini and several other Italian co-editors and contributors. It covers multiple topics involved in the study of fruit science as well as the most important management practices (and the science on which they are based) pertaining to establishing and maintaining fruit tree orchards. A review of this book was recently published in *Chronica Horticulturae* (DeJong, 2019).

Recognizing the extensive use of *Acta Horticulturae* and its many citations in the scientific literature, ISHS PubHort (www.pubhort.org) was developed in the late 1990s as a key gateway for accessing a wide range of horticultural information. The PubHort platform aims to provide opportunities, not only to ISHS publications but also to other important related societies and organizations, for the wider dissemination of information relating to horticulture and horticultural science – much of which is otherwise difficult to access. The PubHort Library portal contains over 78,000 downloadable, full text scientific articles in pdf format, and includes all scientific papers that have been published in *The Horticulture Journal*, the *Journal of the American Pomological Society*, the *Journal of the International Society for Mushroom Science*, the *Proceedings of the International Plant Propagators Society*, the *proceedings of the congresses held by the American Society for Plasticulture*, and the *Journal of the Interamerican Society for Tropical Horticulture*. The ISHS frequently receives requests from members and subscribing libraries for electronic-only copies of ISHS publications, particularly for *Acta Horticulturae*, to reduce physical shelf space in libraries and to reduce the environmental impacts associated with printing and shipping. Some members would also

prefer an electronic version for its search functions. The message is “Go paperless; go green!” The present Board is evaluating the options for moving to electronic-only versions for all of the ISHS publications portfolio, although we anticipate this would occur progressively after some initial testing and feedback. Our Society plays a major role in knowledge transfer within the global horticultural science community through the publication of recognized scientific journals, organizing well-attended scientific meetings, and making available the information presented at such meetings in a readily-accessible series of symposium proceedings. It will continue in such a role and will respond appropriately to new technologies that emerge in the knowledge transfer arena. ●

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Spotlight
on Honoured
ISHS Members

> Krishan Lal Chadha

Position or previous position

President, Indian Academy of Horticultural Sciences; Retired, National Professor and Deputy Director General (Horticulture), Indian Council of Agricultural Research; ISHS Council member representing India (1982-2002)

ISHS honour

Fellow (2014)

1. Tell us a bit about yourself (hometown, present location, family, hobbies, community involvement).

I was born on November 15, 1936, to a family of four brothers and five sisters at Bhopalwala, Tehsil, Deska, District Sialkot, situated in the then Punjab Province of British India, now in Pakistan. I did my primary education at Arya High School, Bhopalwala, Sialkot, before the partition of India in 1947.

Early in my life, I grew up full of pranks and naughtiness associated with many children. What I also cherish, however, is that this period was marked by that rare combination of companionship and competition among friends. It is this kind of spirit that imprints your future progress in life. Alas it was interrupted by the sudden imposition of partition in August 1947 on our communities, which



> Dr. K.L. Chadha with his family members (2012).



> Launching of National Working Group on Horticulture of Indian Chamber of Food and Agriculture, chaired by Dr. K.L. Chadha (2016).

had lived in peace and mutual brotherliness. My family and I underwent severe pangs of this eventuality, having to leave all of our precious belongings back in Sialkot, and face the furious riots and indescribable mayhem on our way out from Sialkot. I still remember that I put on a pair of trousers and three shirts (one over the other) with pocketfuls of peanuts, lest we should find no food on the torturous route to the Indian side of a partitioned country. We settled in Jalandhar, Punjab (India), where I completed high school (1947-51) and went on to carry post-graduate study. I received my doctorate from the Indian Agricultural Research Institute (IARI), Delhi.

I am now settled in New Delhi. My wife, Mrs. Sunita Chadha, very sadly left for her heavenly abode just two months after we celebrated our golden jubilee wedding anniversary on September 4, 2015. I have two well established offspring; my son, Mr. Mohit Chadha, working as a Chief Manager, ICICI Bank, settled in Delhi, while my daughter, Mrs. Mona Chadha, married to Mr. Anish Batlaw, settled in New York, USA.

Professionally, I have been deeply associated with nurturing the Horticultural Society of India (HSI), founded in 1942, now the Indian Academy of Horticultural Sciences (IAHS), continuously for the last 50 years. I have provided the necessary impetus to make it a vibrant national professional society, which is also active and acknowledged internationally. Under my leadership, the society has attained peaks in different activities and has outreached to diverse sections of the society throughout the country and abroad.

I served as President of nine Indian agri-horticultural societies and Vice-President of

five professional scientific societies, including the National Academy of Agricultural Sciences (NAAS), New Delhi, and the Indian Society of Agriculture Sciences. I have consistently endeavoured to contribute to society, and fortunately, have been able to make visible impact on the livelihood and lifestyle of people I have touched in the line of horticultural chain.

For the last 20 years, I have been the Chief Patron of the All India Kitchen Garden Association, which promotes vegetable and flower production, nutrition, balanced diet, urban agriculture and the associated environmental issues. The Institute of Horticulture Technology, Greater Noida (of which I am a Founder Chair) has upskilled 50,000 farmers from about 24 states in field and hi-tech horticulture. As an Advisor to the Federation of Indian Chamber of Commerce and Industry (FICCI), I emphasized adoption of good agricultural practices (EUREPGAP) in horticultural crops for farmers and entrepreneurs as a vital component of export chains of horticultural commodities. I have guided NGOs, such as the Indian Society of Agri-business Professionals (ISAP) and AGRIWATCH, during their difficult phase. We set up the first Community Radio Station at Sironj (Madhya Pradesh), and the Call Centers in Madhya Pradesh, Himachal Pradesh, Haryana, Uttar Pradesh and North-Eastern States of India. Our e-information programme 'Sochna se Samadhan' won the National Award of the Ministry of Information and Technology, Indian Government. Other NGOs to which I was associated are Reliance Agro-tech, World Noni Research Foundation, Agriculture Today, Indian Chamber of Food and Agriculture, and Maharashtra Grape Growers Association.

2. What got you started in a career in horticultural science?

Even as a child, taking part in agricultural operations was fun for me. I used to enjoy the sweet smell of cattle fodder that I carried on my shoulders from the fields after school. The thoughts of an enterprise in the picturesque rural setting never left me. There was an engineering college in Chandigarh around 100 km from my hometown but my family did not favour the idea of me going to live in a hostel for higher studies. There was an agriculture college located at Ludhiana about 10 km from my hometown where I could study without having to move to a hostel. Thus started my formal association with agricultural sciences. After completing my B.Sc. Agri. degree, I got a job as a Fruit Research Assistant at the Regional Fruit Research Station, Mashobra (Shimla) with the Himachal Pradesh Government. I was quick to realize that a Bachelor's degree alone was not enough for a productive career in the field of agriculture. I left the job and took admission in M.Sc. I was actually interested all along in doing an M.Sc. in Horticulture but during those times this subject was not on offer at M.Sc. level. To my good fortune, the Indian Council of Agricultural Research (ICAR), in that very year for the first time, offered a fellowship for a Master's degree in Horticulture. Since the required infrastructure for M.Sc. course in Horticulture was not available at the college, I was obliged to approach Dr. K. Kirpal Singh, Fruit Specialist based in at Patiala, who could provide necessary facilities and guide me towards this degree. Lady luck was further kind to me as I also secured the first Fellowship from the ICAR. I completed the M.Sc. programme in 1959, from Punjab University, Chandigarh.

The job scenario in the field of horticulture remained limited in the public sector. I was selected to the DCM Group as an Agronomist (Horticulture), as the salary was attractive and the job role appeared to be fine. Simultaneously, I was selected in IARI for a Ph.D. degree in Horticulture under the Chairmanship of Dr. G.S. Randhawa. But Horticulture was always my *El Dorado*. This time, my family was not ready for my higher studies. It was my Professor who decided to take things under his control and told me "*Banda ban ja*" (Be a man). I was certainly amused by the sense of ownership of the Professor on me and I eventually enrolled in my Doctoral programme.

3. Give a brief overview of your career/achievements.

I started my professional career as Fruit Research Assistant in Himachal Pradesh as Technical Assistant in ICAR Headquarters followed by Assistant Horticulturist at IARI

in 1963. A year later, I was selected as Fruit Specialist in Punjab Agricultural University. This was an important position which encompassed today's Haryana and Himachal Pradesh States as well as covering six regional research centres. Though this was primarily a research and teaching assignment, the position required me to double up as an Extension Specialist State level.

I served on key national positions in ICAR, namely, Senior Horticulturist and Head, Division of Fruit Crops at Indian Institute of Horticultural Research (IIHR), Bengaluru, Project Co-ordinator (Fruits) and Head, Central Mango Research Station, Lucknow (now Central Institute for Subtropical Horticulture) and Director, IIHR. At this stage, I joined the Indian Government as the first Horticulture Commissioner and concurrently, as Executive Director, National Horticulture Board, to lead the national research and horticultural development programmes in India. Once again, in 1987, I was appointed first Deputy Director General (Horticulture) in the ICAR. My last official assignments were the positions of National Professorship 1997-2001, and Adjunct Professor in Horticulture at IARI 2011-2017, which provided an opportunity to give guidance to 15 postgraduate students in horticulture in different universities.

Also, I was lucky to get an opportunity to undertake short term consultancies in several countries of Asia and the Middle East, namely, Afganistan, Bangladesh, Bhutan, Egypt, Indonesia, Iran, Malaysia, Nepal, Philippines and Thailand. Besides, I had useful experience in international horticulture with



➤ Dr. K.L. Chadha receiving Padma Shri Award from the President of India, Smt. Pratibha Patil (2012).

my election as Member and Vice Chairman, Board of Trustees of International Potato Centre (CIP), Lima, Peru, for seven years.

4. What do you consider to be your greatest achievements?

My influence on the growth and development of Indian horticulture has earned me one of the four top civilian recognitions, 'Padma Shri', given by the Indian Government every year on Republic Day of India. I rate my tenure as Member Secretary of VIII Five Year Plans, Chairman of Working group on Horticulture and Plantation Crops for X and XI Five Year Plans of the Planning Commission, Government of India (now NITI Aayog) as the turning point in the history of horticultural research and development programmes. This helped me to obtain higher funding, build new institutions, and launch several hi-tech programmes through the above senior management positions. For instance, the annual grant for national horticultural development used to be a meagre Rs. 25 crores in VII Five Year Plan. I managed to raise it to a level of Rs. 20,000 crores by XI Five Year Plan, by virtue of a series of firm, progressive growth and development initiatives and proactive decisions. As a result, India's horticultural sector moved into a fast growth lane. For the first time the horticultural sector witnessed a glaring impact on nutritional security, employment generation, foreign exchange earnings, improving incomes of small farmers and so on. Micro-irrigation, high-density planting, rootstocks, micropropagation, and hybrid vegetable seeds became the hi-tech face of horticulture across the country. I also contributed substantially to the formulation of a flagship development programme, i.e., the National Horticulture Mission of the Government of India aimed at doubling the horticultural production from 150 to 300 MT. I was assigned to set up a Mango Research Station on a barren stretch of land and it has now an upgraded status as the Central Institute for Subtropical Horticulture. One of my significant contributions that brought me several recognitions was the development of IIHR into a world class horticultural facility for research and education. I set up more than 50 laboratories to ensure interdisciplinary research in 10 divisions. As a Coordinator, I set up a Centre of Excellence in tropical horticulture at the institute, which provided an opportunity to upgrade research infrastructure and manpower to undertake research and teaching at postgraduate level through exchange of eminent scientists from USA, Italy and Australia with corresponding research workers from the IIHR. The first National Curriculum for Postgraduate education in horticulture was also designed by me in a national workshop. As DDG (Hort), I



› Establishing Central Mango Research Station (now Central Institute for Subtropical Horticulture) from scratch at Lucknow. Picture shows the makeshift office used during the first few years (1972).



› Dr. Manmohan Singh releasing the book entitled 'Agriculture and Environment' authored by K.L. Chadha and M.S. Swaminathan (2006).

was instrumental in setting up nine National Research Centers (NRCs). These were Centers for Citrus, Banana, Grape, Arid Horticulture, Onion and Garlic, Orchids, Oil Palm, Spices and Medicinal and Aromatic Plants, besides the Central Institute of Temperate Horticulture, Srinagar (JK), the Indian Institute of Vegetable Research, Varanasi (UP). This and nationwide introduction and promotion of oilpalm plantation, have contributed to accelerated and multifaceted growth of horticulture in India. My specific contribution as a researcher included: i) Establishment of the National Germplasm Repository on Mango (initially, 763 genotypes and *Mangifera* species), identification of superior clones in mango and walnut resulting in release of a high yielding regular bearing Clone No. 51 of *Dashehari*, ii) Causes and management of citrus decline, malformation, black tip and fruit drop in mango, iii) Mango rootstocks for dwarfing and other economic traits, iv) Pineapple high density production, techniques, leaf/tissue sampling, and v) Optimization and quantifying critical limits of nutrients for various fruit crops, resulting in a record three-fold increase in yield and reduction in the use of inorganic fertilizers.

In the capacity of Executive Director, National Horticulture Board, Government of India, I launched the first national market information scheme (MIS) on perishable commodities (in 15 cities), a scheme providing juice vending machines to popularize fruit juices at airport and town shops, and promoted use of low energy cool stores for potato and onion in the country. I have, besides, headed several committees for development and promotion of horticulture in several states. I have authored/edited 40 books and bulletins, contributed 40 chapters in books, published 135 research papers, and about 200 popular articles. I compiled and published *Advances in Horticulture*, the milestone compilation of research work in Indian horticul-

ture covering more than 9,410 pages in 13 volumes that continues to be a source of reference to researchers and postgraduate students. Similarly *Handbook of Horticulture* (1200 pages; published by ICAR) is a signature publication that is the most unequivocal source for horticulture information in the country for students, young researchers and farmers. Another important publication is *Agriculture and Environment* (900 pages) authored by me and Dr. M.S. Swaminathan, the Father of the Green Revolution in India.

In addition, I was lucky to receive several awards and recognitions from international and national academies, agriculture universities, scientific societies, industry and farmer organisations. These include four fellowships, including those from the International Society for Horticulture Science (ISHS) (2014) and NAAS, New Delhi (1992), and three D.Sc. (Agri) *Honoris Causa* degrees by the State Agricultural Universities, at Kanpur, Uttar Pradesh, Samastipur, Pusa, Bihar and Bhubaneswar, Odisha during 1995, 2008, 2009, respectively. Important awards received by me include Krishi Shiromani Samman (Mahindra & Mahindra Pvt. Ltd., 2014), National Agriculture Leadership Award (Agri Today, 2008), HSI-Sivashakthi Lifetime Achievement Award (2007), Dr B.P. Pal Memorial Award (apex award of NAAS for the best agricultural scientist), S.K. Mitra Memorial Award (AIFPA, 1998), M.H. Marigowda Award (1996), Om Prakash Bhasin Award in Life Sciences (1992), and the Borlaugh Award (1984).

5. Did you encounter difficulties along your career path and how did you deal with them or how did you turn them into opportunities?

I have been lucky not to have encountered any mentionable or insurmountable obstacles in my professional career. I think that almost everyone finds oneself placed in embarrassing positions or in a position of confronta-

tion with administration, while advancing the cause of horticultural science. The major hurdle which I felt was that emphasis and identity of horticultural crops were shadowed by field crops in view of insufficient availability of food. Lack of funds, promotional opportunity for manpower, institutional infrastructure, technologies, and inadequate focus on horticultural research and development at the national level hindered the progress it deserved. I turned these difficulties into opportunities with vigour and vision. In my career path, the biggest challenge was proving that my ability was relevant and competent for almost all senior jobs that I occupied during five decades of my association with horticultural research and development.

6. Tell us about one funny/exciting/interesting experience that happened to you during your career.

Of the forty odd countries that I had visited during my career, several funny incidents happened. One of these happened during my visit to Papua New Guinea, in search of oil palm seeds for India. I, along with a team, took a flight from Indonesia to Papua New Guinea. Surprisingly, when we landed at the airport, I found my checked in baggage was missing. This was embarrassing as my clothes, my shaving kit and other materials were in the missing baggage. I was, however, assured that my baggage would arrive by the next flight and would be delivered to our place of stay. We had to travel to a far-off place in the hinterland of the country where we were to be stationed for about a week for visiting oil palm plantations. At this place, none of the personal use articles were available nearby. As a result, I had to go with only the clothes I was wearing, washing them at night, and using them during the day. I also had to go without daily shaving. The official routine however kept us busy but

our luggage never reached us. On our way back to India after a week, I questioned airport authority about non-receipt of luggage resulting in difficulty and embarrassment. The airline official smiled and said, "Sir this is a once-a-week flight and your baggage has just arrived".

7. What made you become a member of ISHS and why did you keep the membership? What contribution or role has ISHS played in your career?

I became a member of ISHS in 1982, looking at the objective of promotion of horticultural science by the Society. I have had the honour to be the Indian Representative on ISHS Council for more than 20 years (1982-2002); Chair of the Mango Working Group for 16 years (1979-96), organising three International Mango Symposia at Bangalore, Darwin (Australia) and Miami (USA); Secretary, Sub-Group on Viticulture for South East Asia for 10 years (1970-80), organising a seminar titled "Viticulture in Tropics" at Bengaluru; and Vice-Chairman, Commission on Tropical and Sub-Tropical Horticulture for 7 years (1986-90). These steps, decisions, and measures were taken with some foresight, to enable exchange of knowledge for development of research and development in horticulture, at international level.

8. What advice would you give to young people interested in a career in horticulture / horticultural sciences?

Horticulture is a sustainable source of employment and livelihood opportunities for students, young farmers, and entrepreneurs. There is plenty of scope to develop technologies in postharvest management towards minimizing losses, creating adequate cool chain for safeguarding quality, promote mechanization, and alternate horticultural systems such as protected cultivation, aeroponics, hydroponics, peri-urban horticulture, organic farming and GAP. Growth in each of these areas is sure to bring in prosperity to farmers, entrepreneurs, and countries. Several horticultural technologies attract our youth viz., mushroom cultivation, bee-keeping, and custom hiring of tools and machinery. Urban horticultural practices like production, marketing and drying of flowers, interior and architectural landscaping have opened a window of opportunities for trained youth.

9. What are the most interesting new roles or opportunities you see emerging in the future within horticultural science?

Alternate horticulture, diversified production systems such as hydroponics, aeroponics and protected cultivation of horticultural

crops, offer the best choice for improving income of farmers, nutrition, environment and GDP of the country. Floriculture and off-season horticultural crop production in peri-urban areas offer a good potential in the near future.

Expanding the cultivation of medicinal and aromatic plants and bamboo has unlimited scope. Automation of horticultural operations offers a great opportunity to bring efficiency in production and processing sectors. Developing horticultural skill sets and training students at various levels, including agricultural graduates, horticultural officers and farmers, will surely help in the science-led growth of the horticultural sector in India. The ultimate aim is to make horticultural produce affordable for each household, and progressively increase utilization, and horticultural consumption, thus promoting exports and the development of niche markets. I am happy to say that horticultural development is also the priority of the Indian Government, to tackle food, malnutrition, and health issues, and sustain growth of the agrarian sector. ●

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➤ Future direction and opportunities for horticultural research

Yüksel Tüzel and Lukas Bertschinger

This paper was inspired by an invited plenary lecture at the occasion of the Annual Spring Conference of the Korean Society for Horticultural Science (KSHS), May 22-25, 2019 at Gyeongsangbuk-do. The original contribution was supplemented to provide a comprehensive overview to include current challenges of horticulture as well as perspectives of horticultural research and role of the ISHS. The content reflects the personal view of the authors.

Abstract

Horticulture is the art and science of the culture of plants such as fruits, nuts, berries, vegetables, ornamentals and medicinal and aromatic plants for food, beauty, utility, comfort, health and therapy. The history of horticulture dates back more than 10,000 years. The contribution of horticultural production and the related value chain to economy is considerable and growing. Horticultural export values are increasing. Horticulture is critical to the health and quality of human life and society at large. It has gained particular recognition in recent years due to the positive effects of its commodities on balanced nutrition and human well-being. Horticultural production combats hidden hunger. Marketable fruits and vegetables contribute decisively to a healthy life and high quality living standard. Their sustainable production and successful marketing require highly specialised technologies managed by competent value chain actors. In the past, applied research often concentrated on individually defined problems, usually without taking a system view into account, and thus made possible problem solutions that led to impressive gains in plant production. But now holistic solutions are required, because in the globalized world the decisive importance of the complex relations of individual problems with their context has become increasingly evident and tangible. Solutions must be developed while involving stakeholders and keeping the entire value chain context in mind. Thematically, major goals must continue to address sustainability, and the resilience and agility of production systems while drastically increasing the efficient use and re-use of the ever more limited resource base. To reach these ambitious goals, transdisciplinary problem solving in multi-actor settings is needed, which requires appropriate practicable methodologies. These methods must be developed to enable researchers and directors to cope with the requirements of the systems-based approach. Our Society is a global network that promotes and encourages research and education for all branches of horticultural science. We facilitate cooperation and knowledge exchange. We advocate for the changes needed to achieve the sustainable development goals of the United Nations (SDG). The ISHS makes a positive contribution to the SDG.

Introduction

The word “horticulture” is the combination of two Latin words, *hortus* (garden) and *cultura* (culture). Horticulture is the art and science of the culture of plants such as fruits, nuts, berries, vegetables, ornamentals and medicinal and aromatic plants for food, beauty, utility, comfort, health and therapy.

The history of horticulture and that of agriculture have been closely linked for the past 10,000 years. Humans began as hunter-gatherers, scavenging, collecting, and hunting wild animals before initiating a revolution by shifting to agriculture (Janick, 2007). The emergence of agriculture occurred in seven to nine major centers, mainly in the river valleys of the Tigris-Euphrates, Indus and Nile, and in China, Mesoamerica, and East and

West Africa. The domestication of our major food crops (such as turnip, onion, carrot, lettuce, apple, pear, quince, banana, peach, citrus, and almonds from Asia; cabbage, cauliflower, and broccoli from the Mediterranean; corn, beans, tomato, cacao, squash, sweet potato, avocado, and potatoes from Mesoamerica) goes back to 3000 BCE (Von Baeyer, 2014). Grapevine is the first plant manipulated in 6000 to 4000 BCE. The writings of a tablet dating from the 7th century BCE in Babylon (Sumerian civilization) listed the vegetables and herbs of the gardens of Babylonian. Egyptians used technologies such as irrigation that were most probably invented by Sumerians, incorporating with a network of canals, dikes, sluices, and basins. A wide range of food (garlic, onion, radish, let-

tuce, parsley, beans and lentils, melons and gourds, dates, figs, grapes, and later pomegranate, olive, apple, peach and pear), herbs, spices and medicinal plants were cultivated by Egyptians. Also centers of horticultural development were found in South America (Aztec, Maya, and Inca) between 8000 and 2000 BCE, and in China and Japan at least until the 10th century. Greek civilization by 1600 BCE influenced the Romans (7th century BCE to 5th century CE) who inherited the knowledge of grafting, budding, and rotation with legumes (Von Baeyer, 2014).

Agriculture and horticulture continued to evolve jointly until the Middle Ages when horticulture became formally recognized as a discipline distinct from agriculture (Von Baeyer, 2014).

Recent production history of horticulture

Horticulture contributes to the health and quality of life. In particular, horticulture has gained more importance in recent years due to the recognition of health-related effects of horticultural products in our diet, and their importance for a healthy human nutrition and well-being. In addition, horticultural production is beneficial in combating hidden hunger (Grubben et al., 2014).

Horticultural crops require high professional skills and intensive care, and are considered high value crops. They deliver higher financial returns per production unit as compared to agricultural crops. Horticultural production has become particularly important for income generation and food production in developing and emerging economies. Horticultural crops are instrumental for development not only because of their high economic and nutritive value, but also, because they are important for small landholders in terms of their contribution to agricultural and economic diversification (USAID, 2005).

In the 1950s, comparatively more resources were assigned to the improvement of staple grains than to improving horticultural crops. Between 1960 and 2000, the land resources needed for horticultural crop production more than doubled worldwide (Weinberger and Lumpkin, 2005) and continue to increase. The contribution of the horticultural sector to economies being an important source of employment and provider of industrial raw materials is significant (Singh et al., 2015). Among fruits, nuts, berries, vegetables, ornamentals and medicinal and aromatic plants and other food crop sectors, the fruit and vegetable sector compares favourably for employment and income generation (Joosten et al., 2015). Therefore, fruits and vegetables are of priority importance on future directions and opportunities.

Global production trends of fruits and vegetables exhibit an increase, with Asia providing the highest proportion among all continents (Figure 1). Also with regard to per capita supply of vegetables, Asia takes the lead, while with fruits, America, Africa and Europe delivered more per capita (Figure 2).

Challenges and opportunities

Around 10.6% of world population is undernourished (FAO, IFAD, UNICEF, World Food Program, WHO, 2019). The majority (more than 256 million people) live in Africa.

The world population is projected to reach 9 billion by 2050, which will mean an increased food requirement of at least 70% (Marondedze et al., 2018). For 2100, the global population is projected to reach even more than 11.2 billion, increasing food demand enormously.

Horticulture plays an important, multi-faceted role in this context in industrialized as well as in developing countries. Horticulture may offer the best alternatives for increased food self-sufficiency, improved nutrition and ensuring the generation of increased incomes and employment (Irungu, 2011). Also, horticulture forms an integral part of food, nutritional security and poverty alleviation, and is an essential ingredient of economic security (Singh et al., 2015).

Horticulture is globally undergoing significant changes impacting production technology and priorities for research and development (Warrington, 2011). Selected aspects related with the important drivers of this change or with the need to respond to challenges for assuring a sustainable progress are addressed in the following sections.

Globalization and trade

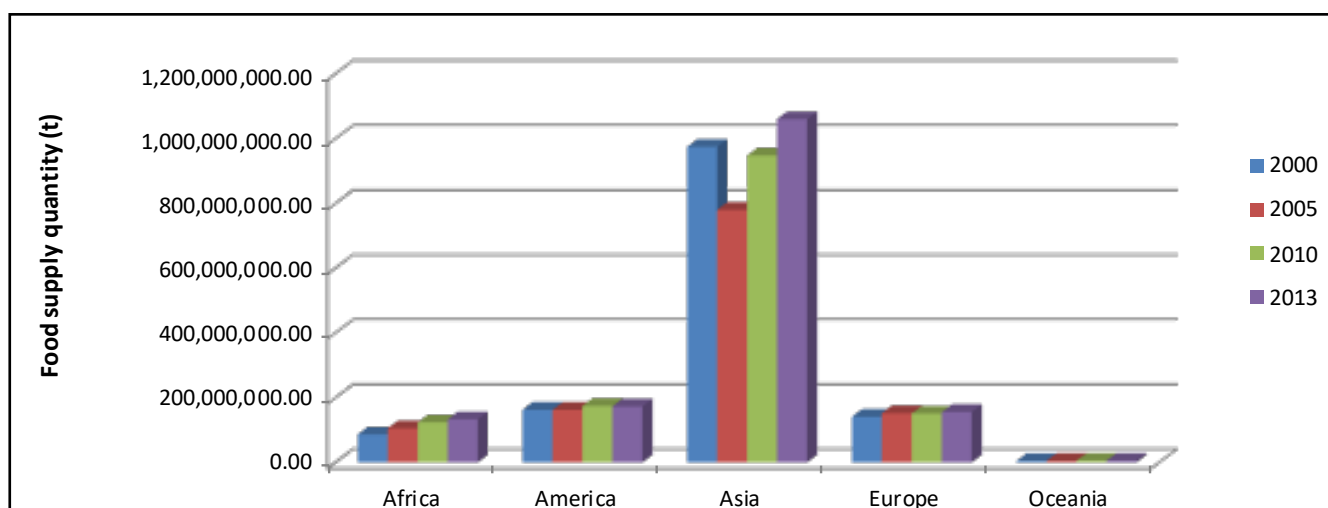
The globalization of societies and markets is represented by intensified trade. Export values of fruits and vegetables increase globally

(Figure 3) and horticultural products increase their share of the total agricultural product export value (see Figure 4 addressing selected countries in each continent).

Fresh fruit and vegetable marketing have undergone significant changes due to globalization and an increasing demand for safe and high quality products (Nicola and Fontana, 2010). Food supply chain demands change consequently in response to changing consumer preferences, a need for product diversity, progress in technologies from farm to fork, easy accessibility of markets and increased levels of international investment, resulting in globally changing wholesale and retail markets in delivering horticultural crop products to consumers year-round (Wu Huang, 2004). The global fruit and vegetable consumer expenditure dynamics changed by geography and will further change with a significantly increasing global share of Asia and Oceania in the future (Figure 5). Super- and hypermarkets began playing an important role in the marketing of horticultural products and have replaced small markets and/or fruit-veg sellers. International retailers have become known globally for their brand names buying power (Warrington, 2011). The marketing channel dynamics will further change, however, after the rising importance of hyper- and supermarkets in the recent past towards increasing shares of out-of-home and convenience channels in the future (Figure 6).

The concentration of the food supply power may continue at the same pace and drivers such as digitalization or changing consumer demands will further intensify or even reverse this concentration of buying and marketing power and provide new significant opportunities for local delivery and supply settings.

Horticulture has a particular role in the globalization context, due to its particularities



■ Figure 1. Vegetable and fruit supply from 2000 until 2013 (FAOSTAT, 2019).

in the societal global and local settings. Horticulture and its products play in these settings often a significant role in rural development, innovating production systems and contributing to a healthy, safe nutrition while also representing cultural values and identification.

Food demand and food waste

Coping with increasing food demand

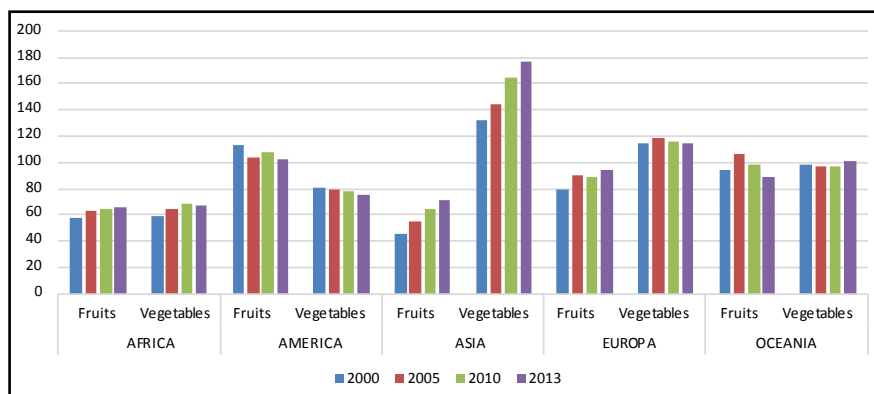
The increased food demand (see above) refers not only to an increasing global population but also to a changing diet. The global diet has changed due to demand differences as a result of shifting demographics (Warrington, 2011; De Clercq et al., 2018). Horticulture must play a significant role in responding to these demands. For instance, fruit intake (Figure 7) does not meet the World Health Organization (WHO) standards. This may relate to consumer trends that horticulture cannot influence. However, value chain actors have an opportunity to anticipate and/or respond to such trends with appropriate technology and communication to meet dietary targets and also capitalize on this challenge for their own benefit.

Avoiding food waste

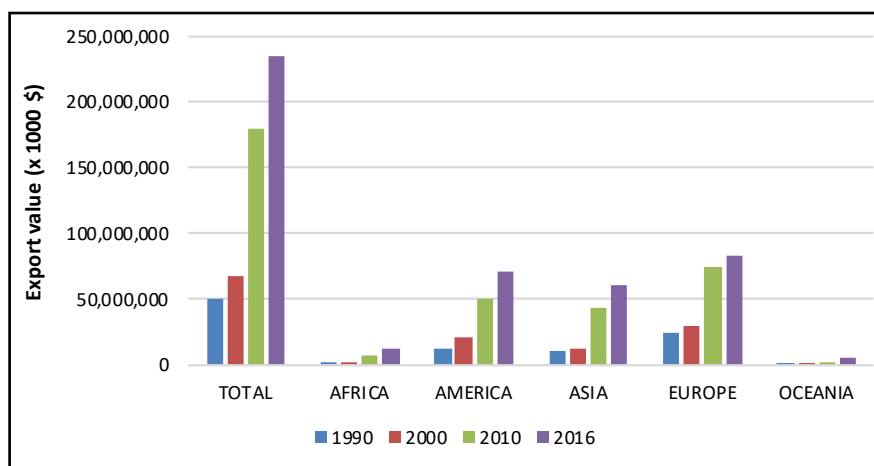
Food waste is a global phenomenon. About one third of the food produced in the world for human consumption every year (approx. 1.3 billion t) gets lost or wasted. Almost half of the fruit and vegetable production is wasted. This would be enough to feed 2 billion people. In industrialized countries, losses and waste value around \$680 billion per year, while in developing countries, around \$310 billion. With 45% of waste and loss, fruits and vegetables along with roots and tubers exhibit the highest amount of waste among any food products. In some continents, the horticultural production process accounts for the highest contribution to waste, while in others it is processing (FAO, 2019a). Food loss and waste can be utilized or avoided. This is a multifaceted challenge and must be fastidiously addressed for each setting. For instance, while some processes for waste utilization are used in developed countries, they may not be adopted easily in others due to economics. Cost effective technologies must be developed to convert waste into value added products (Garg, 2014). Waste contains good sources of potentially valuable bioactive compounds that could be used in different industries (Sagar et al., 2018). Also, practicable methods and made improvements in value chain management are needed to avoid waste.

Demand vs. waste

Meeting the increasing food demand and dietary change could be satisfied at least partially by avoiding and utilizing food waste.



■ Figure 2. Vegetable and fruit supply per capita (kg capita⁻¹ year⁻¹) from 2000 until 2013 (FAOSTAT, 2019).



■ Figure 3. Export value of fruits and vegetables in the world and different regions from 1990 until 2016 (FAOSTAT, 2019).

Also, by finding ways of avoiding food loss and waste, the pressure on horticulture to produce more as well as more efficiently could be alleviated. But realities are more complex. Loss and waste avoidance and reutilization are particularly challenging for fresh horticultural products in view of their particular role for health and well-being and the fact that waste and loss are a consequence of combined circumstances of the value chain. Therefore, a systems approach is needed to identify the key drivers of demand and waste in a particular value chain and to conceptualize and test solutions. Context specific targets must be defined and appropriate procedures and technologies be developed for addressing food demand, the production and market response, and food waste in a concerted way. The different drivers and effects at the value chain level as well as at the macro economical level must be balanced. Sustainable horticultural food systems would be the result.

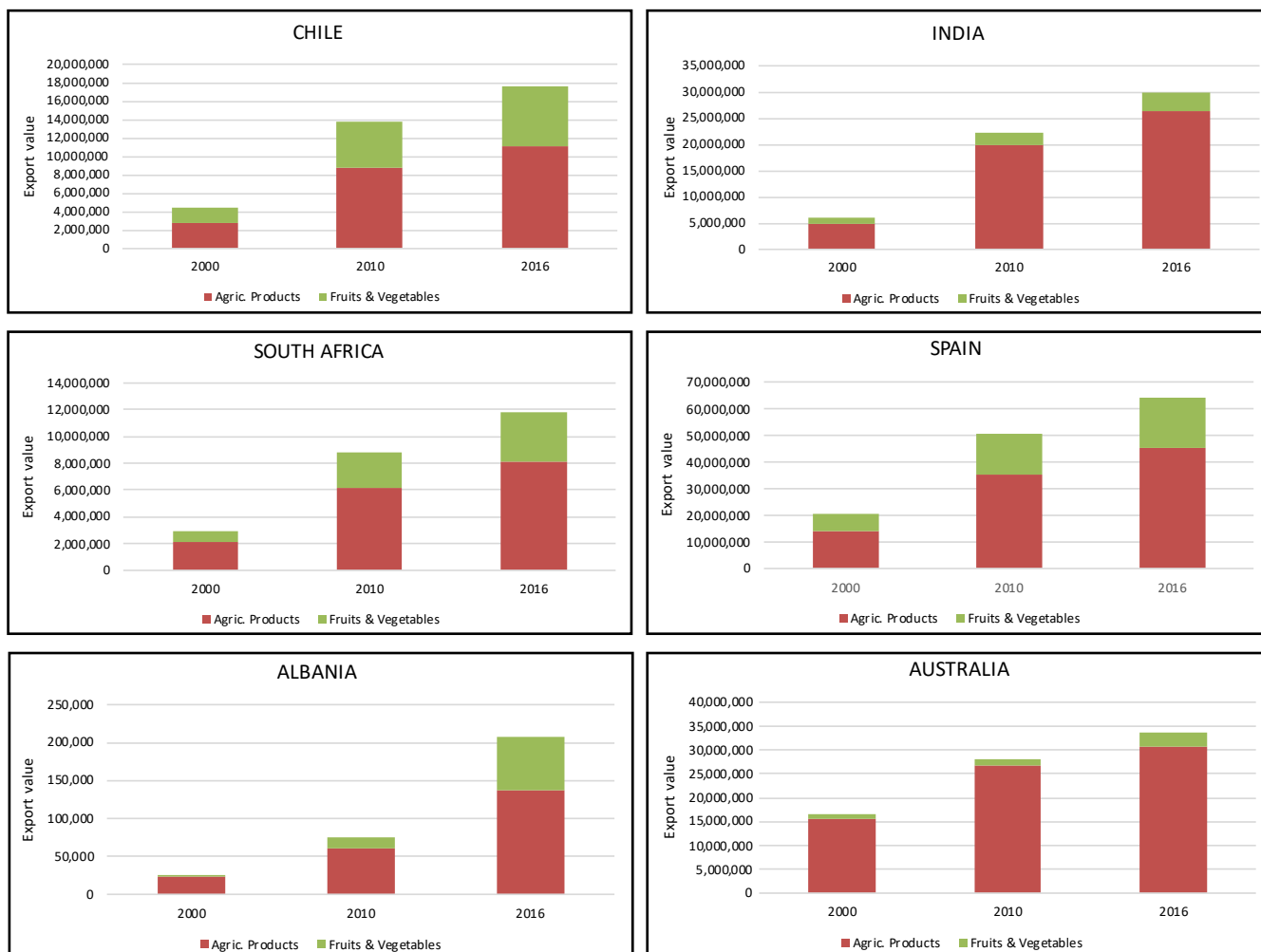
Need for a more efficient use of natural resources

Global material use will double to 190 billion t (from 92 billion) by 2060, with an increase of 110%. This will result in a reduction in

forests and habitats of over 10 and 20%, respectively, and an increase in greenhouse gas emissions of 43%. Rapid growth in extraction of materials is the main reason of climate change and biodiversity loss (Global Resources Outlook, 2019), deteriorating the resilience and long term productivity of agro- and horti-ecosystems.

As a consequence of this resource efficiency challenge, presently used horticultural land resources are globally under pressure. The availability of non-renewable resources used in horticulture, such as water, energy, mineral nitrogen, phosphorous, potassium, and other elements, is already becoming scarce while some of these can only be made available again with highly energy intensive industrial processes (e.g., nitrogen: Haber-Bosch Process).

Horticulture represents particularly intensive use of resources such as labor, water, energy and inputs namely fertilizers and pesticides, due to comparatively high production and process intensity. Land resources may be less pressured in horticulture as compared to agriculture due to a particularly high added value per acreage, but this cannot be generalized around the globe. As a result of the high production intensity, exces-



■ Figure 4. Share of export value of fruits and vegetables in agricultural products in different countries (×1000 \$) (FAOSTAT, 2019).

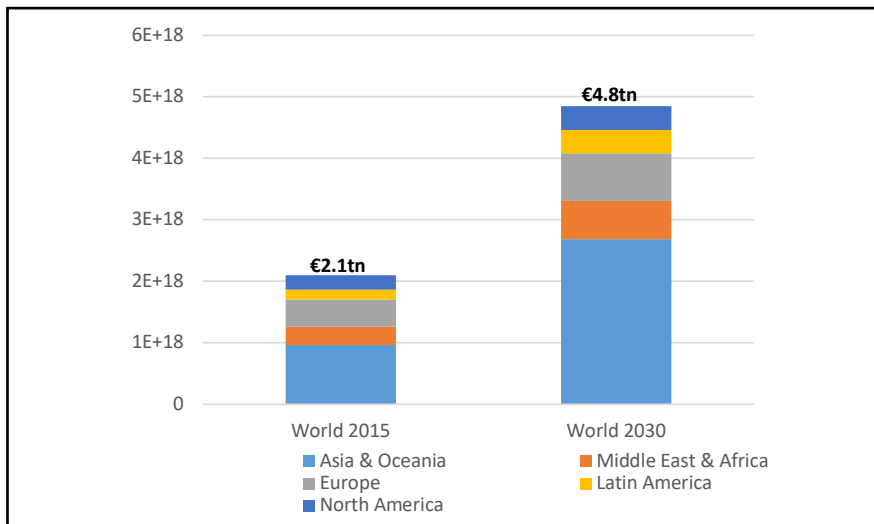
sive use of input resources may have a negative impact on the environment (Wainwright et al., 2014). Societies are increasingly sensitive to pesticide residue and resource inputs into the food system. These old production methods threaten the longterm image and productivity of the horticultural value chain. The increasing food demand and resource efficiency challenges translate into an explicit need of “more” (output) with “less” (input). Horticulture is in the spotlight when strategies and programmes are developed to reduce the dependence on non-renewable resources and negative impact on soils, water, air, organisms, and genomes. Innovative science-based solutions are needed.

Drastical reduction of the dependence on agrochemicals

Pesticides protect crops and their products from insects, mites and nematodes (pests), fungi, bacteria, viruses and viroids, micoplasm (plant pathogens) and weeds. The global cost/benefit of pesticide use (the amount of pesticide use in agriculture and horticulture to produce a certain amount of crop in a year, including insecticides, fungicides, bactericides and herbicides) increased by 22% from 1990 to 2007, and declined since

2007. Pesticide use per ha (total of all categories) developed alike (Zhang, 2018). However, an increased rate of 9% total pesticide use was still noted between 2007 and 2017 (FAO, 2019b). The global pesticide market is expected to further grow from \$75 billion in 2017, to \$90 billion by 2023 (Mathews, 2018). Pesticide use is distributed unevenly across the globe due to the material and labor cost and availability and due to pest/disease problems for specific climatic/geographic regions (Carvalho, 2017). Horticulture delivers many fresh, untransformed products to the food market. Their internal and external quality are at risk in function of the prevalent environmental condition and pressure from pests. Protected measures are needed to prevent rapid deterioration of fresh produce. Pesticides offer attractive opportunities. Although specific data is not available for global pesticide use in horticulture, studies on screening fresh fruit and vegetables for residues point to intensive pesticide use (Zorka and Serdar, 2009; Bakırcı et al., 2014). Besides the positive control measures, pesticides negatively affect human health, drinking water, the ecosystem, and biodiversity. Many reports indicate that occupational exposure to pes-

ticides has negative effects on human health (Tsimbiri et al., 2015). Modern horticulture has been proactive in reducing the risk due to marketable product quality. Public concern regarding pesticide use has risen sharply in recent years. A fundamental change of plant protection strategies and production systems are needed but they may go at the cost of profitability while a practicable path for transformation is less than clear. An increasing number of studies claim, however, that change is possible. For instance, data from 946 non-organic arable farms indicated that pesticide use could be reduced by 42% without any impact on productivity and profitability (Lechenet et al., 2017). Mineral fertilizer is widely used for plant nutrition. Fertilizer use increased by 25% between 2008 and 2018, up to more than 200.5 million t. Nitrogen, phosphate and potash use increased by 1.4, 2.2 and 2.6%, respectively, in 2018 (FAO, 2019c). Fruits and vegetables account for around 16% of world N+P+K consumption (Figure 8). With regard to N, P₂O₅ and K₂O, fruits and vegetables account for 13.5, 18.7 and 19.1% of the global consumption of these nutrients (IFA, 2017). Excessive use of fertilizers (over fertilization) causes serious environmental degradation



■ Figure 5. Modeling of fruit and vegetable marketing geography dynamics based on compound annual growth rate (CAGR) between 2015 and 2030 (Wyman, 2018).

and in particular, excessive N application increases the soil nitrate level excessively resulting in groundwater and environment pollution (Rahman and Zhang, 2018). Consequently, the use of biopesticides and biofertilizers started to increase in the last decade, gradually replacing mineral fertilizers and synthetic pesticides. These are nature identical materials derived from animals, plants, and living micro-organisms. Currently, biopesticides have still a small share of the pesticide market globally amounting \$3 billion but accounting for just 5% of the total crop protection market. An annual 10% increase has been estimated for the coming years (Damalas and Koutroubas, 2018). The global biofertilizer market was worth more than \$1.5 billion in 2018, growing at a compound annual

growth rate (CAGR) of around 10.1% during 2015-2025 (Mordor Intelligence, 2019).

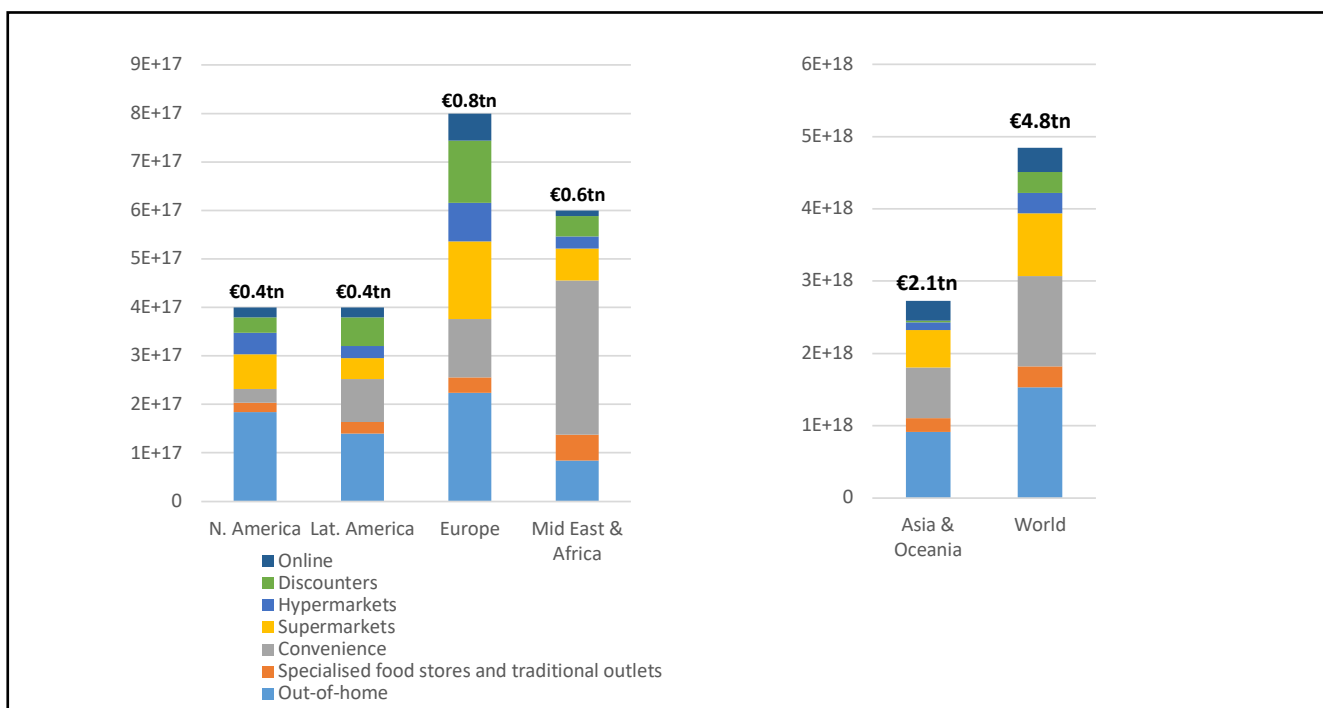
Food safety and sustainable consumption

Scandals triggered by food contaminated with detrimental microorganisms – some on horticultural crops – have led to a growing public concern with regard to food safety (Erickson, 2010; Hussain, 2016). This concern relates to risks for human health and for the environment and it promoted the development of a set of standards to improve production methods, to provide traceability, to control hazards resulting in certificated products and farms (GlobalGAP, ISO22000) and to improve supply chain transparency. Such programs are to ensure that the products are

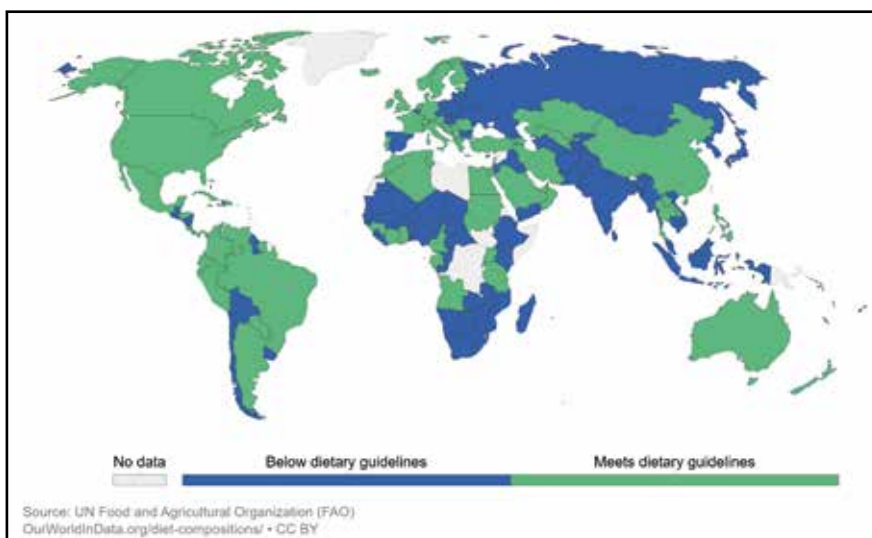
produced according to the standards needed. According to the figures of GlobalGAP, Germany, The Netherlands, Spain and Italy are the leading countries for fruit and vegetable certificate holders. Also, 68% of flower and ornamental certification resides in Germany, The Netherlands, and Italy. In 2018, the largest growth for GlobalGAP Integrated Farm Assurance for fruit and vegetables was recorded in Africa as 68% in non-covered and 46.5% covered crops (GlobalGAP, 2019). Given the particular position that horticultural products have for human health and nutrition, and given the growing damage potential unsafe food may have in an urbanized mobile and open society, affordable, practical procedures and methods that ensure the safety of horticultural products must be given top priority.

Soil fertility and biodiversity loss

Soil fertility is fundamental for a sustainable productivity of agriculture and horticulture. Soil is not only a source of nutrients and an anchoring matrix for plants, but plays an important role in regulating natural cycles impacting on nutrients, flora and fauna and water and in mitigating climate change. It is a complex system including living components that are destabilized and impoverished easily by unqualified crop management. Intensive industrialized horticulture must not be hazardous for soil fertility jeopardizing sustainable production. Appropriate innovative soil management concepts including crop rotations and care for soil organic matter are needed in intensive horticulture (ecological



■ Figure 6. Modeling of fruit and vegetable consumer expenditures (trillion Euro) by geography and channel based on compound annual growth rate (CAGR) between 2015 and 2030 (Wyman, 2018).



■ Figure 7. Average per capita fruit intake vs. minimum recommended guidelines, 2013 (blue: intake <200 g; green: intake >200 g; recommended per day intake reference of 200 g according to World Health Organization (WHO); average per capita fruit supply without correction for waste at the household level) (Ritchie and Roser, 2019).

intensification) to prevent soil fertility loss and jeopardising the multifunctional DNA of soil that qualifies for sustainable production. Production systems characterized by a high biodiversity are more resilient, have a better buffering capacity with regard to climate change incidents and may reduce pest and disease pressure due to an antagonistic microbiome and beneficial insects. For instance, apple production systems enriched with cover crops in the alleyways showed a positive effect on beneficial species and soil fertility (Webber, 2017). Furthermore, genetic diversity is an essential source for developing resilient varieties tolerant and/or resistant to biotic and/or abiotic stresses and/or with improved nutritional composition to adapt to climate change, to enhance food security and to sustain the production in marginal lands (Lutaladio et al., 2010). However, a dramatic loss of biodiversity has become evident globally (Díaz et al., 2019). Both elements of sustainable systems deserve particular attention in horticulture, since horticulture tends to be produced based on intensive systems, while crop management intensity is a major driver of soil fertility and biodiversity loss. There is a great opportunity for horticulture to develop and introduce innovation in production systems that do not endanger but strengthen both parameters.

The urban drive

Urbanization

About 68% of the population of the world will shift from rural to urban areas by 2050. More than half of the world's population will be living in urban areas within the next few years (United Nations, 2019a) (Figure 9). Urbanization may have several positive effects such as increased employment, modernization, easy accessibility. Some of these

effects may turn bad (e.g., loss of employment and increasing poverty). Urbanization is detrimental to the environment, resulting in an increased energy consumption and over population, which calls for the question how urbanization can be made more sustainable.

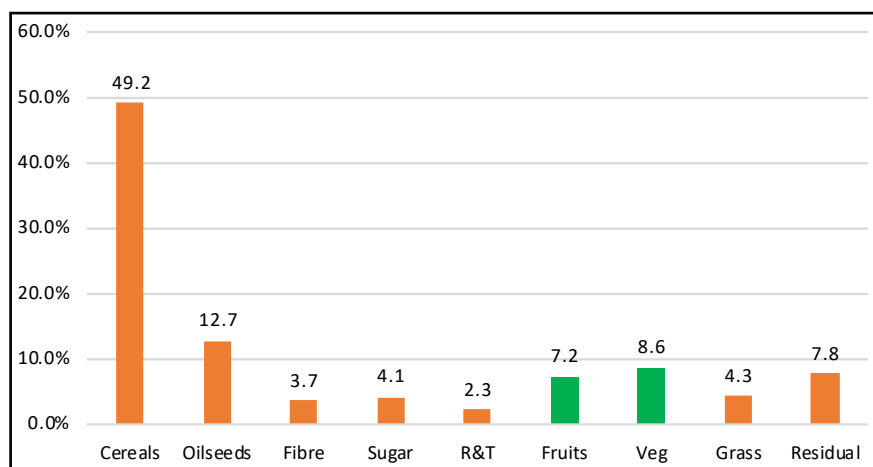
Greener cities

Opportunities arise in this context for horticulture. Horticulture can help to grow greener, more sustainable cities in the industrialized and developing world. Urban and peri-urban horticulture represent cultivating many crops within cities and in their surroundings including fruit, vegetables, roots, tubers and ornamental plants. In Cairo, city temperatures were reduced by 7°C where vegetables were produced on rooftops (FAO, 2010). Around 130 million urban residents in Africa and 230 million in Latin America engage in agriculture, mainly horticulture, for food production and income purposes

(FAO, 2015). In addition, horticulture is essential in greening business places and living zones in urban areas, contributing to people's well-being. Furthermore, local governments in Italy provide allotment gardens to senior citizens because of the socio-cultural and economic functions of gardening (Tei et al., 2010). Horticulture may also educate people through learning by doing and bridging the gap between urban business and rural agrifood production.

Dynamic convenience food market

The progressing global urbanization and related transformation from rural to urban and globalized societies changes food demands for quantity and quality. Modern societies request new types of food. Meat consumption has been increasing with urbanization. Industrialized societies consider it as an indicator of wealth and modern living standards. The modernization of big countries like China and India boosts total meat demand. Unfortunately, industrialized meat production is 3-4 times less resource efficient than plant protein production and contributes up to 40% of the climate change relevant greenhouse gases and carbon dioxide. Food system scenario studies, including dietary changes towards a more plant-based diet and other assumptions, show that the future world population can be fed while respecting the demands of sustainability (Muller et al., 2017; Poore and Nemecek, 2018; Springmann et al., 2018). However, it is hard to predict which societal values and perceptions related with meat production and consumption will globally and massively change to achieve the envisioned transformation even if this seems desirable and inevitable from a public health, climate change, resource efficiency and sustainability focused point of view (Willett et al., 2019). Such conflicts stimulate innovation to contribute to closing the gap between theory and practice. The increased demand for



■ Figure 8. Estimates of N+P+K used by different crop categories in selected countries (%) (2014-2014/15 Campaign) (IFA, 2017).

convenience product innovation to respond to changing urban life styles and consumer behaviours should enroll in this effort (e.g., rising demand for vegetarian dishes for fair trade and regional products). Horticulture can take a lead in this development because its products such as fruits, vegetables, aromatic plants relate ideally to a healthy nutrition, tastiness and convenience. Contributing to a healthy nutrition and taking a leadership role in developing and delivering more sustainable production technologies are in the DNA of horticulture.

The challenge of progressive climate change

Climate change is not new. However, the on-going change is globally challenging humanity with dramatic changes for food production. This is of particular concern for food demand and resource perspectives. Global air temperature is clearly and steadily increasing (Figure 10). Also CO₂ and other greenhouse gases (methane, nitrous oxide, chlorofluorocarbons) are rising. Changes in precipitation (intense floods or severe droughts varying from one region to another) and less fresh water availability are disconcerting for sustainable development (Rather et al., 2015). High temperatures increase evaporation and extend the duration of heat waves, impacting on plant growth, flowering and harvest (Dixon et al., 2014). Climate change also increases the spread and establishment of invasive species (IUCN, 2019). As with many other sectors of the global economies, horticulture is challenged. Crop productivity is reduced in some parts of the world, while in others, new horticultural production opportunities are opening. For instance, apple productivity has declined in lower elevations in India due to the lack of chilling requirement during winter (Singh,

2010). Jangra and Sharma (2013) reported that the increase in average temperature, long drought period in summer and less snow in winter time resulted in shifting to the cultivation of vegetables such as tomato and peas instead of apples in lower areas of Kullu and Mandi Districts (India) while apple production has moved to the higher altitudes with a yield increase of more than 50%. Many studies have demonstrated the significant anthropogenic contribution to climate change in the last decades. Industrialization and intensification of agriculture are at the origin of the actual change. Consequently, future horticulture must be able to reduce and mitigate negative effects of intensive horticulture on climate change as well as to adapt to the climate change challenge. Horticulture will contribute to the mitigation of and adaptation to climate change effects (e.g., by new, resistant varieties, an efficient water and nutrient management, plant architecture). For instance, grape, a temperate fruit, can be grown successfully in tropical

regions if changes in plant architecture and production system management are made (Malhotra, 2017). But climate change affects product quality. Productivity perspectives of horticultural crops must be more systematically examined to develop appropriate mitigation and adaptation response. The quality and productivity potential of a crop might be limited by climate change effects or expanded, offering new opportunities. Innovative and effective problem solutions may then be developed in a directed approach.

The opportunities of digitalization

Horticulture 4.0 is seen as revolutionizing production technology involving the use of sensors, robots, machines, and information technology for fostering a sustainable supply chain (De Clercq et al., 2018). Today the use of smart technologies can be a decisive element in enhancing horticultural crop productivity. For instance an irrigation set allowed for a dramatic yield increase from 50 to 300% by providing micro-irrigation

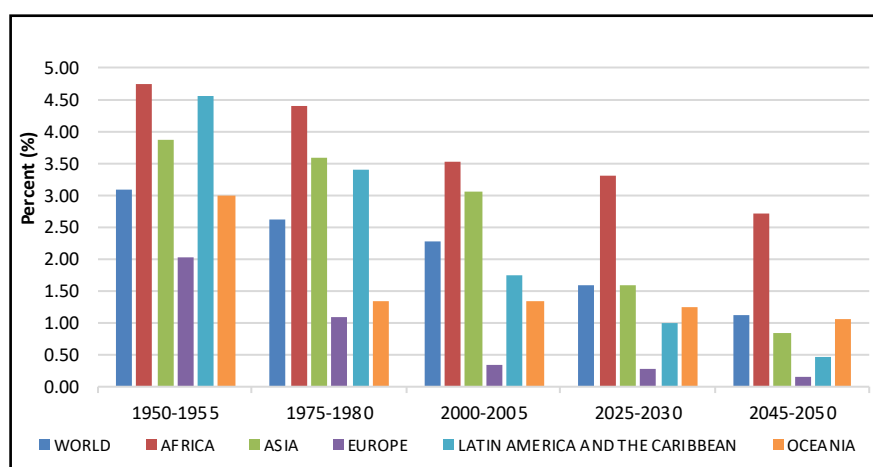


Figure 9. Average annual change rate of population living in urban areas by continent (United Nations, 2019a).

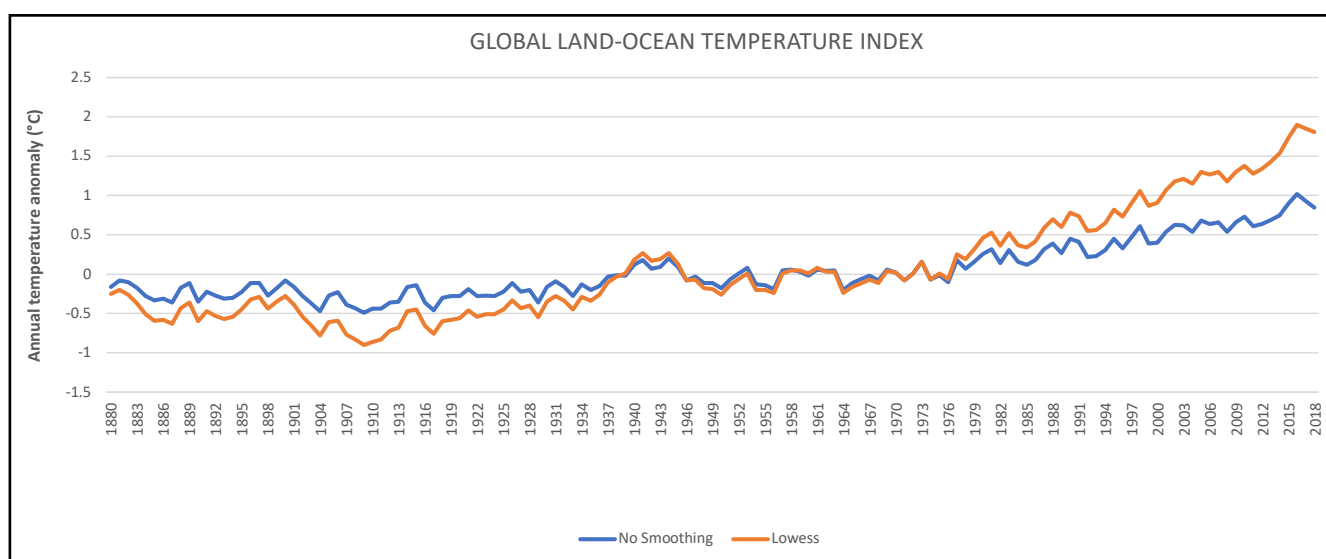


Figure 10. Increase in global air temperature between 1880 and 2016 (NASA, 2019).

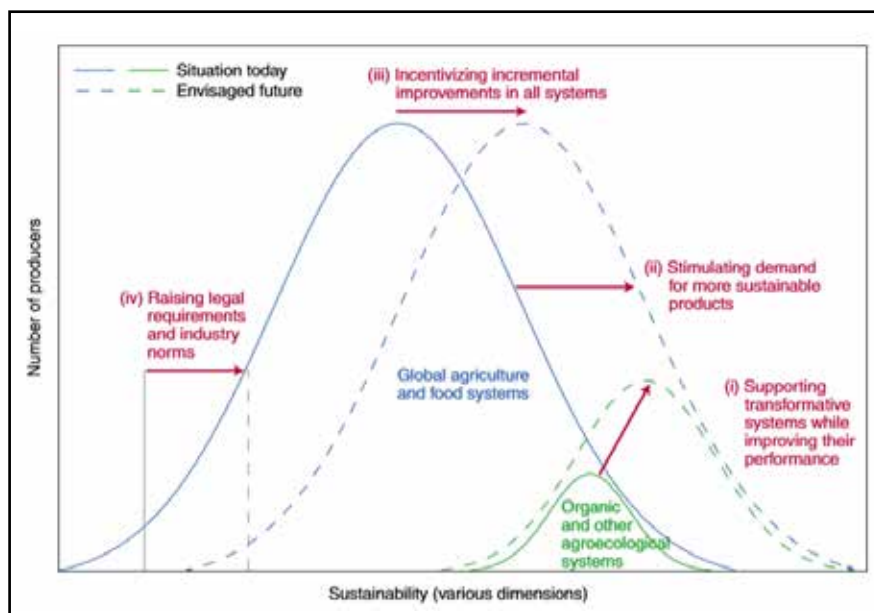
systems for local farmers. Different e-learning modules, web applications, mobile apps, and other tools encourage the introduction of smart horticulture (Roy et al., 2019).

Digitalization will increasingly play an important role in advancing the sustainability of horticultural production and processes. Precision horticulture, automation and robotics for different sections of the crop production chain have been developed for assessing seed germination (Ligterink and Hilhorst, 2017), transplant production (Sakaue, 1992), packing (Luna-Maldonado et al., 2012) and/or the sensor use for different purposes (i.e., climate sensors, soil moisture sensors, nutrition) (Sharma and Ashoka, 2015) and/or computer integrated systems in greenhouses and plant factories (Hashimoto, 1991). Machine learning and artificial intelligence will continue to create new opportunities for a more competitive, sustainable and resilient horticulture. This technology should be advantageous in solving some of the challenges mentioned above (e.g., mitigating climate change by reducing greenhouse gases, and reduce pesticide use).

Goals and the need for transformation

Modern plant breeding and new cultivation techniques have allowed for an impressive increase in productivity and contributed decisively to food security and market adapted food quality. However, our future approach to improve production methods must disruptively change to master the challenges mentioned above. To align forces and specify the goals to be achieved, the United Nations designed on the basis of the millennium development goals (MDGs) the sustainable development goals (SDG; see United Nations, 2019b), which came into force on 1 January 2016 for a period of 15 years. The 17 SDG are the heart of agenda 2030 for a sustainable development, which was approved by the United Nations on 25-27 September 2015, and is a plan of action for people, the planet and prosperity (United Nations, 2019c). The SDG apply to all nations and all sectors of society. Many of the SDG are highly relevant to horticulture.

To achieve these goals, knowledge gaps need to be filled and science-based practical problem solutions be developed. Even if many solutions for solving pressing production problems seem to exist, they may remain without any impact because they are not applicable in practice or have been developed disconnected from the stakeholders. They were not consolidated (e.g., economics) for meeting the requirements of the real world. They are possibly not sustained by the necessary transformative movement. Several initiatives have been



■ Figure 11. Policy interventions (red arrows) to drive sustainability in agriculture and food systems (Eyhorn et al., 2019).

launched at international and national levels (e.g., the sustainable development solutions network, SDSN) for fostering an interdisciplinary and transdisciplinary approach in developing and applying solutions for the pressing challenges. The latter is easier said than done.

How can we foster such an inclusive approach for a progress of agriculture and horticulture into a direction that responds to this challenge? ‘Agroecology’ is a scientific discipline since decades, but the word has in recent years been “re-labelled” becoming a synonym for a movement that represents the “integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic, and social. It’s transdisciplinary in that it values all forms of knowledge and experience in food system change.” (Gliessman, 2018). Agroecology is also discussed with particular regard to research and education in horticulture (Dussi, 2019). This will achieve sustainable agroecosystems better than former concepts, even if evidence is still formative. Horticulture with its high production intensity and specialization can be an ideal testing field for developing and applying inclusive methods that may be groundbreaking also for other food systems.

Which production system may allow for the progress needed, i.e., a progress towards resilient production systems that have the capacity of responding flexibly to unexpected hazards and to a changing context? Much has been discussed whether integrated production, organic farming or any other production system type may provide the suitable frame and guidance for orienting our thinking and action toward the overarching

goals. However, the discussion was exclusive while inclusion is needed. The policy intervention concept recently published (Eyhorn et al., 2019) could help to provide the necessary guidance in driving sustainability into the needed direction (Figure 11).

The role of horticultural research

Over the past 150 years science has been a driver of progress of modern societies, and in particular of agriculture and horticulture. Science-based research became an impactful tool to gain scientific understanding of problem contexts and for subsequent problem solving (Bertschinger and Weber, 2019). Such understanding is achieved by testing hypotheses and predictions, which are confirmed or rejected after thorough experimentation (scientific research) and empirical research based on direct or indirect observation and experience. Both types of research are equally important for solving a problem and create impact (Dejong et al., 2019).

The common approach in the past was to study a problem in a defined space and disciplinary context with science-based generally accepted methods. This was an efficient way for addressing distinct issues being part of a complex reality. It required specialized discipline specific expertise related to the addressed topic. Now, our needs go beyond this. In the next decade, science is expected to facilitate: 1) improving the efficiency of production systems, 2) increasing the sustainability and resource use efficiency, and 3) increasing the resilience of cultural systems in order to cover the demands of future societies (National Academies of Sciences, Engineering, and Medicine, 2019). Horticulture with its particular position in the

global and regional economies is confronted with complex challenges that can hardly be solved by using a conventional approach in addressing and solving isolated problems in a rational systematic process. We will need breakthroughs in research and development making use of an inter- and transdisciplinary approach for dynamically creating, delivering and applying the sustainable techniques and methods needed. Also, the relatively new discipline of citizen science could be a helpful research approach particularly for horticultural contexts, representing consumer-related values like health, nutrition and well-being. This could predestine horticulture to play a leading role for other cropping systems in developing problem solutions responding to pressing societal demands and challenges.

Scientific and empirical research (DeJong et al., 2019) must be the driver of a better understanding of horticultural realities and identify problem solutions and their feasible and affordable adaptation to specific contexts around the globe, and in driving sustainability in the direction needed (Figure 11).

The role of ISHS

Our Society, the ISHS, as a global, large network of scientists, scientific institutions and institutions related to horticulture, effectively facilitates cooperation and knowledge transfer in all branches of horticultural science. Meetings (i.e., symposia, workshops, and congresses), scientific networks, publications and other communication tools provide an ample platform to identify the needs of stakeholders (growers, industry, consumers) and share, exchange and transfer knowledge on horticulture and related problem solutions. ISHS organizes worldwide research and training capacities to strengthen their competences and foster an innovative, science-based spirit.

For this purpose, the ISHS must continue to take an active role in:

- increasing networking opportunities and connecting people,
- improving communication with members,
- developing efficient strategies to network with industry,
- continuing to link with international organizations, national societies, and

societies in horticulture related fields,

- encouraging higher participation and submissions to our meetings and publications,
- strengthening the regional relations,
- promoting and celebrating scientific discoveries and empirical advances made,
- in order to promote the further development and use of emerging technologies and systems and progress of horticulture.

The ISHS shall actively draw on the competences of its members and Divisions/Commissions, and both types of research, scientific and empirical (DeJong et al., 2019), equally required for facilitating the making of the needed breakthroughs. The ISHS must align with other societies and bodies in this effort and take an active role in addressing the UN Sustainable Development Goals (SDG) and communicating them to its stakeholders. It should outreach and make clear what horticultural research and horticulture achieve now and in the future and how ISHS supports its members in going along those lines. ●

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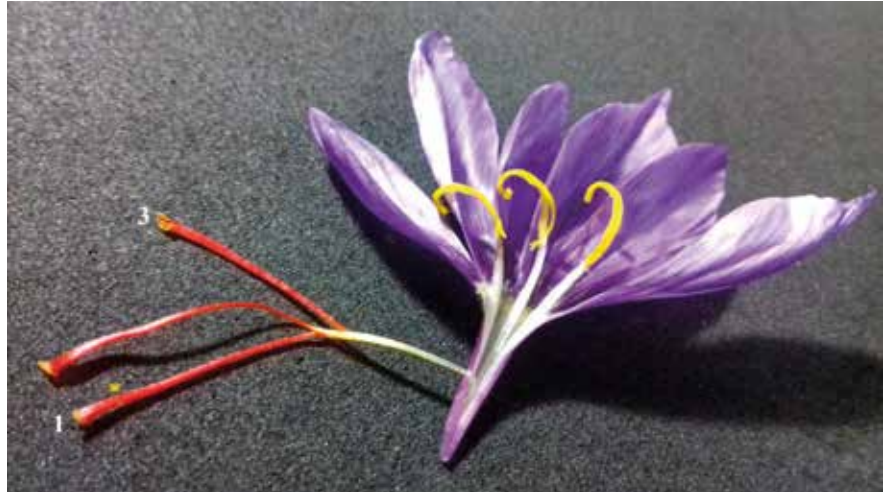
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Breaking the world record: a saffron flower with nine stigmata

Mahmoud A. Sharaf-Eldin

Saffron (*Crocus sativus* L.), a member of the *Iridaceae*, is an important multipurpose plant which is grown in many areas of the world primarily for its stigmata. This flowering plant is cultivated for the culinary and health industries. Saffron, one of the most lucrative spices, possesses many medically significant bioactive compounds. On a daily basis, people worldwide consume a large amount of saffron spice (estimated at 0.5 g d⁻¹ for a family within the Gulf States). Indeed, in the Gulf States cuisine, this red-gold spice is one of the main ingredients for flavouring (Arabic coffee and tea), colouring (rice and other dishes), as well as health and wellness. The saffron flower normally has six tepals, three stamens, and three (×3) stigmata per flower (Figure 1). Over six growing seasons in Alkharj, Kingdom of Saudi Arabia, Professor Mahmoud A. Sharaf-Eldin (member of ISHS since 2005, and elected Chair of ISHS Working Group Moringa) and his team at the Sara Alghonaim Research Chair (SRC), harvested flowers with an augmented number of stigmata per saffron flower. The SRC records were ×4, ×5, ×6, ×7, and ×8 stigmata per flower, which was previously reported (*Chronica Horticulturae* 59 (1), 26). In this past growing season (2019/2020), the SRC record was broken with the development of a plant with



■ Figure 1. Normal saffron flower with three stigmata per flower, harvested and photographed by Professor Mahmoud A. Sharaf-Eldin.

×9 stigmata per flower (Figure 2). Professor Sharaf-Eldin presents these exciting findings to help increase the world saffron yield (Figure 3), which is supporting the Vision-2030 of the Prince Sattam bin Abdulaziz University (PSAU); “A university that is distinguished in education, competitive in research in support of knowledge economy, and effective in partnerships and social responsibility”. ●

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■ Figure 2. Saffron ×9 stigmata per flower, harvested and photographed by Professor Mahmoud A. Sharaf-Eldin.



■ Figure 3. HE Professor Abdulaziz A. Alhamid, Rector, Prince Sattam bin Abdulaziz University (center), Dr. Abdulrahman I. Al-Khedhairi, Vice-Rector for Graduate Studies and Scientific Research (right), and Professor Mahmoud A. Sharaf-Eldin (left), showing saffron flowers with an augmented number of stigmata per flower.

> ISHS Young Minds Award winner summaries

Below is a selection of research summaries from winners of ISHS Young Minds Awards for best oral and poster presentations at ISHS symposia. To view other exciting research summaries by other winners, please visit www.ishs.org/young-minds-award.

Identification of candidate genes for quantitative downy mildew resistance in cucumber



> Jeroen A. Berg

Jeroen Berg is a plant scientist, with a research focus on the role of plant susceptibility genes (S-genes) in plant-pathogen interactions. He finished his BSc in Biology in 2011, and graduated *cum laude* with an MSc in Plant Biotechnology from Wageningen University, the Netherlands, in 2014. Subsequently, he started his PhD research on the topic of cucumber mildew resistance, at the Department of Plant Breed-

ing, Wageningen University and Research. Recently, he completed his PhD thesis, which he defended on 11 October 2019.

The aim of Jeroen's PhD thesis research was to identify genes involved in susceptibility and resistance to two of the most limiting diseases in cucumber production, which are downy mildew (DM), caused by the oomycete *Pseudoperonospora cubensis*, and powdery mildew (PM), caused by the fungi *Podosphaera xanthii* and *Golovinomyces orontii*.

Jeroen investigated *MLO* (*Mildew Locus O*) genes in cucumber, leading to the identification and functional characterization of a loss-of-function allele of the clade V *CsaMLO8* gene as causal for PM resistance in cucumber and the functional characterization of the two other clade V *MLO* genes in cucumber, *CsaMLO1* and *CsaMLO11*. He found that both are functional S-genes too, although they are rather weakly expressed in leaves, presumably leading to a minor role regarding PM susceptibility. In addition, Jeroen examined genes involved in DM resistance. Currently, the most often used source of DM resistance in cucumber is the Indian semi-wild accession PI 197088.

One major quantitative trait locus (QTL) from this resistant accession was introgressed in a uniform susceptible background to fine-map it. This QTL apparently consists of several sub-QTL, each explaining a different aspect of the resistance conferred by the full QTL. Through a combination of transcriptomics and whole genome sequencing, likely candidate genes for two of these subQTL were identified.

Combined, the results described increase our knowledge about the interactions between cucumber and two of its most notorious pathogens, and will facilitate cucumber resistance breeding.

Jeroen Berg won the ISHS Young Minds Award for the best oral presentation at the VI International Symposium on Cucurbits in Belgium in July 2019.

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Exploring chamberless healing for small-scale production of grafted tomato transplants



> Tian Gong

Tian Gong is a PhD student in the Horticultural Sciences Department at the University of Florida, USA. She completed her B.S. and M.S. at Fujian Agricultural and Forestry University in 2015. Her dissertation research

project is focused on categorizing tomato rootstock and scion interactions. The rootstock impacts on tomato scion's vegetative growth and reproductive development, especially fruit yield and quality, can be complex. A detailed understanding of rootstock-scion synergy and underlying mechanisms is needed to optimize the overall performance of grafted tomato plants. Besides giving a talk on her work of tomato rootstock-scion interaction assessment, Ms. Gong presented "Exploring chamberless healing for small-scale production of grafted tomato transplants" during a poster session at the II International Symposium on Vegetable Grafting. She demonstrated a novel procedure toward simplifying the graft healing management to benefit small-scale operations. Compared with the standard procedure where grafted plants are healed in an enclosed area under high humidity for the first few days after

grafting, the chamberless procedure did not decrease the graft survival rate and resulted in similar plant growth of grafted tomato seedlings. In addition, chamberless healing successfully prevented the emergence of adventitious roots around the graft union. Experiments are ongoing to refine this procedure using different tomato rootstock and scion combinations.

Tian Gong won the ISHS Young Minds Award for the best poster at the II International Symposium on Vegetable Grafting in USA in July 2019.

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Effect of different storage temperatures in flowering of *Polianthes tuberosa* L.



› Isabel Niebla López

Isabel Niebla López is a Master's Degree student in Floriculture Sciences at the Research Center for Assistance in Technology and Design of Jalisco State, A.C. (CIATEJ), Mexico. Currently, her research evaluates different forcing temperature treatments to control the flowering time of *Polianthes tuberosa*.

It is supported by SEP CONACYT CB-2015-01 project number 258866. The production of tuberose as a cut flower has great economic importance worldwide and it is carried out both in greenhouses and in open fields. Flowering control, a key trait for this crop, is influenced by forcing temperatures and growth regulators. Isabel evaluated the effects of different forcing temperatures (4, 12, and 27°C) applied for different weeks (4, 5, 6, and 7) on the following flowering parameters: days to flowering (DTF), length of flower stem (LFS), thickness of the flower stem (TS), length of the spike (LS) and number of flowers (NF) for *P. tuberosa* 'Double'. The bulb storage conditions affected the DTF; the treatment at 27°C for 7 weeks provided the early flowering while the storage at 12°C for 6 weeks caused late flowering. On the other hand, 4°C treatments weren't statistically different from the control (room temperature). Storage treatment at 27°C showed an earlier flowering compared to the control. Treatment at 12°C delayed the flowering and the 4°C treatment

was somewhat intermediate. The other flowering parameters were not affected by the storage conditions and the quality of the production was satisfactory. These results directly impact the production management of this crop because growers can control the flowering process without negative effects on the flower quality.

Isabel Niebla López won the ISHS Young Minds Award for the best oral presentation at the IX International Symposium on New Ornamental Crops in Mexico in September-October 2019.

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In vitro biological activity of metabolic extracts of wild and cultivated species of the genus *Polianthes*



› Evelyn Y. Garcia-Ochoa

Evelyn Y. Garcia-Ochoa graduated as Biotechnology Engineer from the Universidad Autónoma de Guadalajara, Mexico. She is currently a student of the Master's Degree in Floriculture Sciences at the Center for Research and Assistance in Technology and Design of the State of Jalisco, A.C. (CIATEJ), Mexico, where she collaborates on the project 258866 supported by SEP CONACYT CB-2015-01 for the genetic improvement and flowering in *Polianthes*, under the supervision of Dr. Ernesto Tapia. Tuberose (*Polianthes tuberosa*) is the most well-known species of the genus. The remain-

ing wild species have been little studied and might possess useful plant secondary metabolites (SM). As part of her thesis research, she extracted methanol from bulbs of cultivars and wild species of *Polianthes*, and related *Manfreda*, and *Prochnyanthes mexicana*. Her objective was to evaluate their in vitro antimicrobial activity against the Tuberose phytopathogens, *Dickeya dadantii* and *Pseudomonas aeruginosa*.

The bioassays were performed in vitro using disc diffusion (Kirby-Bauer method). The objective was to evaluate the percentage of inhibition of methanolic crude extracts with respect to antibiotic control. The tested extracts inhibited the growth of *P. aeruginosa*. The *Prochnyanthes* extract showed the greatest antibacterial activity, with 24±2.34% inhibition. *Prochnyanthes tuberosa* and *P. pringlei* also showed satisfactory results with values of 19.61±2.09% and 16.51±1.7%, at a concentration of 50 mg mL⁻¹. The extracts effective against *D. dadantii* were *P. pringlei* (PI = 21.8±2.39%), *Prochnyanthes* (PI = 15.5±0.86%) and *P. montana* (PI = 9±1.16%) at concentrations of 50 mg mL⁻¹, and *Manfreda* sp. (PI = 14.4±1.7%) at a concentration of 100 mg mL⁻¹. Evelyn's research showed that the methanolic extract of the *P. tuberosa* cultivar had bioactive activity only against *P. aeruginosa*, while the extract from *P. pringlei*

and *Prochnyanthes mexicana* showed the highest antibacterial activity. *Manfreda* sp. showed less inhibitory effect against either pathogen. She concluded that the differences in antibacterial activity of the crude extracts might be due to the nature and abundance of secondary metabolites accumulated in the bulb of the tested species. This study provided the basis for characterization of SM in bulbs of commercial cultivars and wild species from *Polianthes* with antibacterial activity. The candidates that produced the best extract from this testing would be: *P. pringlei*, *Prochnyanthes mexicana* and *P. tuberosa*.

Evelyn Y. Garcia-Ochoa won the ISHS Young Minds Award for the best poster at the IX International Symposium on New Ornamental Crops in Mexico in September-October 2019.

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Application of organic photo-voltaic films on fruit trees: a proof of concept for a self-sustainable orchard



> Gianmarco Bortolotti

Gianmarco Bortolotti is a PhD student at the Department of Agricultural and Food Sciences of the University of Bologna, Italy. He participated in the International Symposium on Precision Management of Orchards and Vineyards, presenting innovative system integration of fruit trees and energy co-production.

The study determined that more than 50% of the hail-net surface of an orchard can be covered by organic photovoltaic (OPV) films without decreasing plant performance. This was the initial concept of his research within the ecophysiology group led by Professor Luca Corelli Grappadelli.

Gianmarco also examined the physiological/efficiency aspects of innovative orchard designs, precision orchard management (POM) techniques, and new technology applications. Among these three main topics he is actively participating in the development of a multifunctional hail-net solution (MHS) – photovoltaic with protection from hail, insects, rain – where the main aim is to take advantage of the electrical production for supporting the energy consumption needed for the fruit growth process. Moreover, within the MHS trial, Gianmarco is involved in the development of a totally automated irrigation system driven by plant-based sensors. He is evaluating a “dynamic” cultural

coefficient based on the microclimate/physiological status of the tree induced by the innovative hail-net solution.

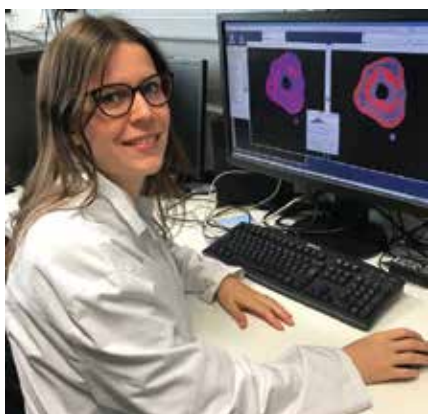
Gianmarco has a multi-disciplinary project combining automation, sensors, and other innovative technologies on 2D multi-axe training systems. The aim is to quantify the advantages/disadvantages of these technologies compared to traditional 3D training systems.

Gianmarco Bortolotti won the ISHS Young Minds Award for the best oral presentation at the International Symposium on Precision Management of Orchards and Vineyards in Italy in October 2019.

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Combining flow-MRI and modeling approach to assess sap flux in tomato plant architecture in response to water deficit



> Jeanne Simon

Variations of tomato fruit weight and composition throughout the cycle of production make the management of fruit yield and quality complex. These variations are linked to the fluctuation of water and carbon available for fruit growth and depend on the genotype and environmental conditions. Some structural functional plant models can predict the concentration of water and carbon in the plant architecture and the consequences on fruit growth. Obtaining

measures of sap fluxes in situ is difficult. Evaluating and validating these models to understand fruit growth relations in a fluctuating environment is our goal. For that, many techniques exist but only a few non-invasive approaches are feasible. Nuclear magnetic resonance imaging (MRI) is a direct and non-invasive method that allows the study of plant water status and sap transport in large potted plants. The objective of my work is to estimate the anatomical and functional properties of the conductive tissues and to quantify the sap fluxes at different levels of the tomato plant architecture, using a combination of approaches: MRI, histological observations, and plant modeling. We perform MRI experiments on an Agilent scanner working at 9.4T using inflow and outflow sensitive spin echo pulse sequences. We use a novel flow-MRI method, taking advantage of inflow slice sensitivity, called the flip-flop method, to measure the water fluxes at different plant levels in response to water deficit. Histological measurements are used to identify the nature of the conductive tissues in which we measure fluxes with MRI. This technique allows us to quantify the surface

of conductive tissues, depending on the environment or on the genotype, at the pedicel and stem levels. Then, the measurements found with these two techniques are compared to the predictions of a structural functional tomato plant model. The combination of techniques and the confrontation with the model predictions allow us to obtain quantitative data at the vessel level to improve model predictions.

Jeanne Simon won the ISHS Young Minds Award for the best oral presentation at the XI International Workshop on Sap Flow in Finland in October 2019.

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The role of plant water status on source water uptake



> Magali F. Nehemy

All terrestrial plants transpire water, but where exactly does that water come from within the soil? This seemingly simple research question has been the subject of studies for many years. Stable isotopes of oxygen and hydrogen “tracers” have proven useful for shedding light on patterns of plant water use. However, the use of such tracers alone limits our understanding of patterns of source uptake and the mechanisms behind tracer observations. To go beyond this black

box approach, we integrated measurements of stable isotope composition in xylem and soil water. We measured tree water status, fine root distribution, and soil matric potential, to investigate the mechanism(s) driving soil water source partitioning. We used a large soil column planted with a small willow tree (*Salix viminalis*) to conduct a high-resolution experiment on the campus of the École Polytechnique Fédérale de Lausanne in Switzerland. By carefully monitoring tree and soil conditions and controlling moisture regimes, our experiment showed that patterns of tree water use were driven by the tree’s water status, and not by patterns of fine root distribution. The proportions of water taken up by roots across different depths in the soil profile and held under different tension within the soil matrix was regulated by plant hydraulic response to changing atmospheric demand and soil water availability. Source water partitioning followed patterns of soil water availability during periods of tree water deficit. In the absence of a water deficit, tree water uptake was proportional across all available soil sources. Contrary to steady-state assumptions in previous

tree water source investigations, the willow showed a dynamic water uptake driven by tree water deficit. Our results also indicated that tree water deficit is a more integrative measure of plant water status when compared to sap flow rates. Sap flow rates only showed response to atmospheric demands, without any indication of water stress. Our findings suggest a new research focus for future plant water investigations. Tree water status needs to be incorporated with tracer observations to provide a clearer understanding of plant water uptake patterns.

Magali F. Nehemy won the ISHS Young Minds Award for the best poster at the XI International Workshop on Sap Flow in Finland in October 2019.

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Temporary immersion systems for the production of *Moringa oleifera* tissues and metabolites



> Elmien Coetser

Elmien Coetser is an MSc (Agric) Horticulture student at the Department of Plant and Soil Sciences under her main supervisor, Professor Elsa S. du Toit from the University of Pretoria, South Africa, and co-supervisor, Professor Gerhard Prinsloo from the University of South Africa. She completed her degree in BSc (Agric) Plant Production and Soil Sciences at the University of Pretoria. Her current research involves tissue culture of *Moringa oleifera* using two different methods; con-

ventional solidified medium method and temporary immersion bioreactors. *M. oleifera* is a valuable medicinal plant, but highly variable in genetic make-up. This tree produces a range of biologically active compounds, some of which may not have been clearly identified or understood, and thus has the potential for the discovery of new drugs. Tissue culture methods provide a controlled environment where plant tissues can be produced in sterile conditions, reducing contaminants and variability within a plant product. Temporary immersion systems are in vitro systems that, instead of using solidified nutrient media, use liquid nutrient media in which explants are immersed for set periods. Research has shown that these temporary immersion systems may be more beneficial to plant health and increase production of secondary metabolites, compared to conventional methods. These tissue culture methods were compared for the clonal production of moringa seedling material and metabolomic analyses have been conducted with the use of H^1 NMR-based metabolomics. It was found that a pre-culturing phase allows the explants to establish some growth before moving onto shooting media. This pre-culturing phase increases survival rate of explants

in bioreactors and also serves as a “screening” phase to reduce risk of contamination. During the shooting phase explants were either planted individually onto a solidified medium in GA-7 vessels or in groups of ten in bioreactors. After several weeks of shoot growth, explants were harvested, measured for growth and analysed with H^1 NMR metabolomics to determine the difference between these two tissue culture methods. Elmien has finished her experiments and is currently busy analysing the data and writing her Master’s thesis.

Elmien Coetser won the ISHS Young Minds Award for the best oral presentation at the II International Symposium on Moringa in South Africa in November 2019.

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The world of Horticulture

> Horticulture in South Africa

Karin Hannweg

The diversity of South African horticulture

South Africa is the southernmost country on the continent of Africa. Its neighbours include Eswatini and Mozambique to the east, Zimbabwe, Botswana and Namibia to the north, whilst Lesotho is land-locked within South Africa. The country's climate is influenced by the Indian Ocean to the east and south; and the Atlantic Ocean to the west. These ocean influences, together with altitudes ranging from sea level to over 3450 m, ensure that the country is well-positioned for the cultivation of a wide range of horticultural products, owing to the diversity of available microclimates.

South Africa's diverse weather and climatic conditions (from subtropical to Mediterranean to semi-desert), soil types and farming practices (which include protected cultivation) enable the country to cultivate and produce a wide variety of horticultural products – even though only 12% of the available land is arable and suitable for crop production (Goldblatt, 2010). Although agriculture as an industry only contributes approximately 3% to the gross domestic product (GDP), primary agriculture is an important sector in South Africa. Its contribution to the GDP for 2017 was estimated at R277.6 billion¹ with horticultural products contributing R75 billion², or 27% of South Africa's agricultural production (DAFF, 2018). This was facilitated by increased exports of oranges, grapes, wine, maize, apples, lemons, mandarins and pears, amongst others. While the major markets for horticultural products include the United Kingdom and the European Union, markets in the Middle East, Asia and the US are becoming more important as demand



> South Africa's diverse eco-climatic zones facilitate the cultivation of an incredible diversity of horticultural crops. Photos: top left: E. Louw; remainder: K. Hannweg.

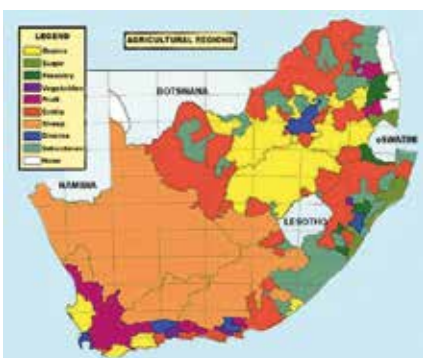
from middle income consumers in developed countries increases. This is particularly true for 'new' products such as innovative wines, indigenous rooibos and honeybush teas as well as subtropical fruits and tree nuts. Agricultural research and development is critical for growth, especially considering that a relatively small proportion of land in South Africa is prime agricultural land. Both the private sector and government play an active role in horticultural research and development, and most of the major commodity organisations contribute towards research programmes that address challenges within the industries. Close interactions between industry, the market and research organisations, including tertiary education institutions, result in the development of new and alternative technologies in cultivation practices to ensure market competitiveness, despite the disadvantages of limited natural resources.

The increasing effects of climate change (declining water resources due to drought, marginal lands and soil degradation, high

temperatures, etc.) have a direct impact on natural resource availability and crop productivity. Research focusing on diverse disciplines covering all aspects of horticultural crop production, including plant breeding and improvement, biotechnology, crop manipulation, postharvest storage methods, agro-processing and product development, crop protection (including integrated pest management), soil fertility and productivity as well as modelling and forecasting, are all geared towards adaptability to the increasing impact of biotic and abiotic stressors on crops.

The challenge of economic development and food security

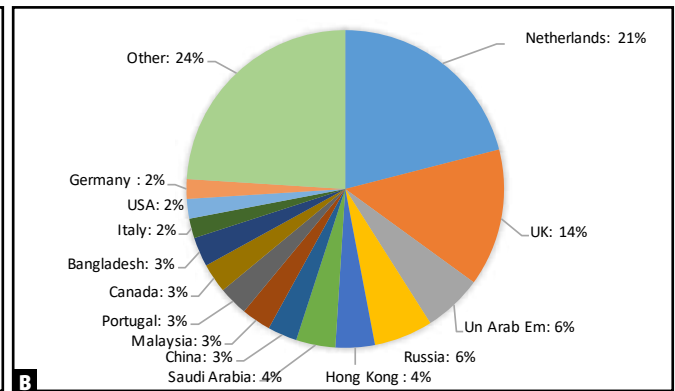
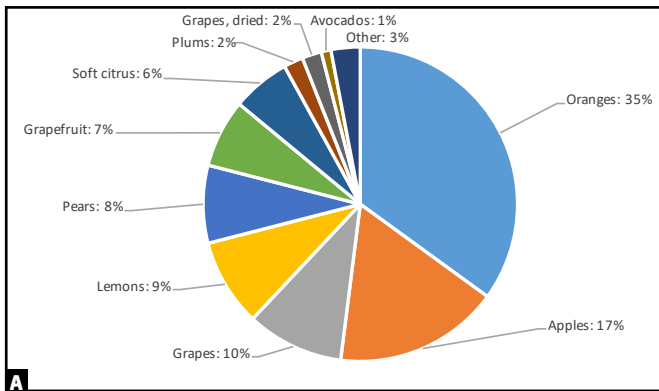
As the world's population continues to grow, more food will be required to feed an estimated 9 billion people by 2050. Although South Africa is one of the most food secure countries in Africa, almost 7 million South Africans are food and nutrition insecure and for whom household food security is an enormous challenge, particularly in resource-poor



> The most important agricultural regions in South Africa. Source: Goldblatt (2010).

¹18.8 billion Euro or 22.6 billion USD (calculated at December 2017 exchange rate).

²5.1 billion Euro or 6.1 billion USD (calculated at December 2017 exchange rate).



➤ A. The largest fresh fruit commodities exported from South Africa in 2017 include oranges, apples, grapes, lemons and pears followed by a variety of other fruits. Source: freshplaza.com. B. Countries to which fresh fruit produced in South Africa was exported, showing the most important markets, which include the Netherlands (EU), UK and UAE, followed by emerging Middle-East and Asian markets. Source: freshplaza.com.

communities (Stats SA, 2019). The South African government aims to accelerate economic development to reduce poverty and food insecurity. As such, one of its strategic objectives is increasing agricultural productivity, coupled with sustaining, and sustainable, high agricultural growth rates, which will, in turn, be pivotal in the supply and availability of food in the future. The impact of land reform in horticulture is also significant and governmental policies and research agendas have a strong focus on supporting emerging farmers. Without doubt, there is enormous potential for the economic development of these farmers. However, their current entrepreneurial skills and technical knowledge of producing horticultural products is limited. Relatively recent efforts have focussed on capacitating this sector, resulting in a fairly sizable increase in the number of agri-businesses involved in crop cultivation and agro-processing/value-adding initiatives. Such initiatives, including technology incubators, agripark development, and training and skills development programmes, are rapidly facilitating farmer development.



➤ Theewaterskloof Dam in the Western Cape is a major supplier of water to the Cape Town metropole and surrounding areas which include vast tracts of cultivated lands. Decreasing rainfall in the catchment area has resulted in serious consequences for water usage by consumers including agriculture. Source: www.ewn.co.za.

Harnessing South Africa's rich indigenous plant genetic resources

Apart from a rich history of conventional horticultural crop cultivation, South Africa is blessed with its incredible diversity of indigenous flora, numbering almost 20,000 species, as well as indigenous knowledge (van Wyk and Gericke, 2000). Horticultural research on South Africa's indigenous plant genetic resources has developed by leaps and bounds over the last decades and indigenous plant species with enormous commercial potential for the fresh and processed product markets continue to be identified and investigated. Export products derived from three of the most well-known species include Amarula liqueur

(produced from the fruit of the marula tree, *Sclerocarya birrea*) and the rooibos and honeybush teas. It must also not be forgotten that many of the world's most popular cut flowers such as gerbera, gladiolus, freesia, watsonia, ornithogalum, zantedeschia and protea, to name just a few, are derived from South African indigenous species. Many more species and hybrids of several other genera are also of interest to breeders across the world (Reinten et al., 2011).

The future – developing the new crop of horticultural scientists

In South Africa, there are serious skills shortages throughout the horticulture subsector. Most notable are the gaps in highly skilled



A



B



C



D

➤ Household planting in the relatively poor regions of the Eastern Cape Province of South Africa plays an enormous role in reducing food insecurity. B. Intercropping fruit trees with vegetables ensures cash flow and sustainable income in rural areas of South Africa. C. Smallholder farmers receiving training on banana cultivation. D. Community members undergoing training in jam and marmalade making using fruit sourced from local growers within their village. Photo: R. du Preez.



› School pupils receiving career information in the field of horticultural crop protection and plant propagation. Photos: K. Hannweg.

horticulturists across all disciplines, where there is little interest in entering post-school education programmes in the field of horticultural science. Potential students either aren't aware of horticultural science and its diversity, or the science is not seen as "cool" or wealth-generating, or interested school-leavers do not obtain suitable grades to pursue further studies. Further, inexperienced graduates also struggle to find place-

ment within the diverse horticultural science environment. There are, however, a number of interventions that have been put in place to assist both school-goers and graduates. Tertiary horticultural science education is spread throughout South Africa across several universities offering undergraduate and postgraduate degree programmes, as well as universities of technology, which have a variety of undergraduate and postgraduate diploma programmes. Several training organisations also offer learnerships and/or short courses in horticulture. With the diversity of horticultural industries and enterprises in South Africa, horticultural science graduates in South Africa obtain employment at research institutions, tertiary education institutions or within the government and private sectors, respectively. Many successful graduates have made an enormous impact on the industries they serve, be it governmental or non-governmental, and this has provided the impetus for future development and growth of the South African horticultural sector.

multitude of other horticultural crops, which include tree nuts (primarily macadamia and pecan), minor fruit crops, vegetables, cotton, tea, herbal teas, coffee and ornamental and flower crops. These industries are well-supported by world-class horticultural research focussing not only on academic understanding of processes and systems, but also on the development of practical solutions developed by a thriving body of horticultural scientists, ensuring that the sector remains globally competitive. This article seeks to provide a snapshot of the country's horticulture and horticultural science, and future articles will showcase the variety of vibrant horticultural industries South Africa has to offer. ●



› The King Protea (*Protea cynaroides*), South Africa's national flower, is cultivated for its use in the cut flower industry. Photo: M. Schaffner.

Conclusion

The expansion of the South African horticulture sector is export-driven and is underpinned by increased exports of high quality products to both existing and new markets. While the country is known globally as a producer and exporter of citrus, deciduous and subtropical fruits, it also produces a



› Karin Hannweg

› About the author

Dr. Karin Hannweg is a Senior Researcher at South Africa's Agricultural Research Council-Tropical and Subtropical Crops campus based in Nelspruit, South Africa. She is a horticultural scientist whose main interests include the use of a variety of biotechnological tools for subtropical crop and indigenous plant improvement and propagation. E-mail: karin@arc.agric.za

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> Panorama of French horticulture

Marie-Agnès Oberti, Claude Chailan and Françoise Brugière



France is honored to host the 31st International Horticultural Congress (IHC) in August 2022. This is a great event to take place at Angers in the Loire Valley. The organizing committee is aiming for a high-level scientific event that will encourage collaboration as well as the three way connection between research, education, and industry. The IHC2022 is the best opportunity to enhance exchanges on science, knowledge and culture between southern and northern countries.

Over one week, IHC2022 will gather more than 3,000 participants. The backbone of the congress is the series of plenary sessions and about 25 symposia. Workshops, business meetings, side events, student job dating, etc. will in addition allow participants to meet, connect, discuss and debate around a central motto: "HORTICULTURE FOR A WORLD IN TRANSITION". IHC2022 will indeed address major topics and issues related to Horticulture around four main priorities:

- Competitiveness and skills for the horticultural sectors,
- Food, health and well-being,

- Sustainability of production systems,
- Adaptation to climate hazards and mitigation solutions.

This world-class congress is a unique opportunity to discover the city of Angers and its area through a week-long rich program of social events, and also the Loire Valley, Brittany and so many French regions after the congress through various professional and touristic tours, in order to enjoy some pieces of the French "Art de vivre", made of rich cultural heritage and creative cuisine. A series of articles specially designed for *Chronica Horticulturae* will set up an overview and highlight some specificities of horticulture in France¹ from this issue until August 2022. An editorial team including Agnes Grapin and Jean-Claude Mauget (Agro-Campus Ouest Angers), Jean-Luc Regnard (Montpellier SupAgro), and Rémi Kahane (CIRAD Montpellier) is dedicated to finding contributors among scientists and professionals to give a taste of the French realities, specialties, challenges and research in horticulture, in the European and international context. Just a way to attract you to Angers on 14-20 August 2022!

Diversity of horticultural production in metropolitan² France

France offers a great diversity of territory and landscapes that correspond to a wide range of micro-climatic situations. These production areas are associated with equally diverse sociocultural traditions and practices concerning food, healthy consumption, and well-being (Figure 1). As a result, in the sectors that make up Horticulture³, the range of French production and products resulting from their transformation is extremely diverse. By juxtaposing fruit and vegetables, ornamental and nursery crops, plants for essential oils, and herbal, medicinal and aromatic plants (HMAP), the number of plants cultivated or harvested is estimated at more than 20,000. French plant diversity includes specific territories and origins that command value added benefit for fruit and vegetable product chains (Figure 2).

Agronomically speaking, the cropping systems are diverse. They include an intensive soilless system in greenhouses, which allows a finely tuned control of environmental conditions (vegetables, flowers), mechanized

industrial cropping (plants for essential oils, vegetables for processing), "market gardening" (vegetables for direct sale, aromatic plants and herbs), fruit cropping systems, and nurseries. Most of these sectors are labor intensive. Further downstream, even if one considers only the first postharvest processing that is sometimes carried out by producers themselves (e.g., drying herbs, distilling aromatic plants), the technical operations are also diverse, to cover the multiplicity of commercial outlets. These operations mobilize specific materials and knowledge bases.

Presentation of the different sectors

Considering the above-mentioned diversity in a value chain approach that constitutes the core business of FranceAgriMer, three groups of production with several main characteristics have been distinguished (Table 1).

Issues and challenges

In the 1960s and 1970s, the large number of crop production and the heterogeneity of farms could be perceived as indicators of delayed French agriculture and its difficulty

to adapt to modernity. However, this perception has greatly changed. Diversity is nowadays regarded as an essential condition that enables the adaptation of agricultural and horticultural farms to market constraints and societal expectations.

In the context of urban sprawl, which induces a quest for naturalness, horticultural productions of the three different sectors convey very positive values for health and well-being, and resilience to climate change. Beyond the maintenance of local markets with fresh products, horticulture for landscaping and leisure is perceived to play a key role, for example by limiting urban heat island effects and greening urban spaces.

The downstream industry has made no mistake, when referring to the potential benefits of horticultural produce crossing all sectors: healthy food ("eat five fruits and vegetables each day"), health food supplements extracted from plants (booming of nutraceuticals), plant natural cosmetics, alternative medicines based on plants, etc. With a slight delay, produce from ornamental horticulture are more and more appreciated for their "well-being" effects besides their decorative interest/function.

¹Metropolitan and overseas departments including French West Indies, Mayotte and Reunion islands.

²The data presented in this article do not include French overseas territories and departments. They also exclude the wine sector, the cider and perry industry, as well as derived alcohols and spirit drinks.

³In France, the term "horticulture" is sometimes restricted to the sectors of ornamental and nursery production. It is not the case here.



■ Figure 1. Fruit and vegetable Eiffel Tower at the International Agriculture Fair, Paris, 2014. ©Jacques Bousquier.

The positive current context is likely to be sustainable according to multiple general or sectoral studies analyzing consumer expectations. In the long-term however, it does not offer a perspective of profit for the sectors concerned, in particular for producers who must constantly adapt to a set of constraints through innovation.

The special issues for fresh produce

While some primary products are immediately processed on farm, the destination of many products is to be sold fresh, such as fruit and vegetables, herbs and aromatic plants, cut flowers, and potted plants. Being perishable, i.e., not easily storable or only shortly, these products also show a sensitivity to climatic conditions, more importantly than in other agricultural sectors, both in terms of supply and consumption. Moreover, competition between products or even among species is

real, and substitution occurs at both the distribution and consumption stages (e.g., juice vs. fresh fruit). This situation requires permanent adaptation capacities for the upstream sector (producers), onset of reliable information networks (on markets, costs, prices), and adapted logistics organization. In view of what exists for the horticultural sector in other countries, such as floriculture in the Netherlands, French horticulturists have room for improvement in terms of economic and logistical organization and data management.

Means of production

For the most intensive production systems, horticultural companies are capital-intensive and implement high technical knowledge in cropping, adaptation to climate change or prevention of meteorological hazards, and protection against pests and diseases. As horticultural farms are labor intensive, they often have to comply with many social responsibilities within the various labor markets, while having to address imperatives of the global market.

The French horticultural production chains are characterized by contrasting environmental impacts. Heated glasshouses consume fossil oils and generate greenhouse gas. However, they can use cogeneration to optimize the energy management, and carry out integrated biological protection systems, in order to lower the use of phytochemicals. Moreover, plastics are now frequently used for mulching, covering tunnels, netting against hail or to control pests. This occurs despite most plastics being hard to recycle.

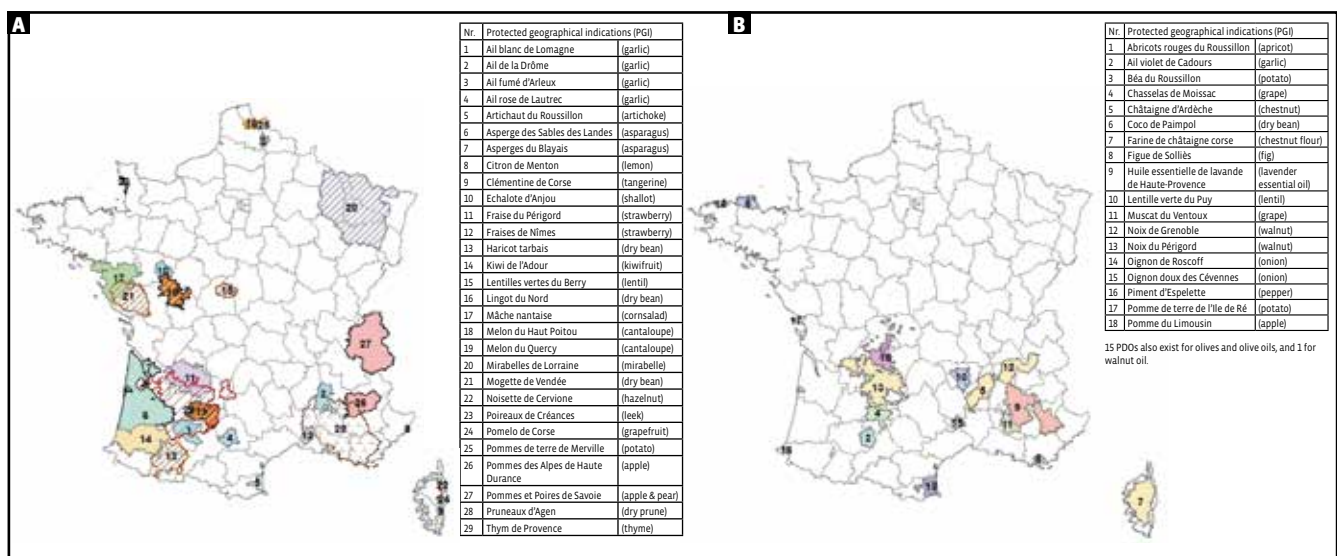
Vegetable production systems have become particularly diversified, from open-field production for the processing industry, heated

and lighted greenhouses, to market gardening systems in open air or under low shelters. It must be highlighted that different systems can co-exist on the same farm.

The French fruit production has evolved towards a regional specialization (Figure 3). The plantation of productive orchards has largely turned towards fresh produce markets with a strong development of integrated fruit production (IFP) as a standard. From 2000 to 2010 (according to the periodical national survey of the French Ministry of Agriculture), the national fruit potential lost 25% of its area, but was restructured thanks to new varieties better adapted to markets, and orchards managed according to the IFP principles (for apple, pear, peach, nectarine and apricot) (Figure 4). To these already common trends, some emerging goals have more recently been added such as: zero pesticide residue and high environmental value.

At the same time, the organic shares of fruit and vegetables grew in production: from 2001 to 2012, the area of organic fruit production increased from 4.0 to 12.5%, while that of organic vegetables rose from 1.8 to 4.0%. This trend even accelerated between 2012 and 2016 according to the French organic agency⁴. Such a trend can be verified at the consumption level: from 1999 to 2012, the global market for organic fruit and vegetables was multiplied by four, and was estimated to have doubled from 2015 to 2016, this segment representing nowadays about 10% of the market share (Figure 5).

The French ornamental production sector is strongly challenged by low-cost or highly organized countries. It has also experienced a concentration of companies with the disappearance of almost half of them over the last



■ Figure 2. Mapping of regional horticultural labels in metropolitan France: A. Protected geographical indications; B. Protected designations of origin.

⁴<https://www.agencebio.org/>.



■ Figure 3. Citrus germplasm collection orchards managed by INRA in San Giuliano, Corsica. ©INRAe.



■ Figure 4. Harvesting of apples cropped under hail nets in the Valois region, north-east of France. ©Jean-Luc Regnard/ Montpellier Supagro.

decade. In recent years, this sector decided to restructure and create various differentiation tools (brands, certification and quality labels) in order to meet the expectations of consumers and citizens in terms of environmental, social, economic and health performance (Figure 6).

The perfume, medicinal and aromatic plant sector (PPAM) has largely benefited from the market demand for natural produce with a 40% increase in production area over the last five years. For these crops, which are mostly transformed, the specific investments focused both on cropping (mechanization) and on processing (dryers, distilleries). With the implementation of technical means that were largely lacking until the end of the 80s, the production schemes have been greatly modernized (Figure 7), reassuring the customers of these quality materials, and discouraging them from switching to other supply solutions (competition of synthetic vs. natural produce).

The challenges for research, experimentation and innovation

For all sectors, applied research, experimentation and innovation are considered essential components of their development, of their economic sustainability and therefore,



■ Figure 5. 'Cantaloupe' melon on a market in Brittany.

of their permanency in the national territory. For example, despite the diversity and the quality of the offer, the French fruit and vegetables sector suffers from a lack of competitiveness at export. To analyze this situation, the Ministry of Agriculture and Food mandated FranceAgriMer to identify the factors that negatively affected the agricultural and agri-food trade balance in recent years, and establish a diagnosis at national level. This analysis will be carried out by a working group under FranceAgriMer supervision, bringing together specialists in value chain economy across various ministries and professional bodies. It aims to imagine practical solutions towards a better future in terms of market share and export capacity.

Reducing the use of plant protection chemicals is one of the major issues facing producers today. Given the multiplicity of species, varieties, and growing environments, research needs are huge. Due to the rapid decline of the use of phytosanitary chemicals, the horticultural sectors set up alternative methods whose objectives are to meet the expectations of reducing the negative impacts of crop production on the environment, to develop high quality products, and to avoid horticultural producers left in technical dead ends. It should be noted that many of these crops gather modest acreages compared with other field crops such as cereals. Accordingly, the phytochemical companies invest little resources for these crops and a large part of the chemical uses are described as "minor", meaning that they result from the transposition of solutions for another crop. This work is frequently performed by technical institutes (see Table 1).

Biocontrol is now widely developed in all sheltered production units and in orchards. It contributes to a significant reduction in the use of conventional phytochemical treatments. Biocontrol includes both uses of macroscopic biocontrol agents such as

auxiliaries, of microorganisms, and of natural products in crop protection (plant extracts, products of animal or mineral origin), as well as the use of chemical mediators (volatile compounds). For example, INRA studies the vegetable plant protection effects of macro organisms such as trichogramma. These micro-hymenoptera, whose larvae develop in the eggs of lepidopteran pests, are effective parasitoids to hinder the development of caterpillars of harmful species (e.g., tomato moths). However, these methods have partial effects, and new challenges appear every time with new pests: for instance, today no method is effective for controlling certain invasive species such as the spotted wing drosophila (*Drosophila suzukii*, severe pest on red fruit) or the brown marmorated stink bug (*Halyomorpha halys*). Thus, although biocontrol is a real alternative to pesticides, it still needs to increase its effectiveness, by coupling its use with other levers: physical protection methods such as insect nets often installed in addition to anti-rain nets, rain-proof plastic sheeting, and mass trapping.

For sheltered ornamental productions, alternative techniques to the reduction of treatments by growth regulators (narcotics) have also been developed, consisting for example of mechanical and automated stimulation of plants (project "@Casper" led by Astredhor).

For field crops, important work is being done on alternative techniques to chemical weed control, some using the most advanced techniques (e.g., geolocation of plants, automatic detection and treatment of weeds, autonomous robots).

For perennial perfume crops such as lavender, innovative inter-row plant cover techniques have been developed to hinder the spread of leafhoppers (*Hyaletthes obsoletus*), vectors of the phytoplasma (*Candidatus Phytoplasma solani*) responsible agent for the dieback of lavender (*Lavandula* spp.) fields. Incidentally, this work⁵ highlighted other

⁵<http://www.sauvegarde-lavandes-provence.org/images/Programme-Euclide-light.pdf>.



■ Figure 6. Branding French ornamental produce as a quality criterion for consumers. ©Agnès Grapin/ACO Angers.



■ Figure 7. Mechanical harvesting of lavender in Provence, south of France. ©CRIEPPAM.

Box 1. EUFRUIT⁶ project (3 years, 2016-19)

The project consortium consisted of 21 members, including research institutes, universities, and industrial partners who represent key parts of the fruit supply chain, from 12 European countries. Through a multi-actors approach, the EUFRUIT project (funded under the European Horizon 2020 research support program) aimed to improve the implementation of research outcomes into practical and applicable knowledge that will directly benefit the highly challenged European fruit sector. The difficulties met are of technical, sanitary or environmental nature, as well as economical (market), while the fruit sector is trying to meet the expectations of consumers and ensure the sustainability of farms. Within EUFRUIT an international knowledge platform has been created (<http://kp.eufrin.eu/>) on the following four thematic areas:

- Performance of new fruit varieties,
- Reduction in pesticide residues,
- Postharvest fruit quality,
- Design of sustainable fruit production systems.

It has been possible to share a complete vision between researchers and practitioners in the perspective of a reduced use of synthetic phytosanitary products, what allowed a reduction in chemical residues in the fruit and a smaller footprint on the environment.

This project has highlighted the strong development of alternative methods to chemical pesticides, be it bio-control or physical control methods (orchard netting against pests, plastic cover against diseases), or a combination of both.

Box 2. Research and development players in the fruit and vegetable sector

- The Interprofessional Technical Center for Fruit and Vegetables (CTIFL) is the leading applied research organization in the French fruit and vegetable sector, serving the different professionals from production to commercialization. Its annual activity program is based on the sector strategic program, aligned on a budget of over 20 million Euros consisting of professional funds (extended voluntary contribution), research and experimental funds related to program grants or competitive projects (European or national calls), and private funds. CTIFL carries out activities of experiment and research, innovation transfer, economic and regulatory intelligence, training and dissemination of information and knowledge to horticultural professionals. Recognized as a competent authority, CTIFL is in charge of the control and certification of fruit propagation materials, excluding strawberry plants. CTIFL is present in the main French production basins with four regional centers, which constitute, in partnership or in association with regional experiment stations, an experiment network unique in Europe.
- Regional experiment stations: the French fruit and vegetable sector also benefits from a network of ca. 30 experimental stations located in their territories in connection with the multiplicity of species and regional issues. This historic network (80s) is of great importance because it has significant experimental capacities. It addresses regional issues linked

to CTIFL and according to priority needs. The funding of these stations can be private and/or public. The proximity of producers favors a quick dissemination and transfer of results.

- Scientific interest groups (GIS):
The GIS Fruits, created in 2012 with 22 partners (INRA, CTIFL, CIRAD, professional organizations, higher education, etc.), aims to contribute to sustainable development oriented innovation in fruit crops through the production of scientific and operational knowledge. It seeks to support changes in the fruit sector by triggering and promoting research, experiment, extension and training activities. The GIS PicLeg (stands for Integrated Production of Vegetable Crops) was created in 2007. It enables the development of vegetable crops and cropping systems taking into account societal expectations reconciling food quality, environmental impact, economic performance of farms and social requirements. Its field of study takes into account all modes of production (open field, soilless, greenhouse and shelters). In the framework of a ten-year agreement (2017-2027), two themes are developed: strengthening the knowledge and the design of low-input cropping systems at the plot scale, and developing new actions around diversification and organization of food systems at the scale of farms, territories and vegetable value chains.

⁶<https://eufrin-test2-9fy.micusto.cloud/?id=55>.

■ Table 1. Main economic and structural characteristics of the various horticultural sectors in France^a. Sources: data from the French inter-professions, Ministry of Agriculture and the French customs (mean data for 2016-2017). NA: Not applicable (for acronyms of French organizations, see Box 2&3).

Horticultural sectors	Ornamental horticulture, floristry & landscaping	Herbs, medicinal & aromatic plants (HMAP)	Fruit & vegetables
General data	53,000 firms (farms and companies): production, trade, landscaping Jobs: ca. 170,000 employees Annual sector turnover: 14 billion € including sales of flowers & foliage, nursery plants: 2.5 billion € (direct consumption stage)	ca. 5,000 producers (not necessarily specialized) Annual sector sales: more than 5 billion € (consumption stage, variable data depending on the scope of products considered)	75,000 firms (farms) Vegetables: 5.3 million t (including 35% for processing industry) Potatoes: 7.0 million t Fruit: 2.7 million t (including 20% for processing industry) Annual sector turnover: 16.5 to 18.0 billion € (consumption stage, potatoes excluded) Processing industry: 144 units Annual industrial turnover: 2.9 billion € (consumption stage)
Activities in the upstream production chain	Plant material propagation: production of seeds (ornamentals & vegetables), cuttings, young plants & transplants, etc.		
Activities of the production sector	Flowers, foliage, potted plants & bedding plants, nursery plants (trees & shrubs), bulbs, etc.	Fresh plants or plant components (herbs)	Fruit & nuts, bramble fruit Vegetables issued from open field or shelters, cultivated mushrooms
First use/first transformation activities	Bouquets, sheaves, flower arrangements, etc.	Drying or distillation (frequent at production stage) Other processing operations requiring industrial facilities (e.g. deep-freezing)	Canning, deep-freezing, ready-to-eat (fresh-cut or processed), sugar-preservation, oil extraction, jams & beverages (e.g. juice), fermentation, pickling, etc.
Second transformation activities	None	Perfume, aromas, nutraceuticals, drugs, food supplements, etc.	Fruit mix, mixed vegetables, agri-food industries
Other plant use	Landscaping for communities or individuals	NA	NA
Sale activities	On-farm sales, fairs and city markets, garden-centers, mass retails, florists, online sales	On-farm sales, agri-food industries	On-farm sales, primeurs and city markets, specialized fresh retails, mass retails, online sales Private and collective catering
Production units	3,300 (as main activity)	ca. 5,000 (farms)	Fruit: 27,600 farms Vegetables: 30,800 farms (including 6,000 dedicated to processing) Potato: 19,900 farms
Production surfaces	15,000 to 16,000 ha (including shelters: 1,600 ha)	53,000 ha	Fruit: 170,000 ha Vegetables: 220,000 ha (including shelters: 7,500 ha) Potato: 165,000 ha
Trade/sales	18,900 firms including: - 395 wholesalers, - 15,100 florists, - 3,400 garden-centers	Many trade channels, depending on the nature of plant extracts and uses	Shipping & export business: 350 Wholesalers (including central purchasers): 1,168 Primeurs and specialized fresh retails: 11,700 Hyper- & supermarkets: 12,776 Importers: 150
Landscaping	30,250 firms	NA	NA
Annual turnover (production stage)	1.6 billion € (50% finished plants/50% nursery plants)	0.15 billion €	8.1 billion €
Evolution	Reduction in the number of farms, reduction in the number of jobs (full time equivalent)	Sharp development: +40% over the last 5 years	Fruit crops overall in decline vs. stability for vegetables Significant increase in the organic products segment: +16% of sales in 2017 Slow decrease in consumption of fresh and processed vegetables, stability for fruit
Offer grouping	ca. 15 producers' organizations	ca. 15 producers' organizations	225 producers' organizations, 300 cooperatives (partial double count)

Import	0.9 billion €	2.45 billion € (essential oils)	Fruit: 4.7 billion € Vegetables: 2.1 billion €
Export (value)	56 million €	2.2 billion € (slightly processed), more than 10 billion € (finished products)	Fruit: 1.6 billion € Vegetables: 1.1 billion €
Production staff number	19,300	6,000	450,000 (including 250,000 seasonal jobs)
Inter-branch organisations	VAL'HOR	CIHEF (essential oils)	INTERFEL ANIFELT
Signals of quality (certification or labelling)	Red labels and Blue Plant label, high environmental value (HEV ^b) and milieu programma sierteelt (MPS ^c), Fleurs de France, etc.	1 PDO + 1 PGI (Figure 2) Organic farming certification, Red labels, etc.	18 PDO + 28 PGI (Figure 2) 24 Red labels, etc.
Technical institutes	ASTREDHOR with a network of 10 regional stations	Network of 4 entities, including ITEIPMAI Partnerships with organic agriculture institutes (ITAB, GRAB)	CTIFL and a network of 27 regional stations UNILET (processed vegetables) Arvalis (potato) Partnerships with organic agriculture institutes (ITAB, GRAB) CTCPA (Technical institute for food industry)
Public research	INRA centers (Angers, Sophia Antipolis, PACA Avignon) Joint research units with higher education organizations & joint technological units with other partners	INRA centers (Angers, Clermont-Ferrand, Evry) French higher education organizations in partnership with CRIEP-PAM & ITEIPMAI	INRA centers (Angers, PACA Avignon, Bordeaux, Corsica, Montpellier, Rennes, Toulouse) CIRAD (Montpellier) Joint research units with higher education organizations & joint technological units with other partners

^aMetropolitan France, including Corsica, and excluding the French West Indies, French Guyana, La Réunion and Mayotte islands.

^b<https://agriculture.gouv.fr/hev-certification>.

^c<https://www.my-mps.com/en/>, mainly used in the ornamental sector.

favorable effects of plant cover in terms of tolerance to drought and heat on the dry soils of the Provence highlands where most of these plants are cropped.

Developing innovation

Beyond the technical solutions expected by each commodity chain for the resolution of their cropping problems and the reduction of their production costs, research and innovation largely contribute to the dynamics of the chain concerned. This is particularly the case of “produce innovation,” whether it is about releasing new varieties or increasing the processed value of secondary metabolites (Box 1).

This axis of innovation is particularly important in the HMAP sector, where the market life of an end-product can be ephemeral, whereas a rapid turnover is observed (over 1,000 monthly applications on the registration portal for food supplements). For processed products, innovations in the processing are also crucial and can greatly influence the future of a crop production. This is the case, for example, with the modernization of harvesting operations, upstream of a distillation plant for essential oils, that can greatly contribute to the development of aromatic or medicinal plants.

In the fruit and vegetable sector, innovation

is the key driver for the agroecological transition and for securing the quality of the produce (especially food safety of fresh produce to be processed) (Box 2-3). In the sector of processed fruits and vegetables, the Qualiveg-2 technological mixed unit supported by the Technical Center for the Conservation (and processing) of Agricultural Products (CTCPA) and the National Institute for Agricultural Research (INRA) in Avignon, is in charge of developing collaborative projects related to organoleptic, health and nutrition quality of fruit and vegetable produce. Innovation ultimately increases value and contributes to the competitiveness of French industries that are strongly challenged internationally by countries with lower production costs. Organizational innovation is sought as well, such as corporate social responsibility (CSR) implemented downstream in value chain companies generally, which contributes to local or at least national sourcing.

Foresight studies at FranceAgriMer

What would happen if, in 25 years, the fruit tree breeding is controlled by the processing industry? If ornamental plants are only cultivated for their capacities of phytoremediation of polluted soils, storm water management, urban temperature mitigation, etc.? If

climate change completely upsets the list of varieties of fruit and vegetables cultivable in France? If the food stores totally disappear? And if ...?

Because the long-term future is neither predetermined nor predictable, because it opens many options, and because it never emerges from the void but from the present, which holds heavy tendencies and weak signals as well, foresight studies allow consideration of the room to maneuver that actors have to favor the arrival of a desirable future, or at least chosen in part. These studies make use of a systemic approach that brings into perspective each question raised in relation to different possible constructions of the future world. Since its creation in 2009, FranceAgriMer has coordinated a series of foresight studies within the agricultural and horticultural sectors (Box 4) to jointly build common representations of these sectors and to discern scenarios for the future. Once a foresight study is completed, the actors of the concerned sector are invited to analyze the consequences of the various emerging scenarios. Then, from the subsequent debate on the future, possible scenarios of evolution can emerge, giving rise to a collective strategy for the sector. ●

Box 3. Research and development players in the ornamental and nursery chains

- ASTREDHOR, the technical institute of horticulture, was created in 1995. It now includes a national unit and six regional units, grouping ten experimental stations distributed in the different French horticultural production basins. It mobilizes a total of 105 employees (87 full time equivalent) of whom 75% are scientific staff. Its consolidated budget is 6.9 million Euros. Its scientific project is structured for the period 2018-2022 around five major challenges for the sector:
 - development of alternative production systems and accompanying related transitions,
 - development of green engineering and the consideration of ecosystem services provided by plants,
 - emergence of new industrial recovery opportunities for the bioeconomy,
 - adaptation of companies to economic developments and markets,
 - emergence of “connected” horticulture.ASTREDHOR is involved in different partnership arrangements at the European, national or regional levels.
- ITEIPMAI: applied research and experiments in medicinal and aromatic plants are mainly carried out under the aegis of this national technical institute by a network of four technical structures including ITEIPMAI, the Regional Interprofessional Center for Experimentation in Perfume, Aromatic and Medicinal Plants (CRIEPPAM) specialized in the Mediterranean cultures and their first transformation, the National Repository of Perfume, Medicinal and Aromatic Plants (CNPMAI) ensuring the germplasm conservation, and Agriculture Chamber of the Drôme department. This network brings together about 55 permanent staff for an annual budget of about 4 million Euros. Partnerships with public research centers are established as needed, depending on the nature of the projects. Insofar as these productions are of little interest to plant breeders, phytosanitary firms and manufacturers of agricultural equipment, the field of investigation of these organizations is very broad: genetic improvement, crop protection, weeding, mechanization of crops, first transformations, and technical support.

Box 4. Foresights applied to French horticulture: example of the scenario “Fruit varieties for the future”

At FranceAgriMer, a small team carried out foresight exercises to meet the demands of the agricultural sectors. Based on a method developed in the 90s by Michel Sebillotte at INRA, this team implemented various methodological complements allowing for scale changes (from national to local, from the whole sector to a profession, etc.), and the passage from micro- to macro-scenarios. A dozen exercises have been carried out since 2009 for plant and animal sectors. For horticulture in particular, the studies were as follows: Foresight on fruit & vegetables (October 2009 - October 2011), Foresight on ornamental horticulture (March 2012 - March 2014), Foresight on the cider value chain (March 2014

- January 2016), Foresight on fruit varieties for the future (April 2016 - November 2018), Foresight on the French HMAP sector (in progress from June 2018). A comprehensive report and a synthesis were published from these analyses, as well as the organization of participatory presentations. For example, the foresight on fruit varieties of the future produced four contrasting scenarios:

- Variety innovation for orchards adapted to climate change,
- Dynamics in fruit breeding under control for demanding consumers,
- A slow fruit variety creation for a low price market,
- Transformers driving variety innovation.



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> II International Symposium on Moringa

Division Horticulture for Human Health

#ishs_dhea



> Participants of ISM2019 at the entrance of the CSIR International Convention Centre, Pretoria, South Africa.

The II International Symposium on Moringa (ISM2019) was held at the CSIR International Convention Center in Pretoria, South Africa (SA), from 10-13 November 2019. The theme of this year's symposium, "The Power of moringa in solving global challenges", is very timely as moringa is one of the popular "super foods" in addressing health, nutrition and socio-economic issues.

The Moringa Development Association of South Africa (MDASA), the Agricultural Research Council (ARC) and various universities have organised this gathering of

125 experts and interested parties from 25 countries (Germany, Indonesia, Nigeria, Brazil, USA, France, Zambia, Zimbabwe, India, Benin, amongst others) under the aegis of the International Society for Horticultural Science to share best practices and scientific information on the production and many different uses of moringa. During the symposium 53 oral presentations and 34 posters were presented and these were published in the symposium book of abstracts. The local organising committee was led by Dr. Sunette Laurie, specialist researcher from the Vege-

table and Ornamental Plant campus of the ARC. Other members were from MDASA, the University of Witwatersrand (WITS), University of Pretoria (UP), Tshwane University of Technology (TUT), and Department of Science and Innovation (DSI) (a major sponsor).

This is also a significant and important symposium for the ISHS, which recognizes moringa as a high value multipurpose plant. Likewise, the South African government acknowledges the importance of partnerships in socio-economic endeavours promoting moringa. Studies have shown that there



> Professor Manny Palada (right), former Chair of ISHS Working Group Moringa, presenting the ISHS Medal Award to Dr. Sunette Laurie (left), Symposium Convener.



> Organizing Committee of ISM2019. From left to right: Dr. S. Amoo (ARC), Prof. E.S. du Toit (UP), Dr. S. Laurie (Convener; ARC), Mr. W. Ntike (MDASA), Dr. A. Ndhlala (ARC), Dr. R. Kleynhans (TUT), Prof. L. Chimuka (WITS), Mr. R. Munya (MDASA), Ms. L. Smith (Event organiser) (absent Ms. M. Tang (DSI)).



► Professor Manny Palada, former Chair of ISHS Working Group Moringa, presenting the ISHS Young Minds Award to A) Ms. Elmiën Coetser for the best oral presentation, B) Mr. Bonga Ngcobo for the best poster.

are several areas of SA suitable for moringa cultivation, and this means that the plant, with its many medicinal and nutritional benefits, should be able to contribute to food security and job creation too.

A pre-symposium workshop on “Unlocking moringa market access” was held on 10 November 2019. Mr. Cyril Lombard of the United Kingdom provided a synopsis of the moringa industry in SA, representatives of the moringa industries in Zambia and Ghana gave presentations, while Dr. Andile Grootboom from the Department of Science and Innovation expanded on the South African government’s support of moringa farmers and enterprises. One of the major outcomes of the day was the formation of a Moringa Steering Committee for Africa as proposed by Professor Chishimba Mowa from North Carolina, to synthesize efforts of various organisations. Some of the committee members are Professor Mahmoud A. Sharaf-Eldin (Egypt), Dr. Ida Risenga and Dr. Luke Chimuka (SA), Professor Carrie Waterman (USA and Kenya), Professor Mowa (Zambia and USA) and Dr. Newton Amaglo (Ghana), who will take the lead.

The symposium included the following sessions: Food security, nutrition and health; Germplasm, botany and production technology; Climate change, environment and agro-ecosystems; and Agro-processing, industrial use and commercialization. Keynote speakers included Professor Theodore Radovich (University of Hawaii), Professor Manny Palada (Philippines), Professor Chishimba Mowa (USA) and Dr. Newton Amaglo (Ghana). Professor Palada gave a presentation relating moringa to climate change. He mentioned that one moringa tree can equal the carbon sequestration of 50 Japanese cedar trees, emphasizing the role moringa can play in

circumventing climate change. Dr. Newton Amaglo from Ghana explained his model for commercialization of moringa through high density planting of moringa, coupled with trees in the open spaces between rows. In his model, 1 ha moringa plantings are established at 100 farms and one agro-processing facility is set up. He is of the opinion that moringa will be able to provide in the desperate need of protein in the poultry industry in the near future. Moringa oil is also highly valued. A very informative talk was presented by Professor Carrie Waterman from UC Davis in the USA, relating to the isothiocyanates available in moringa leaves and seeds. Her work on feeding trials using rats showed that moringa delayed onset of diabetes. She further stressed that scientists should join hands in doing more bio-efficacy studies with moringa.

Invited speakers included Professor Habauka Kwaamba (University of Namibia), Professor Mark Olsen (University of Mexico), Professor Elsa du Toit (UP), Dr. Ashwell Ndhala (ARC) and Professor Luke Chimuka (WITS). Professor Kwaambwa presented his work on the use of *Moringa oleifera* seeds in water purification where his research group isolated different proteins and used them in their purification process. Furthermore, they have developed different water treatment prototypes. Noteworthy, Professor Olsen highlighted that despite the global importance of *Moringa oleifera*, it is still unclear which wild species it was domesticated from, and without knowledge of its closest ancestor, it is impossible to know where to search for the best candidates for desirable variants for improving the domesticated varieties.

ISHS Young Minds Awards were presented to two student delegates. Miss Elmiën Coetser, MSc student of supervisor Professor Elsa du

Toit, Department of Plant and Soil Sciences, University of Pretoria, SA, received the award for the best oral presentation entitled “Temporary immersion bioreactors for clonal production of *Moringa oleifera* tissues”. Mr. Bonga Ngcobo, PhD student of supervisor Professor Isa Bertling, Department of Horticultural Science, University of KwaZulu-Natal, Pietermaritzburg, SA, received the award for the best poster presentation entitled “Influence of foliar *Moringa oleifera* leaf extract (MLE) application on growth, fruit yield and nutritional quality of cherry tomato”.

During the symposium, 19 vibrant exhibitors hosted by research institutions, commercial entities and allied trade, presented their display with various moringa products, from raw seeds and leaf powder to tea, juices, biscuits and chocolates, including skincare and medicinal products.

The ISM2019 was concluded by a technical tour in which about 90 delegates took part, first visiting the Innovation Hub, an incubator facility aimed at supporting upcoming entrepreneurs. The second stop was Lefakong, a moringa farm in Hammanskraal visiting their drying facility, products and moringa plantations. Ms. Matlou is indeed an example of an entrepreneur ploughing back into her community. The tour proceeded to ARC-Vegetable and Ornamental Plants (ARC-VOP) where the visitors were welcomed by Dr. Sonja Venter, Senior Manager, Vegetable Research. At the ARC-VOP the delegates had the opportunity to visit the moringa agro-processing unit, moringa research trials and the quality laboratory, which plays an important role in testing moringa products for entrepreneurs.

On a lighter note, delegates experienced the African vibe through Zulu dancers at the cocktail event, and excellent South African food at the gala dinner with a delicate touch of moringa in the tomato and mozzarella caprese skewers.

During the ISHS Moringa Working Group business meeting, Professor Mahmoud A. Sharaf-Eldin from Egypt was elected as the new Chair of the Working Group. It was proposed to hold the next symposium in 2021 in Brazil to be convened by Mr. Alvaro De Araujo. Other countries that offered to host the symposium were China, Ghana and Egypt.

Sunette Laurie



► Lefakong farm visited during the technical tour. A) Ms. Mabuang Mathlou (manager of Lefakong), B) processing of leaves.

► Contact

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> IX International Symposium on New Ornamental Crops

Division Ornamental Plants

Division Landscape and Urban Horticulture

Division Plant Genetic Resources and Biotechnology

Division Protected Cultivation and Soilless Culture

#ishs_dorn

#ishs_durb

#ishs_dbio

#ishs_dpro

The IX International Symposium on New Ornamental Crops was held in Guadalajara, Mexico, from September 30 to October 3, 2019. The event was organized by the Research and Assistance in Technology and Design Center of the State of Jalisco [Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco. A.C. (CIATEJ)] under the aegis of the International Society for Horticultural Science (ISHS) and was sponsored by the Consejo Estatal de Ciencia y Tecnología de Jalisco and the Oficina de Visitantes y Convenciones de Guadalajara. The event was attended by 50 participants, among which were students, researchers, and the general public from 13 countries. Their contribution included 27 oral presentations and 28 posters. A welcome reception took place on the first day, followed by two days of scientific sessions. On the fourth day, an excursion to the mountainous area near Guadalajara took place, to observe natural wild species. The symposium aimed to present the international research on the production of new ornamental crops.

The first day of the scientific sessions began with a welcome message from Dr. Eugenia del Carmen Lugo Cervantes, Director of CIATEJ. This was followed by a presentation from Dr. Margherita Beruto, Director of the Regional

Institute for Floriculture (IRF), Sanremo, Italy, and Chair of ISHS Division Ornamental Plants, who gave an introduction of the ISHS and the upcoming events of the Society. The scientific program was divided into seven sessions, of which four took place on the first day. The session “Sustainable use of biodiversity for floriculture and landscape” was opened by the keynote lecture of Dr. Johan Van Huylbroeck, from the Flanders Research Institute for Agriculture, Fisheries and Food, Belgium. Dr. Van Huylbroeck’s research focuses on the development of efficient hybridization and selection strategies, and the creation of cultivars for sustainable agriculture and horticulture. His lecture was about breeding for sustainable ornamental plants and was followed by two more lectures. The session “Potential use of native flora” was initiated by the keynote lecture of Dr. Kenneth W. Leonhardt, from the University of Hawaii at Manoa, USA. Dr. Leonhardt gave us a sensational lecture on variety improvement in tropical ornamentals, for landscape uses and floral products. He is an expert in developing improved ornamental crops, with emphasis on protea and landscape trees. The session continued with three lectures that covered Amazonian shade tolerant species with ornamental potential, new ornamental bedding

plants for temperate and cold regions, and ornamental *Acer* taxa that can thrive in dry environments. The next session was “Native plants and genetic resources” and began with the keynote lecture of Dr. Chunlin Long, from the College of Life and Environmental Sciences, Minzu University of China and Kunming Institute of Botany, Chinese Academy of Sciences. He made significant contributions in fields of biodiversity conservation, ethnobotany and ethnoecology, phytochemistry and natural products, plant taxonomy and phylogeny. He presented the fascinating lecture: “Will East Asia continue to make contributions to the world’s gardens?” His lecture was followed by two more lectures in which we were able to learn about new developments in *Torenia* and the first approaches in *Argyllia* for future plant breeding. The last session was “Genetic resources and biotechnology”, where we listened to four excellent lectures, regarding the breeding and selection of *Leucospermum*; the reduction of seed pod litter and polyploid induction of ornamental trees; antioxidant properties in bracts of sun *Poinsettia*; and the molecular characterization of *Heliconia*. During the coffee break we enjoyed the presentation of high-quality posters while we ate seasonal fruits and bread.



> Participants of the symposium.



► Dr. Rodrigo Barba-Gonzalez, Convener, and Dr. Margherita Beruto, Chair ISHS Division Ornamental Plants, presenting the ISHS Young Minds Awards to A) Isabel Niebla López for the best oral presentation, and B) Evelyn Y. Garcia-Ochoa for the best poster.

The second day of scientific sessions was initiated by the session “Propagation and production”, which began with the keynote lecture of Prof. Jose Merced Mejia-Muñoz, full professor at the Floriculture Academy of the Chapingo Autonomous University. He is a specialist on dahlia and has conducted important research not only by developing new cultivars but also researching the importance of dahlia inulin to control diabetes. He delighted us with his lecture: “Research on dahlia, the national flower of Mexico”. The session was followed by lectures that covered topics such as: effect of light and phytohormones on the differential response of the organogenic-embryogenic somatic clone of *Agave victoriae-reginae*; discernment of pollen grain fertility and stigma receptivity plying hasty-easy techniques of *Heliconia*; and the effect of different storage temperatures in flowering of *Polianthes tuberosa*. The next session “Postharvest biology, technology and quality” began with the keynote lecture of Dr. John Dole from the North Carolina State University, USA. Dr. Dole is Associate Dean and Director of Academic Programs at North Carolina State University and past President of the American Society for Horticultural Science. He has a long history of significant research, teaching, extension, and outreach contributions in the field of floriculture, most notably in the areas of production and postharvest handling of cut flowers, cuttings and poinsettias. His lecture was the “Current and future directions in cut flower postharvest handling” and was followed by interesting lectures such as “Vase life of

58 new cut flowers”; “Introduction of new species to extend the period of decorative duration of flower collections of the Nikitsky Botanical Gardens”; “Volatile compounds in flowers of *Polianthes* genus”; and “Evaluation of carnation flower diversity in terms of flower color, flower color pattern and flower pigment”. The last scientific session was “Disease control”, where we were able to listen to great lectures on the topics: advances in *Botrytis* control for flower crops; assessing fire blight resistance of new *Cotoneaster* genotypes inoculated with *Erwinia amylovora* in the field; development of a real-time duplex isothermal assay for the detection of *Tobacco rattle virus* and an endogenous internal RNA control in ornamental hosts; and polyploidy as an *Erythrina* gall wasp management strategy for the Indian coral tree. After the scientific sessions, we enjoyed the presentation of the posters of the second day and had time to discuss the research presented with the authors. By the end of the day, we had a round table regarding the future of new ornamental crops, where we discussed the new regulations of the Nagoya protocol, the Access and Benefit Sharing (ABS) and the International Union for the Protection of New Varieties of Plants (UPOV). We also remembered the previous symposium held at Perth, Australia, in 2015, and the International Symposium on Wild Flowers and Native Ornamental Plants held in Iran in 2017, and we concluded on the importance of creating a directory of researchers working on new ornamental crops. The symposium was not over yet, Dr.

Margherita Beruto gave the ISHS Young Minds Awards to Isabel Niebla López from CIATEJ, Mexico, for the best oral presentation given by a junior scientist entitled “Effect of different storage temperatures in flowering of *Polianthes tuberosa* L.” and to Evelyn Y. Garcia-Ochoa, also from CIATEJ, Mexico, for the best poster presented by a junior scientist entitled “In vitro biological activity of metabolic extracts of wild and cultivated species of the genus *Polianthes*”. During the ISHS business meeting it was agreed that the next International Symposium on New Ornamental Crops will be in China in 2023. On the last day of the symposium we traveled to the town of Tapalpa and the surrounding areas, where we were able to walk in nature, we visited waterfalls and observed the natural blooming of wild species in the mountains.

Rodrigo Barba-Gonzalez

► Contact

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► Participants observing native flora during the field trip to A) the waterfalls of Tapalpa, B) in a *Cosmos* field.

› IV International Conference on Fresh-Cut Produce

Division Postharvest and Quality Assurance
Division Protected Cultivation and Soilless Culture
Division Vegetables, Roots and Tubers

#ishs_dphq
#ishs_dpro
#ishs_dveg



› Participants of the symposium.

The IV International Conference on Fresh-Cut Produce was held in Taian, Shandong Province, China, on August 12-17, 2019. Under the aegis of the International Society for Horticultural Science (ISHS), the conference was organized by Shandong Agricultural University and the Postharvest Branch of the Chinese Society for Horticultural Science. The conference attracted over 360 participants including experts, scholars, and engineers and managers of fresh-cut produce companies from 17 countries.

The conference focused on the quality and safety of fresh-cut produce. The topics included fresh-cut related biology, quality maintenance and product development, processing facility, food pathogen hazard control, atmosphere management and packaging, and waste or by-product management. During the three days of scientific sessions, 60 oral and 13 e-poster presentations were given. Among them, the following talks or topics gave the latest theory and technological knowledge to the international fresh-cut world.

The conference provided the latest biological and physiological knowledge in association with fresh-cut produce, which included “responses of plants to damage mediated by proteases, signaling peptides, and calcium signaling”, “physiological basis of fresh-cut fruit and vegetable differences”, “transcriptional profile changes and quality maintenance of fresh-cut produce”.

The conference gave a series of new technology strategies to improve the quality of fresh-cut produce. For achieving good quality, a combination of preharvest and postharvest

technology, including plant stress control, physical, safe chemical and biological methods, is necessary. The lectures were given by Professor Maria Gil, Carol Wagstaff, Lihua Fan, Qingguo Wang, Xiaoyan Zhao, Yang Bi, Peng Jin, Xia Liu, and Victor Rodov.

The conference provided suggestions to guarantee the food safety of fresh-cut produce. The talks of Dr. Xuetong Fan, Yen-Con Hung and others stated that no silver bullet ensures microbial safety for fresh produce. A holistic approach including prevention of contamination and cross-contamination in the field and during postharvest handling and processing remains as the most practical and effective approach.

Professor Giancarlo Colelli discussed novel information about the history, present quality, and future possibilities of fresh-cut fruit and vegetable production. This is a valuable and interesting research area.

The conference provided the trends in packaging and processing facility innovation for the fresh-cut international world. Dr. Eva Almenar described new packaging for emerging shopping markets – e-commerce, intelligent packaging, adequate packaging for high hydrostatic pressure (HHP), cold plasma, etc. – are needed now and in the future. Rudi Groppe, President and CEO of Heinzen Manufacturing International, reported on easier procedures for sanitation and maintenance. The ease of operations, equipment disassembly and reassembly and the cost matrix are the issues that the facility producers should consider.

Maoshan Wang described cutting style and requirements suitable for Chinese cuisine.



› Prof. Christopher Watkins (left) presenting the ISHS Young Minds Awards for the best oral presentation to Lei Wang (second from left), Ruihua Wang (center) and Haonuan Zhao (right).

This fruit and vegetable cutting technology and art expert showed a growing market of fresh-cut produce in China that will provide a great opportunity and challenge for the producers of international processing facilities and packaging materials.

Value added utilization of by-product or waste from fresh-cut processing was an important topic of the conference. Dr. Changmou Xu, Xiaomeng Wu and Xiao Jun Liao gave the talks and provided a demonstration using processed by-products as sources of functional ingredients. This approach would be rendered ineffective without careful selection of the type of waste used as a raw material.

The ISHS Young Minds Award was given to Alessia Incardona (University of Foggia, Italy) for the best e-poster entitled “Monitoring the effect of cutting blade sharpness on quality of fresh-cut produce”. There was a three-



> Participants visited the processing of fresh-cut vegetables in Lianyungang.



> Participants saw the value-added garlic product in Cangshan.



> Prof. Yunbo Luo (right) presenting the ISHS Young Minds Award for the best e-poster to Alessia Incardona (left).

way tie for the ISHS Young Minds Award for the best oral presenter. The co-awards were presented to Lei Wang (Zhejiang University, China), Ruihua Wang (Shandong Agricultural University, China) and Haonuan Zhao (Shandong Agricultural University, China) for the best oral presentations entitled “Efficient microencapsulation of *Syringa* essential oil: the valuable potential on quality maintenance and storage behavior of ready-to-eat produce”, “Investigation of the reasons for two treatments inhibiting browning of fresh-cut potato by metabolomic analysis” and “A novel molecularly imprinted surface-enhanced Raman spectroscopy substrates modified with dendritic gold nanoparticles for the determination of patulin in apple juice”, respectively.

In addition to the oral presentations and e-posters, a fresh-cut panel discussion was held at the end of the symposium. During the closing ceremony, Professors Christopher Watkins and Yunbo Luo presented the ISHS Young Minds Awards to the four young winners and the organizing commem-

orative ISHS Medal to the convener of the conference.

During the ISHS business meeting, led by Prof. Christopher Watkins, Chair of ISHS Division Postharvest and Quality Assurance, Dr. Maria Isabel Gil from CEBAS-CSIS, Campus Universitario de Espinardo, Murcia, Spain, was elected as Convener of the V International Conference on Fresh-Cut Produce in Murcia, Spain in 2023.

Participants of the two-day technical tour after the three days of scientific sessions visited five industries, including value added garlic and fresh-cut vegetable producers and postharvest storage companies.

Qingguo Wang

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> XVII International Symposium on Apricot Breeding and Culture

Division Temperate Tree Fruits

#ishs_dfru

The XVII International Symposium on Apricot Breeding and Culture was held in the world apricot capital, Malatya, Turkey, from 6-10 July 2019. The symposium was organized by Atatürk University, Apricot Research Institute and Turgut Özal University, under the aegis of the International Society for Horticultural Science (ISHS) Working Group Apricot Breeding and Culture, in cooperation with the Governorship of Malatya, Ministry of Industry and Technology FIRAT Development Agency, and the Municipality of Malatya.

A total of 100 international scientists from 22 countries attended the symposium. Four days of the symposium were devoted to scientific oral and poster presentations and one day to a technical tour. The wide range of topics on apricots was divided into five sessions: breeding and cultivar evaluation, fruit quality, climate challenges and ripening, genetics and genomics, and pest and diseases. Altogether, 29 oral presentations and 61 posters were presented during the symposium.

During the technical tour participants visited some modern intensive apricot orchards and drying facilities in the Battalgazi District, where they became more familiar with the characteristics of Malatya apricots. Dr. Sezai Ercisli, Symposium Convener, and Abdullah Erdogan, Head of the Apricot Research Institute, managed the field trip. Participants asked the orchard owner many interesting questions related to production methods, orchard management, and the drying process.



> Participants of the symposium.

Dr. Sezai Ercisli welcomed everyone and extended his thanks and gratitude to the participants and to the members of the Scientific and Organizing Committees. Özkan Kayaçan, representative of the Turkish Ministry of Agriculture and Forestry, Professor Dr. Aysun Bay Karabulut, Rector of Turgut Ozal University, Selahattin Gürkan, Mayor of Malatya, and Aydın Baruş, Governor of Malatya, also greeted the participants and gave a plaque to Sezai Ercisli, Jean-Marc Audergon, David Ruiz and Daniele Bassi for their contribution to apricot science in the world. Professor Dr. Daniele Bassi, former Chair of ISHS Working Group Apricot Breeding and Culture, welcomed the participants on behalf of ISHS and gave a short presentation about ISHS.

In the first session on “breeding and cultivar evaluation” ten oral presentations from different countries were given, mostly dealing with new insights into apricot breeding and characteristics of diverse apricot cultivars in different ecological environments around the globe. In the session on “fruit quality”, five oral presentations on fruit external and internal quality related issues were presented. The session on “climate challenges and ripening” covered many topics of scientific interest on how climate change affects apricot production in different areas in the world. A future projection was also discussed on this topic. The session on “genetics and genomics” was one of the largest sessions of the symposium and covered a wide range of topics. In the session on “pest and diseases” problems associated with *Plum pox virus*

(PPV) were recognized as a very important issue, and in the frame of this session, a number of oral presentations on management of PPV were presented.

At the business meeting, a very active debate took place concerning the next symposium, taking into account the proposal that has been going on for many years of holding a joint symposium for apricot, plum and prune. It was decided to try and hold a joint symposium. A tentative venue, Avignon, France, and convener, Jean-Marc Audergon, was selected for the next apricot symposium. The date has not yet been finalized. Dr. Sezai Ercisli was elected as new Chair of ISHS Working Group Apricot Breeding and Culture.

ISHS Young Minds Awards were given to Mariem Nsibi from the Unité Génétique et Amélioration des Fruits et Légumes (UGAFL), INRA, France, for the best oral presentation entitled “Genomic selection which prospects in *Prunus armeniaca*” and to Marieta Nesheva from the Fruit Growing Institute Plovdiv, Bulgaria, for the best poster entitled “Inheritance of apricot growth habit in breeding materials”.

Sezai Ercisli

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> Prof. Dr. Daniele Bassi, ISHS representative (left), and Prof. Dr. Sezai Ercisli, Convener (second from left), presenting the ISHS Young Minds Awards to Mariem Nsibi (right) for the best oral presentation and to Marieta Nesheva (second from right) for the best poster.



> Processing unit at the Apricot Research Institute.



> Welcome speech of Convener, Prof. Dr. Sezai Ercisli.



> Apricot orchard at Battalgazi district.

› XII International *Rubus* and *Ribes* Symposium: Innovative *Rubus* and *Ribes* Production for High Quality Berries in Changing Environments

Division Vine and Berry Fruits
Division Protected Cultivation and Soilless Culture

#ishs_dvin
#ishs_dpro

The XII International *Rubus* and *Ribes* Symposium of the ISHS took place from 23 to 28 June 2019, in Germany and Switzerland. The organizers were Gunhild Muster, LVVO Weinsberg (Germany), Erika Krüger, Geisenheim University (Germany) and Christoph Carlen, Agroscope (Switzerland). After the pre-symposium tour from Germany to Switzerland, the symposium took place at the ETH Zurich, a university in science and technology. The symposium included 203 researchers from 36 nations who discussed and exchanged views on the production of raspberries, blackberries and currants. The presence of 42 researchers from the USA was impressive and underlines the great importance of berry production there. Attendance from Germany, China, France, Spain, Canada, Italy, Japan and Switzerland were next with around 10 participants each.

Pre-symposium tour through southern Germany to Switzerland

On 23 June, about 100 participants met in Frankfurt to take part in the pre-symposium tour. The aim of the excursion was to present new methods in raspberry and blackberry cultivation, as well as currant production. Production systems on field, under rain shelters, plastic tunnels and greenhouses were visited in Germany and Switzerland. Furthermore, production systems offering fruits over a longer period could be viewed. Experiments on regulation of the number of canes per meter or the number of flowers in order to optimise the fruit picking performance were presented, as well as the “annual” cultivation of raspberries, and the possibilities and limits of the use of beneficial insects in strawberries, raspberries and blackber-

ries. The organic cultivation was a topic too. While the focus at the farms in Germany was primarily on soil-dependent raspberry and blackberry production, visitors to the two Swiss farms were able to see production on substrate. Despite the heat, the cultures looked really beautiful and the guests were amazed by the good quality of the berries.

Symposium at the ETH in Zurich

After the excursion, the symposium began at the ETH Zurich on 26 June. Around 200 participants followed the latest horticultural developments and results in 45 lectures and 73 posters on the topics of genetics and breeding, crop management, physiology, plant protection as well as quality and postharvest treatments. By far the most presentations were on genetics and breeding, as well as on crop management, in particular the cultivation of raspberries and blackberries on substrate.

Such a symposium also offers the opportunity for personal exchange and discussion of current problems in the individual countries, as well as to prepare the possibility of cooperation.



› Participants of the symposium.



› The old and the new chairperson of ISHS Working Group *Rubus* and *Ribes* Species and Management: Dr. Pedro N. Brás Oliveira (left) and Dr. Dorota Jarret (right).



› ISHS Medal Award to the three symposium conveners by ISHS representatives. From left to right: C. Finn, USA; K. Hummer, USA; P. Oliveira, Portugal; G. Muster, Germany; E. Krüger, Germany; and C. Carlen, Switzerland.



› Impression from the pre-symposium tour.



› Lisa DeVetter, winner of the ISHS Young Minds Award for the best oral presentation.

ISHS Young Minds Awards

Two junior scientists received the ISHS Young Minds Awards: Dr. Lisa DeVetter, Washington State University, USA, for the best oral presentation entitled “Promoting raspberry plant establishment using polyethylene and biodegradable plastic mulches in spring-planted systems”, and Mr. Fhilmar Raj Jayaraj Mallika, University of Helsinki, Finland, for the best poster entitled “Small RNA deep sequencing for plant virus discovery in cultivated *Rubus* and *Ribes* in Finland”.

Next meeting

Traditionally, the place and date of the next symposium is determined at the end of the symposium. We are looking forward to the

XIII International *Rubus* and *Ribes* Symposium in 2023 in Washington and Oregon, USA, organized by Dr. Lisa DeVetter, Washington State University and Dr. David Bryla, USDA-ARS, Oregon.

New chairperson of ISHS Working Group *Rubus* and *Ribes* Species and Management

A new leader of the ISHS Working Group *Rubus* and *Ribes* Species and Management was elected. Congratulations to Dr. Dorota Jarret from James Hutton Limited, Dundee, Scotland. Many thanks to her predecessor Dr. Pedro N. Brás Oliveira, University of Lisbon, Portugal, for the very good work during the past years.

Many thanks to secretariat of the symposium, the scientific committee, the ETH Zurich, the numerous sponsors, all the participants and the authors of oral presentations and posters.

Christoph Carlen, Gunhild Muster and Erika Krüger



› Dr. Christoph Carlen (right) presenting the ISHS Young Minds Award for the best poster to Mr. Fhilmar Raj Jayaraj Mallika (left).

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› Chenin Blanc International Congress

Division Vine and Berry Fruits

#ishs_dvin

The first Chenin Blanc International Congress held in Angers, France, from 1 to 3 July 2019, “was THE place to be!” The theme of this first Chenin international congress, co-organized with Destination Angers and held under the aegis of the ISHS, was “The Chenin in a changing environment”. The congress was attended by 314 participants from 13 different countries (South Africa, Germany, Belgium, Canada, China, USA, France, Italy, the Netherlands, Romania, UK, Switzerland, and Thailand) who attended over the three days. During the congress, 349 Chenin cuvées from different parts of the world were tasted and 251 participants attended the excellent presentations and sessions.

The current issues regarding ‘Chenin Blanc’ in a fast and powerful changing world were discussed and debated: climate change and its consequences on viticulture, oenology, the adaptability of the Chenin grape, the key point of its versatility, its relationship to terroirs, the Chenin tastes and sensory neurobiology, economic models, markets, segmentation, wine tourism and culture.

Exciting learning tours in the vineyards of Angers and the Loire were related with the morning sessions. The most beautiful Chenin of the world tasting event, revealed its incredible potential of “passeurs de terroirs”, vine growers and winemakers, very beautiful evenings, and the welcome of the city of Angers. The setting was exceptional with a renovated Congress Center. All these elements together made this first congress a success that challenges the next ones.

More than 40 winemakers, oenologists and scientists were present. In addition, Touraine and Anjou vine growers, scientists from

Montpellier and the Loire, and their professional organizations participated.

The spirit of the congress

The spirit of this congress was to give rise to another view on ‘Chenin Blanc’ viticulture in the world: a cross-view of the two major Chenin producing regions, the Loire and South Africa. Other smaller production regions were present. This meeting presented a winemakers’ view, winemakers full of desire to learn and understand the many different points of view of experts, researchers, specialists, sommeliers and other wine-makers; a solidary men and women’s view, forced to adapt to the changes of the 21st century in this wine world; a certain view, the view of the winemaker who seeks new ways, who refuses what is imposed, who wants to understand and choose its future, who fits in the multi-thousand-year history of wine and its place in civilization, in its ability to express terroirs, landscapes, who wants to be free, understood, respected and live worthily from its labour and his work, who respects the consumer. To encourage these exchanges of views, the party was taken on the one hand to rely as much as possible on the on-going projects and on the results provided by scientific research, and on the other, to have a dialogue with practitioners and professionals together around one single cultivar, ‘Chenin Blanc’.

Round tables

The round table discussion, which addressed crucial and very diverse topics for the future of ‘Chenin Blanc’, reflected the spirit of the congress. The topics that were covered included many challenges of tomorrow’s viticulture in a changing environment.

Jean Michel Boursiquot, professor at Montpellier SupAgro, revealed his latest discoveries on ‘Chenin Blanc’ of which he had found an affiliation with the ‘Savagnin’ and the ‘Sauvignon-asse’. He then presented the ampelographic underpinnings of ‘Chenin Blanc’, the essential aspects of their genetics and their diversity. He opened the debate on the steps taken to ensure the conservation and the cultivar improvement for adaptation to a changing environment. The conservatory program of this diversity, conducted in Anjou, was presented by Virginie Grondain (French Institute of Vine and Wine). Research on resistant cultivars was also discussed by Johan Burger, Professor of Molecular Genetics at the University of Stellenbosch, and two nurserymen, Olivier Zekri from the Mercier nursery and Thomas



› Jean Michel Boursiquot presenting the parents of Chenin.

Dormegnies from the Berillon nursery.

The historian, Henri Galinié, former CNRS researcher, revealed his new discoveries on the history of Chenin with the presentation of the oldest historical document currently known on the “encépagement” (planting) in Anjou, in 1804.

Patrick Baudouin, winemaker and president of the Anjou blanc AOC, proposed different thoughts to be discussed about the history of Chenin’s implantation in the Loire between Amboise and Ingrandes sur Loire, an area representing 90% of Chenin’s surface in France: the key to this privileged niche being the versatility of Chenin merging with the specific terroirs of this part of the Loire Valley.

Irina von Bolt told us with passion and humor about the adventure of Steen (Chenin Blanc) in South Africa since the end of the 17th century. Thierry Pelloquet (chief curator of the Heritage of Maine et Loire), Myriam Laidet (Chargé de Mission Heritage and International Mission Val de Loire) and Claude Mettavant (historian) explained how ‘Chenin Blanc’ shaped the landscapes of the Loire, with the vineyards, fences, manor houses, chateaux, the most amazing cellars, gardens and agricultural parks, a remarkable UNESCO World Heritage Site. André Morgenthal (creator of the Old Vine Project SA) explained to us how in South Africa the validity of the heritage is more focused on the collections of old vines, sometimes more than 150 years old, highlighted at the foot of sumptuous wild landscapes.

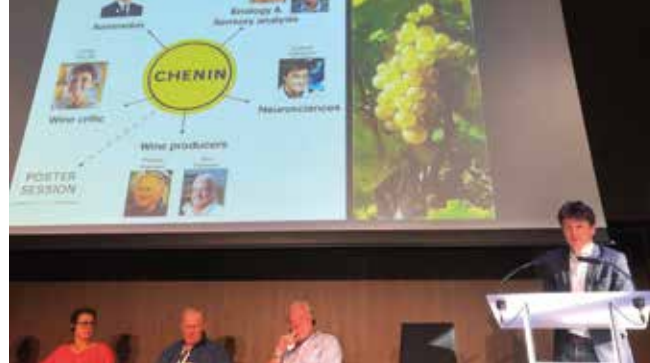
Hervé Hannin, Director of Development of the Institute of Advanced Vine and Wine Studies at Supagro Montpellier, Etienne Neethling (Master in Agro-climatology ESA) and Isabelle Lajeunesse (Associate Professor University of Tours) moderated the round table “Environmental dynamics, challenges and landscapes” on climate change and its possible consequences for the vineyard. This discussion with input from Marco Ventrella (Chief Viticulturist at KWV South Africa) evoked the difference



› Evelyne de Pontbriand, Symposium Convener.



► Dr. François Laurens, ISHS Board Member and President of IHC2022, presenting the ISHS Young Minds Award for the best poster to Chloé Plumas.



► Gabriel Lepousez presenting the taste of Chenin.

of the problems in the Loire and South Africa. Vincente Sotes (Professor, Polytechnic University of Madrid) told us about his experiences with Agudelo (another name for Chenin) in Spain and the climatic problems he has encountered. He presented his model projecting future problems and the spectacular rise of the Mediterranean climate up to the Loire area. A study conducted by the Tours CNRS, with the AOC Montlouis, highlighted the process of developing adaptation strategies by winegrowers.

The following round table discussed the viticultural and oenological itineraries of the Chenin grape's culture and winemaking under the conditions of climate change in France and South Africa.

Laurence Guérin (Vinopole Tours, research on sustainable viticulture) with winemakers presented ideas on a decision support system to predict the maturity of 'Chenin Blanc' berries. He analyzed sugar loading for the last five vintages. Other data by Nicolas Bernard de Vivelys, from a group of winemakers from Anjou, and Laurent Polleau, from the Union of Oenologists of the Loire Valley, discussed the evolution of oenological practices in the Loire. Niel Groenewald from Distell, presented production under new conditions of South Africa. The effects of certain cultural practices, such as the architecture of the vine on the Chenin wine styles, were the topic of posters by Valeria Panzeri and Astrid Buica of the University of Stellenbosch. Ambroise Bécot of the Chamber of Agriculture also explained in a poster the research project on the biodiversity of AOC Chaume and Savennières, with ESA Angers and Agrocampus West.

The tastes of 'Chenin Blanc' were brilliantly evoked by Gabriel Lepousez (RVF Grand Maintenance April 2019), a neurobiologist and

researcher at the Institut Pasteur who is conducting studies to better understand the link between the brain, the senses, olfactory and taste factors, culture and wine tasting. David Biraud, our guest of honor, best sommelier of France in 2002 and Meilleur Ouvrier de France in 2004, finalist in 2016 of the Contest of the Best Sommelier of the World where he ranked 2nd, chief sommelier of the Mandarin Oriental, made the participants' mouths water with the infinite pairings that Chenin Blanc offers in gastronomy. Then professor-researcher in biotechnology, Helene Nieuwoudt, and her team from the University of Stellenbosch, Valeria Panzeri, Jeanne Brand and Astrid Buica, and Hanneke Botha presented results of their analysis of the place of sweet wines on the international white wine market. Pascal Poupault (ITV specialist engineer) completed this picture with elements that characterize the wine profile in a relevant and objective way. Patrick Baudouin rebounded on Gabriel Lepousez's scientific presentation to call upon the delay that takes the profession to accept the diversity of expression of Chenin and its evolution, in relationship to the sensory and cultural biological diversity of the tasters and of the market.

Lastly, the economic stakes of 'Chenin Blanc' wines and proposed options were discussed, as well as marketing strategies such as an innovative wine tourism.

Ken Forrester (President South Africa Chenin Blanc Association and winemaker) and Jonathan Steyn (Wine Business Management University of Cape Town) shared their vision of 'Chenin Blanc' economy.

Fanny Gauthier of Interloire's Economic Analysis Service gave a very complete picture of the key figures for the American and European Chenin markets, published recently.

Jeremy Arnaud (Terroir Manager consultant) presented to the participants the main lines of the study made with the 'Chenin Blanc' producers of AOC Anjou (Groupe Chenin) and the proposed strategy: 'Chenin Blanc' "fan-clubisation".

Finally, André Deyrieux (WineTourism Consulting), author of "For a better knowledge of modest and forgotten grape varieties - the other taste of wines" pictured wine tourism as a creator of the imaginary and totally corresponding to the current demand of consumers by positioning 'Chenin Blanc' in

the context of the multi-thousand-year-old wine civilization, wine-growing landscapes and human encounters. André Morgenthal of Old Vine Wine Cellars gave an excellent example of this potential of imaginative creation by wine tourism, making us dream considering the incredible quality of the vineyard landscapes of South Africa and the tourism developed around the wine in this same country. Evelyne de Pontbriand, from Domaine du Closel in Savennières, summarized the elements brought to the participants at the various round tables and visits during the three days of the congress, highlighting how these elements enriched the construction of a common speech, a common imaginary world of Chenin Blanc between South Africa and the Loire.

ISHS Young Minds Award

The ISHS Young Minds Award was presented to Chloé Plumas from the Laboratory CNRS, University of Tours, France, for the best poster entitled "Perceptions of climate change and adaptation strategies implemented by the winegrowers of the Méntrida Denomination of Origin".

The tasting

A 'Chenin Blanc' International Congress could not be done without an exceptional tasting of 'Chenin Blanc' wines from all over the world. It was organized by the Federation Viticole d'Anjou. More than 350 samples from around the world were received, catalogued and staged by wine region and style; sparkling, dry, semi-dry and mellow. This tasting was highly appreciated, especially by sommeliers and wine journalists who had never had the opportunity to apprehend in this way the remarkable versatility of the Chenin grape cultivar and its potential.

The learning expeditions

In the afternoon, guided tours by the speakers were organized to illustrate the themes of the round tables and to discover the landscapes of Anjou and Touraine: Savennières, Quarts de Chaume, Saumur and the Loire as well as tastings on the Loire Tourangelle Chenins de Touraine, in particular Vouvray.

Evenings in Anjou

The congress was a remarkable place for



► Henri Galinié presenting the 1804 archive.

human encounters: lunches in the lobby of the Convention Center overlooking the beautiful botanical garden of Angers and the evenings were rich moments of friendly, international exchanges in emblematic Anjou heritage sites: a welcome cocktail at the Museum of Fine Arts offered by the city of Angers, then a Gala dinner at the Royal Abbey of Fontevraud and finally the evening of the Ambassadors of the Mayor of Angers to close after some enthronements by the Bacchic Brotherhoods before passing the torch to South Africa for the next edition in 2021.

Conclusion

Hervé Hannin from Supagro Montpellier closed the congress with our guest of honor,

sommelier David Biraud, stressing the importance of these international perspectives on Chenin Blanc's different issues in our changing environment, which allow us to start a scientific multifaceted debate, a desire to work together, to understand together the issues, to find solutions, to build the future while evoking the immense taste pleasures of great wines from this surprising cultivar. The congress paid tribute to Christian Asselin, pioneer of the renaissance of Chenin Blanc in Anjou and Touraine. Patrick Baudouin concluded by calling on all delegates to reflect and work together, in all their areas of expertise, to find human and sustainable responses, for the vineyards and for the society, to the current climate upheavals.

All presentations are available at www.academieduchenin.org. Full text papers will be published in the *Acta Horticulturae* congress proceedings.

Evelyne de Pontbriand

> Contact

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> New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Argentina: Prof. Dr. Juan Carlos Diaz Ricci;
Armenia: Ms. Syuzanna Hovsepyan;
Australia: Dr. Fran Doerflinger, Mr. Dallas Hill, Ms. Joanna Kristoffersen, Gamila MacRury, Ms. Linda Marchesani, Dr. Dylan McFarlane, Mr. Shane Phillips, Mr. Adam Pratt, Mr. Giovanni Recchia; **Bangladesh:** Prof. Dr. Md. Anwar Hossain, Mr. Azizul Huque; **Belarus:** Dr. Natallia Klakotskaya, Assoc. Prof. Roman Puhachov; **Belgium:** Mr. Dieter Baets, Joris Cambie, Mr. Johan Jacobs, Stef Laurijssen, Ms. Prisca Meyer, Mr. Hans Vanderhallen, Ms. Emmanuelle Verdecchia, Dr. Jarinda Viaene, Dr. Yijie Zhao; **Benin:** Mr. Mathieu Ayanan; **Bosnia and Herzegovina:** Prof. Dr. Lutvija Karic; **Brazil:** Prof. Dr. Clíssia Barboza da Silva, Mr. Everton Carvalho, Prof. Cicero Deschamps, Dr. Laudecir Raiol Júnior, Dr. Márcio Rosa; **Bulgaria:** Ms. Diyana Aleksandrova, Dr. Nataliya Dimitrova; **Canada:** Ms. Nivethika Ajeethan, Mr. Thomas Albaret, Mr. Kenneth Anku, Peniel Bustamante Villalobos, Dr. Eve-Catherine Desjardins, Prof. Dr. Annie Deslauriers, Ms. Maty Diop, Assist. Prof. Travis Esau, Dr. Eric Gerbrandt, Ms. Amrita Ghosh, Dr. Kirsten Hannam, Mr. Austin Lloyd, Mr. Simon Morvan, Prof. Dr. Maxime Paré, Kaaren Pearce, Dr. Joana Pico Carbajo, Ms. Lila Naouelle Salhi, Dr. Jatinder Sangha, Mr. Umanath Sharma, Ms. Maryam Shojaei, Dr. Nadler Nahindy Simon, Dr. Tyler Smith, Dr. Marion Tétégan Simon, Dr. Scott White, Ms. Yifan Yan; **Chile:** Nicolas Cobo, Dr. Juan Hirzel,

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From the
Secretariat

> In memoriam

Chad E. Finn (1962-2019)



Dr. Chad Elliott Finn, USDA-ARS research geneticist, Corvallis, Oregon, USA, died on December 17, 2019, from injuries suffered in a tragic accident while on vacation in Hawaii. He is survived by his wife Barb Fick, their sons Elliott and Ian Finn, his brothers Dan, Mark, and Bart Finn, his sister Beth Madden, extended family, and many friends.

Chad was an extremely accomplished scientist, had valued colleagues throughout the world, and believed in serving industry and professional organizations including the American Society for Horticultural Science (ASHS) and the ISHS. He was known for living life to its fullest, his boisterous, joyful personality, booming, infectious laugh, and enveloping, strong hugs. Chad had a clear passion for horticulture sharing this with students, industry, colleagues, and friends worldwide. All who knew him respected him and considered him a friend. Dr. Finn was born in Indiana and grew up in Maryland. He attained his Bachelor's degree in Horticulture Production from Purdue University (1983) and his M.S. and Ph.D. (1989) in Horticulture with a Minor in Plant Breeding from the University of Minnesota, with Dr. James Luby. He then accepted a position as an extension fruit horticulturist at the University of Missouri, Columbia. In 1993, he joined the USDA-

ARS Horticultural Crops Research Unit, as a Research Geneticist in berry crops. Chad was a perfect match for this unique position, part of the only government-university cooperative breeding program in the world. He served as the USDA-ARS breeder and I, as the OSU horticulturist partner, co-releasing cultivars. We had a very close working relationship in a cooperative breeding program that is over 100 years old. In his 26-year career, Chad developed what many consider the most diverse berry crop breeding program in the world with significant germplasm and cultivar development in blackberry, black and red raspberry, strawberry, and blueberry. He was part of multiple plant collecting trips in the USA, Canada, Ecuador, and China, searching for *Rubus* and *Vaccinium* germplasm that could provide useful traits. He released or co-released 51 new cultivars (21 blackberry, 11 red raspberry, 12 strawberry, and 7 blueberry). His first genetically thornless trailing blackberries, 'Black Diamond' and 'Columbia Star', are major cultivars in Oregon. 'Columbia Star' is also grown in Europe. His early-season 'Obsidian' blackberry is grown for fresh market in Oregon and Europe. Chad recently released 'Galaxy', 'Eclipse', and 'Twilight', the first to combine eastern traits and western trailing ones, for late-season fresh market. In strawberry, 'Tillamook', with high yield, large berry size, and high picking efficiency, dominates the area planted in Oregon. 'Vintage' and 'Kokanee' primocane-fruiting raspberry are grown throughout North America. His most recent commercial blueberry 'Mini Blues' is unique in producing very small, exceptionally-flavored fruit for a machine-harvested processed niche market. The impact of his cultivars to nurseries and growers in the northwestern region of the USA was over US\$450 million for the last 10 years. He worked with colleagues of diverse disciplines (e.g. molecular biologists, flavor chemists, plant pathologists, virologists, horticulturists, breeders) to evaluate a wide range of traits and worked actively to develop molecular markers for traits of interest. He shared

knowledge with peers through a prolific record of journal articles and presentations at conferences. Chad also loved sharing his expertise with industry and students. He was active in undergraduate and graduate student education and was lauded as an exceptional mentor for students and junior scientists.

Dr. Finn was a leading authority on berry crop cultivars and breeding, receiving over 50 international speaking invitations. He also hosted visiting scientists from 27 countries and 30 USA States. Chad was active in ISHS serving on the Scientific Committees for *Rubus* and *Ribes*, *Vaccinium*, and Strawberry symposia since 2001. He co-convened (with me) the IX International *Vaccinium* Symposium (2008) in Corvallis, Oregon and the II International Berry Fruit Symposium (2014) in Brisbane, Australia. He was an active member of the American Pomological Society, serving on advisory committees and the Executive Board. He co-edited the blackberry and hybridberry (1999-2013) and strawberry (1999-2009) Fruit and Nut Cultivar Lists. He was active in the N.A. Raspberry and Blackberry Growers' Association (NARBA) and the N.A. Strawberry Growers' Association, serving on the research committee and board of the latter.

In recognition of his innovativeness and the impact of his research, Dr. Finn received a USDA-ARS Technology Transfer award, was elected a Fellow of ASHS in 2010, received the American Pomological Society's Wilder Medal and a Federal Laboratory Consortium Far West Regional Award, and was honored as a Distinguished Alumnus by Purdue University's Department of Horticulture. In March 2020, NARBA will honor Chad posthumously with the Distinguished Service Award.

The world has lost an outstanding berry crop breeder and an amazing colleague and friend of many. Chad will be long remembered for his accomplishments, generosity, big heart, and bright personality. He will be greatly missed.

*Bernadine C. Strik,
Oregon State University, USA*

> Calendar of ISHS events

For updates and extra information go to www.ishs.org and check out the calendar of events. Alternatively use the “science” option from the website navigation menu for a comprehensive list of meetings for each Division or Working Group.

To claim reduced registration for ISHS members, your personal membership number is required when registering - ensure your ISHS membership is up-to-date before registering. If in doubt, sign in to your membership account and check/renew your membership status first: www.actahort.org or www.ishs.org

Year 2020

- April 22-26, 2020, Uvero Alto, La Altagracia (Dominican Republic): **X International Pineapple Symposium**. Info: Mr. Joelin Santos, AsoproPimopla, C/ Altagracia 100, Monte Plata, Dominican Republic. Phone: (829)745-0318, E-mail: j.santos@asopropimopla.org E-mail symposium: xpineapple2020@gmail.com Web: <http://www.cedaf.org.do/eventos/xpineapple2020/>
- May 17-20, 2020, Leuven (Belgium): **XIII International Controlled and Modified Atmosphere Research Conference - CaMa2020**. Info: Prof. Bart Nicolai, Flanders Centre for, Postharvest Technology, W. De Croylaan 42, 3001 Heverlee, Belgium. Phone: (32)16322375, Fax: (32)16322955, E-mail: bart.nicolai@biw.kuleuven.be or Dr. Maarten Hertog, BIOSYST-MeBioS, K.U. Leuven, de Croylaan 42 - bus 2428, B-3001 Heverlee, Belgium. Phone: (32)16322376, Fax: (32)16322955, E-mail: maarten.hertog@kuleuven.be Web: <https://cama2020.org/>
- May 20-22, 2020, Torino (Italy): **IV International Symposium on Woody Ornamentals of the Temperate Zone**. Info: Prof. Dr. Valentina Scariot, Università degli Studi di Torino, Dept. Agric., Forestry & Food Sci., Largo Paolo Braccini 2, 10095 Grugliasco, Torino, Italy. Phone: (39)0116708932, Fax: (39)0116708798, E-mail: valentina.scariot@unito.it or Prof. Dr. Gabriele Loris Beccaro, Università degli Studi di Torino, Dept. Agric., Forestry & Food Sci., Largo Paolo Braccini 2, 10095 Grugliasco, Torino, Italy. Phone: (39)0116708802, Fax: (39)116708658, E-mail: gabriele.beccaro@unito.it E-mail symposium: woodyornamentals2020@unito.it Web: <https://www.woodyornamentals2020.com/>
- June 2-6, 2020, Stuttgart (Germany): **IV International Symposium on Horticulture in Europe - SHE2020**. Info: Prof. Dr. Jens N. Wünsche, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70593 Stuttgart, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de or Dr. Michael Helmut Hagemann, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70599 Stuttgart, Germany. Web: <https://she-ihf-fav2020.de/>
- June 2-6, 2020, Stuttgart (Germany): **V International Humulus Symposium**. Info: Prof. Dr. Jens N. Wünsche, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70593 Stuttgart, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de or Dr. Michael Helmut Hagemann, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70599 Stuttgart, Germany. Web: <https://she-ihf-fav2020.de/>
- June 2-6, 2020, Stuttgart (Germany): **VIII International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2020**. Info: Prof. Dr. Jens N. Wünsche, University of Hohenheim, Department of Crop Science, Section Crop Physiology of Specialty Crops, Emil-Wolff-Str. 25, 70593 Stuttgart, Germany. Phone: (49)711-459-22368, Fax: (49)711-459-22351, E-mail: jnwuensche@uni-hohenheim.de or Prof. Dr. Bhimanagouda Patil, VFIC, Texas A&M University, Department of Horticulture, 1500 Research Parkway Ste A120, College Station, TX 77845, United States of America. Phone: (1)9794588090, Fax: (1)9798624522, E-mail: b-patil@tamu.edu Web: <https://she-ihf-fav2020.de/>
- June 7-11, 2020, Ma'ale HaHamish (Israel): **IX International Symposium on Mineral Nutrition of Fruit Crops**. Info: Dr. Uri Yermiyahu, Gilat Research Center, Soil and Water, Mobile Post Negev 85280, Israel. Phone: (972)89928649, Fax: (972)79926485, E-mail: uri4@agri.gov.il or Dr. Arnon Dag, Plant Sciences, Gilat Research Center, Agricultural Research Organization, (The Volcani Center), Mobile Post Negev, 85280, Israel. Phone: (972)506220155, Fax: (972)89926485, E-mail: arnondag@agri.gov.il Web: <https://www.ortra.com/events/mnutrition2020>
- June 7-11, 2020, Moscow (Russian Federation): **XV International Symposium on Virus Diseases of Ornamental Plants**. Info: Dr. Tatiana Mitouchkina, Branch of Institute of Bioorganic Chemistry, Science av.6, 142290 Moscow region Pushchino, Russian Federation. Phone: (7)4967731779, Fax: (7)4967731779, E-mail: tatiana@planta.bio Web: <http://isvdop2020.ru/>
- June 8-12, 2020, Malmö (Sweden): **IX International Symposium on Light in Horticulture**. Info: Assist. Prof. Most Tahera Naznin, Department of Biosystems and Technology, Swedish University of Agricultural Sciences, Box 103, 23053 Alnarp, Sweden. Phone: (46)40415019, E-mail: naznin.most.tahera@slu.se or Dr. Maria Karlsson, Växtskyddsvägen 3, skne, Hunnestorpsvägen 29, skne, 23053 BstadAlnarp, Sweden. Phone: (46)40-415370, E-mail: maria.e.karlsson@slu.se or Prof. Dr. Beatrix Waechter Alsanus, Dept. of Biosystems and Technology, SLU, Box 103, 230 53 Alnarp, Sweden. Phone: (46)40415336, E-mail: beatrix.alsanus@slu.se E-mail symposium: ISHSLight2020@slu.se Web: <https://www.ishslight2020.se/>
- June 21-26, 2020, Coimbra (Portugal): **VIII International Symposium on Production and Establishment of Micropropagated Plants**. Info: Prof. Dr. Jorge Canhoto, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)239855210, Fax: (351)239855211, E-mail: jorgecan@ci.uc.pt or Dr. Sandra Correia, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal. Phone: (351)239240700, Fax: (351)239240701, E-mail: sandraimc@ci.uc.pt E-mail symposium: pempishs.coimbra2020@uc.pt Web: <http://www.uc.pt/en/uid/biotec/events/pempishscoimbra2020>
- July 7-10, 2020, Zlatibor (Serbia): **XII International Symposium on Plum and Prune Genetics, Breeding and Pomology**. Info: Dr. Darko Jevremovic, Kralja Petra I 9, 32000 Cacak, Serbia. Phone: (381)32321375, Fax: (381)32321391, E-mail: darkoj@ftn.kg.ac.rs E-mail symposium: plum2020@institut-cacak.org Web: <http://www.plum2020.com>
- July 22-24, 2020, Bogor, West Java (Indonesia): **II International Symposium on Tropical and Subtropical Ornamentals**. Info: Dr. Syarifah Iis Aisyah, Dept. of Agronomy and Horticulture, IPB, Jl. Meranti, Kampus IPB Darmaga, 16680 West Java Bogor, Indonesia. Phone: (62)2518629353, E-mail: [syarifahiis@yahoo.com](mailto:syarifahis@yahoo.com) or Dr. Dewi Sukma, Department of Agronomy and Horticulture,

Bogor Agricultural University, Jl. Meranti Kampus IPB Dramaga, 16680 Bogor, Indonesia. Phone: (62)-251-8629353, Fax: (62)-251-8629353, E-mail: dsukma70@yahoo.com E-mail symposium: tso2020indonesia@gmail.com Web: <http://tso2020.ipb.ac.id>

■ July 26-31, 2020, Wenatchee, WA (United States of America):

XII International Symposium on Integrating Canopy, Rootstock and Environmental Physiology in Orchard Systems.

Info: Prof. Stefano Musacchi, Washington State University, TFREC, 1100 N. Western Ave., Wenatchee, WA 98801-1230, United States of America. Phone: (1)509-663-8181, Fax: (1)509-662-8714, E-mail: stefano.musacchi@wsu.edu E-mail symposium: info@2020orchardsystems.com Web: <https://2020orchardsystems.com/>

NEW

■ August 25-28, 2020, Bangalore (India): **International Symposium on Tropical and Subtropical Viticulture.**

Info: Prof. Dr. Dilipraj Patil, Associate director of Research, MHREC, University of Horticultural Sciences, Udyanagiri, Bagalkot, 587104, India. E-mail: adrebagalkot@uhsbagalkot.edu.in or Dr. Girigowda Manjunatha, Officer In-charge, Bio-control laboratories, Directorate of Horticulture, University of Horticultural sciences, Bagal, Karnataka, 570020, India. Phone: (91)9916219697, E-mail: gmanjunath2007@gmail.com Web: <http://iststvbagalkot2020.com/>

■ August 29 - September 3, 2020, Halifax, Nova Scotia and Charlottetown, Prince Edward Island (Canada): **XII International Vaccinium Symposium.**

Info: Prof. Dr. David Percival, Dalhousie University, Department of Plant, Food, and Environmental Sciences, PO Box 550, Truro, NS B2N 5E3, Canada. Phone: (1)9028937852, Fax: (1)9028931404, E-mail: david.percival@dal.ca Web: <http://www.Dal.ca/ivs>

■ September 7-10, 2020, Palermo (Italy): **International Symposium on Tropical and Subtropical Horticulture in Mediterranean Climate.**

Info: Prof. Vittorio Farina, Università degli Studi di Palermo, Dipartimento Scienze Agrarie, Alimentari e Forestali, viale delle Scienze edif 4 - 90128 Palermo, Italy. Phone: (+39)09123896090, E-mail: vittorio.farina@unipa.it or Dr. Giuseppe Sortino, Department of Agricultural & Forest Science, University of Palermo, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39)09123861234, E-mail: giuseppe.sortino@unipa.it E-mail symposium: info@tropmed2020.it Web: <http://www.tropmed2020.it>

■ September 21-24, 2020, Palermo (Italy): **II International Symposium on the Role of Plant Genetic Resources in Reclaiming Lands and Environment Deteriorated by Human and Natural Actions.**

Info: Prof. Francesco Marra, Department of Agricultural & Forest Science, Viale delle Scienze, Edificio 4 ingresso H, 90128 Palermo, Italy. Phone: (39)09123861236, Fax: (39)09123861211, E-mail: francescopaolo.marra@unipa.it or Dr. Emilio Badalamenti, Viale delle Scienze, Palermo, Italy. E-mail: emilio.badalamenti@unipa.it E-mail symposium: info@ispgr-it2020.it Web: <http://www.ispgr-it2020.it>

■ September 24-26, 2020, Ohrid (North Macedonia): **VIII South-Eastern Europe Symposium on Vegetables and Potatoes.**

Info: Prof. Dr. Gordana Popsimonova, Debarca 16, 1000 Skopje, North Macedonia. Phone: (389)70255878, E-mail: gpopsimonova@yahoo.com or Skender Kaciu, Univ. of Prishtina-Faculty of Agri., and Veterinary, Boulevard B.Clinton bb, 10000 Prishtina, Kosovo. E-mail: skenderkaciu@yahoo.com E-mail symposium: contact@ishs8.org Web: <https://ishs8.org/>

■ September 28-30, 2020, Bari (Italy): **I International Symposium on Plant Propagation, Nursery Organization and Management for the Production of Certified Fruit Trees.**

Info: Prof. Salvatore Camposeo, Università di Bari, Dipt. di Scienze Agro-Ambientali e Territor, Via Amendola 165/a, 70126 Bari, Italy. Phone: (39)0805442982, Fax: (39)0805442982, E-mail: salvatore.camposeo@uniba.it or Prof. Dr. Tiziano Caruso, Department of Agricultural & Forest Science, University of Palermo, Viale delle Scienze, Edificio 4

ingresso H, 90128 Palermo, Italy. Phone: (39) 09123861207, E-mail: tiziano.caruso@unipa.it or Prof. Vito Nicola Savino, University of Bari - Microbiologia Applic., Dip. Protezione delle Piante, Via Amendola 165a, 70126 Bari, Italy. Phone: (39)0805443069, Fax: (39)0805443608, E-mail: vitonicola.savino@uniba.it E-mail symposium: info@certfruit2020.org Web: <http://www.certfruit2020.org>

■ October 5-8, 2020, Catania (Italy): **III International Organic Fruit Symposium and I International Organic Vegetable Symposium.**

Info: Prof. Dr. Ferdinando Branca, Di3A, Università di Catania, Via Valdisavoia 5, 95123 Catania, Italy. Phone: (39)095234307, Fax: (39)095234329, E-mail: fbranca@unict.it or Dr. Alberto Continella, University of Catania, Via Valdisavoia 5, Catania, Italy. Phone: (39)095-234455, Fax: (39)095-234406, E-mail: acontine@unict.it or Dr. Alessandro Tribulato, via Valdisavoia, 5, 95123 Catania, Italy. Phone: (39) 095 234328, Fax: (39) 095 234329, E-mail: atribula@unict.it E-mail symposium: info@orghort2020.it Web: <https://www.orghort2020.it/>

■ October 6-9, 2020, Yalova (Turkey): **X International Symposium on Kiwifruit.**

Info: Dr. Arif Atak, Horticultural Central Research Institute, Yalova, Turkey. Phone: (90)2268142520, Fax: (90)2268141146, E-mail: atakarif@gmail.com E-mail symposium: secretariat@kiwi2020.org Web: <http://www.kiwifruit2020.org/>

■ October 11-15, 2020, Stellenbosch (South Africa): **XI International Symposium on Grapevine Physiology and Biotechnology.**

Info: Melané Vivier, Institute for Wine Biotechnology, Department of Viticulture and Oenology, Private Bag x1, Matieland, 7602, South Africa. Phone: (27)218083773, Fax: (27)218083771, E-mail: mav@sun.ac.za or Johan Burger, Stellenbosch University, Department of Genetics, Private Bag X1, Matieland, 7002 Stellenbosch, South Africa. E-mail: jtb@sun.ac.za Web: <http://www.isgpb2020.com>

■ October 11-15, 2020, Nara (Japan): **VII International Symposium on Persimmon.**

Info: Prof. Dr. Keizo Yonemori, Faculty of Agriculture, Ryukoku University, 1-5 Yokotani, Seta Oe-cho, Otsu 520-2194, Siga, Japan. Phone: (81)775995695, Fax: (81)775995608, E-mail: keizo@agr.ryukoku.ac.jp E-mail symposium: 2020persimmon@gmail.com Web: <http://kaki2020.jshs.jp>

■ October 14-17, 2020, Nanjing (China): **V International Symposium on Biotechnology and Molecular Breeding in Horticultural Species.**

Info: Jun Wu, Nanjing Agricultural University, College of Horticulture, Nanjing, Jiangsu, 210095, China. E-mail: wujun@njau.edu.cn or Prof. Dr. Shaoling Zhang, Nanjing Agricultural University, 1 Weigang, 210095 Nanjing, China. E-mail: nnzsl@njau.edu.cn Web: <http://www.bmbh2020.org>

■ October 15-17, 2020, Kansas City, MO (United States of America): **XV International People Plant Symposium and II International Symposium on Horticultural Therapies.**

Info: Dr. Candice Shoemaker, 2021 Throckmorton, Department of Hort, Forestry, Rec Res, Kansas State University, Manhattan, KS 66506, United States of America. Phone: (1)7855321431, Fax: (1)7855326849, E-mail: cshoemak@ksu.edu

NEW

■ October 19-24, 2020, Kunming (China): **XII International Symposium on Banana: ISHS-ProMusa Symposium on Healthy Banana Production Systems for Better Livelihoods.**

Info: Sijun Zheng, Beijing Lead 2238, Kunming, Yunnan, 65020, China. E-mail: s.zheng@cgiar.org E-mail symposium: symposium@promusa.org Web: <http://www.promusa-yaas.com/mtweb/en/>

■ October 25-28, 2020, Seoul (Korea (Republic of)): **III International Symposium on Germplasm of Ornamentals.**

Info: Prof. Dr. Byoung Ryong Jeong, Department of Horticulture, 501 Jinju-daero, Gyeongsang National University, Jinju, Gyeongnam 52828, Korea (Republic of). Phone: (82)55-772-1913, Fax: (82)55-757-7542, E-mail: brjeong@gmail.com Web: <http://www.isgo2020.org>

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> *Chronica Horticulturae* author information

Chronica Horticulturae is the quarterly publication of the International Society for Horticultural Science (ISHS) and is received by all members of the Society and numerous libraries throughout the world. Members and non-members are urged to contribute articles for consideration. However, it needs to be understood that *Chronica* is not to be construed as a scientific journal that publishes original research. Research articles appropriate for *eJHS*, *Fruits* or *Acta Horticulturae* are usually inappropriate for *Chronica*. We seek horticultural articles of interest to a broad audience composed of ISHS members and the horticultural, scientific, and academic communities.

Chronica Horticulturae is currently made up of as many as nine sections as follows:

News & Views from the Board. This section is usually confined to editorials from Board Members as well as general announcements of the Society.

Issues. Articles of a broad focus that often involve controversial topics related to horticulture, including broad social issues and economic development, are appropriate for this section. These articles are intended to stimulate discussion. Often, guest writers are invited to contribute articles.

Spotlight on Honoured ISHS Members. ISHS Fellows and Honorary Members complete an interview on how they started and progressed in their careers, what affected their decisions and attitudes and how their involvement with ISHS assisted them. In addition, they are invited to comment on how they see the future of horticultural science for young people. Articles in this section are by invitation only.

Horticultural Science Focus. This section is intended for in-depth articles on a topic of horticulture that is generally, but not always, scientific in nature. Many articles are mini-reviews and will provide up-to-date information on current topics of interest to the horticultural community. We encourage these articles to be illustrated.

Horticultural Science News. Shorter articles about current topics including horticultural commodities and disciplines are welcome.

History. This section includes articles on the history of horticulture, horticultural crops, and ISHS.

The World of Horticulture. Articles in this section highlight horticultural industries and research institutions of particular countries or geographic regions throughout the world. Illustration with figures and tables is extremely helpful and highly advised. This section also includes book reviews that are requested by the Editor. Members who wish to recommend a book review should arrange for a copy of the book to reach the Secretariat.

Symposia and Workshops. Meetings under the auspices of ISHS are summarized, usually by a participant of the meeting. These articles are arranged by the symposium organizers.

News from the ISHS Secretariat. This section contains information on membership, memorials of deceased ISHS members, and a calendar of ISHS events. Brief memorials (up to 500 words) should be sent to the Secretariat.

Authors who wish to submit articles for publication in *Chronica* should contact ISHS headquarters and their request will be transmitted to the Editor. Authors should be aware that most articles should have a broad international focus. Thus, articles of strictly local interest are generally unsuited to *Chronica*. Illustrated articles are usually 1500 to 5000 words long. There are no page charges for *Chronica Horticulturae*. Photographs submitted should be of high resolution (≥ 300 pixels per inch). Send articles or ideas for articles to:

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