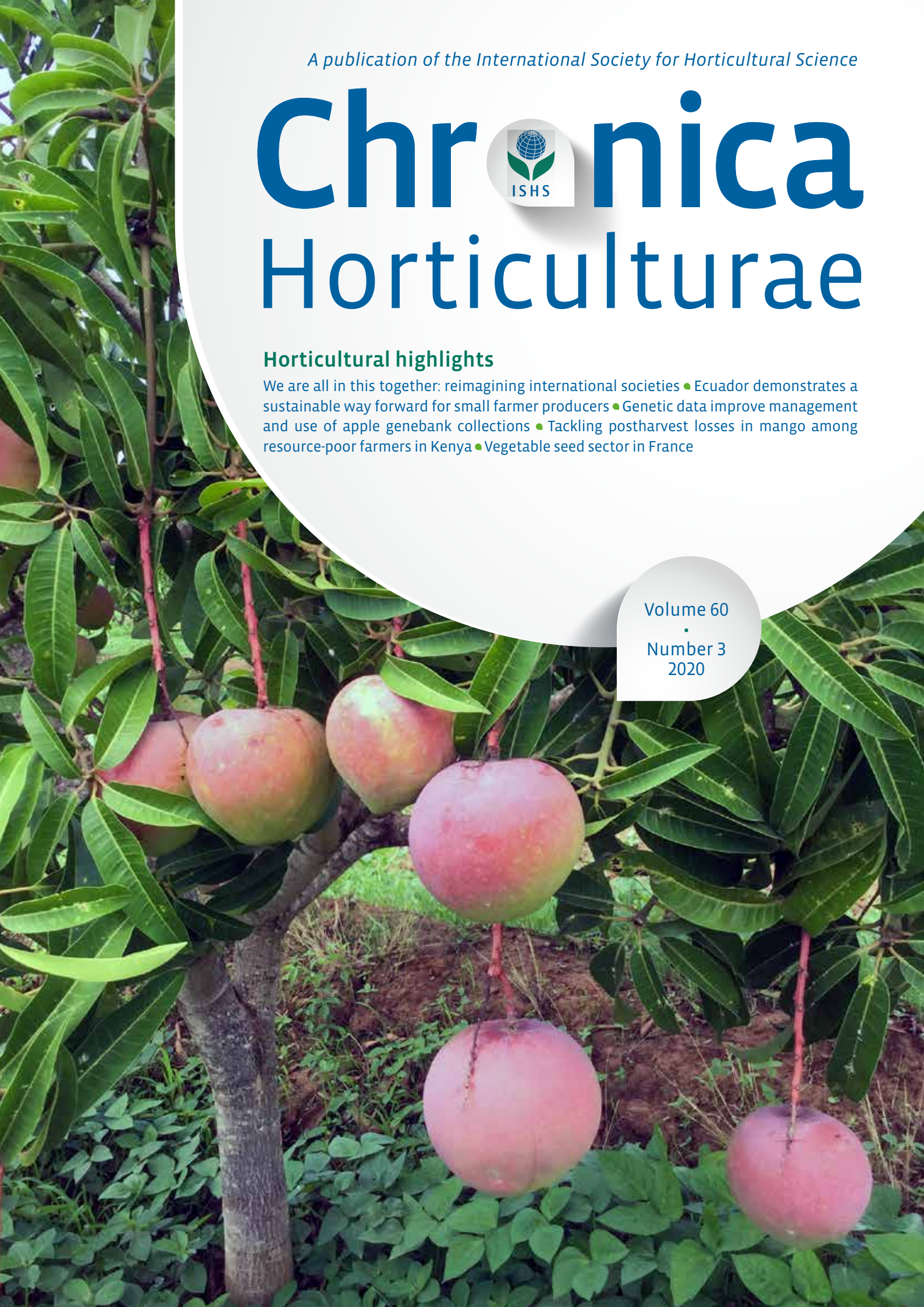
A publication of the International Society for Horticultural Science

Chronica Horticulturae

Horticultural highlights

We are all in this together: reimagining international societies • Ecuador demonstrates a sustainable way forward for small farmer producers • Genetic data improve management and use of apple genebank collections • Tackling postharvest losses in mango among resource-poor farmers in Kenya • Vegetable seed sector in France



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Cover photograph: 'Apple mango' fruits ready for harvest in a typical smallholder farm in Embu County, Kenya. See article p.28.

Coping with the effects of COVID-19

Yüksel Tüzel, President of ISHS

› Yüksel Tüzel

The COVID-19 outbreak is a serious threat with serious implications on our health, well-being, and lifestyles, and has already resulted in tragic consequences around the world. It also significantly impacts on all sectors and work worldwide. Most of us have now changed our daily lives and have been practicing self-isolation for up to three to four months. Working from home has become the norm. Even in the "normalization" period, which has already started in many countries, though in a stepwise approach, we are not sure how our lifestyles will continue to be impacted by the pandemic or for how long.

The impact has been different from sector to sector and region to region throughout the horticultural value chain actors. The working conditions did not change much in the agricultural sector, but the social distancing created the need for additional arrangements and increased the cost of business. Logistical challenges within supply chains, particularly border closures, quarantines, as well as shortages in labor availability, caused huge disruptions in the food supply at large but also in the horticultural value chains (ILO, 2020; Poudel et al., 2020). For instance, the results of a joint survey by the International Association of Horticultural Producers (AIPH) and FloraCulture International Magazine (FCI) show that the impact of COVID-19 was severe on their members due to the loss of sales because of the interruption in the logistic supply chain (AIPH, 2020). In the UK, The National Farmers Union reported the difficulty of accessing the usual workforce due to the travel restrictions (Skentelbery, 2020). In Africa, with high dependence on importation of seeds of exotic vegetables and ornamentals and other inputs, import restrictions have triggered shortages and price hikes of these commodities. However, increased food demand and fruit and vegetable consumption during the outbreak has highlighted the importance of agricultural and horticultural products. Agriculture will continue to be an essential industry. Among the horticultural crops, the highest negative impact was on the demand for floricultural crops in almost every country.

ISHS activities

ISHS is a truly global Society, with members from 125 countries and from across all horticultural sectors and disciplines. One of the aims of ISHS is "*to facilitate cooperation and knowledge transfer on a global scale through its symposia and congresses, publications and scientific structure*". Specialized symposia are organised under the aegis of ISHS on technical subjects – crop or research area oriented at the worldwide scale. The biggest events of ISHS are quadrennial international congresses (IHC), and regional congresses (Asia, Europe and Africa) held on even years between IHCs. These meetings are critical for the success of ISHS. They promote effective communication among researchers, institutions, and the private sector, demonstrating the leadership role of ISHS in international scientific cooperation for horticulture at all levels.

On average, between 2010 and 2019, the ISHS annually sponsored 43 symposia including those organized at the International Horticultural Congresses, in 2010, 2014, and 2018 (Figure 1).

The pandemic significantly affected our meeting schedules. The restrictions for meeting in large groups and the domestic and foreign travel bans forced most meetings planned for 2020 to be cancelled or rescheduled (see the ISHS website for the latest schedule changes). This delay of meetings may also affect our memberships in 2020, because many new members sign up when they register for their symposium of interest. Prior to the onset of COVID-19, we had 38 scheduled symposia for 2020.

In the second year after IHC2018, our usual Society calendar scheduled three regional congresses. Not only were 33 symposia postponed or cancelled, but the Asian Horticultural Congress (AHC), the International Symposium on Horticulture in Europe (SHE), and the All Africa Horticultural Congress (AAHC) have also been postponed. While this has caused anguish and difficulties for conveners, meeting venues and hotels have generally been understanding and willing to reschedule within one year. A number of conveners have determined that rescheduling for a later date is the best way to proceed. Happily, a few symposia are rescheduled for the end of this year. The Asian Horticultural Congress (AHC2020), scheduled for May 2020 has been moved to December 2020. Although the number of ISHS meetings for 2020 has dropped dramatically, 35 *Acta Horticulturae* are expected to be published in 2020 as planned, including ones remaining from the previous years' symposia (Figure 2).

The cancellation and/or postponement of meetings has had significant effects on networking and communication opportunities between our members and with other researchers in similar disciplines. ISHS meetings have always provided an excellent opportunity for participants to present their work, and exchange information and ideas. The shared scientific discussions and debates that occur at symposia form a bond between members within their scientific field. These

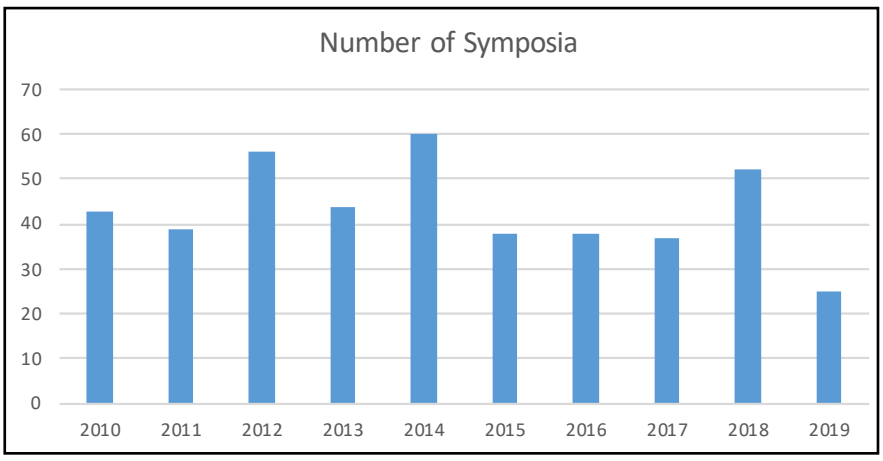

Figure 1. The number of ISHS symposia held annually since 2010.

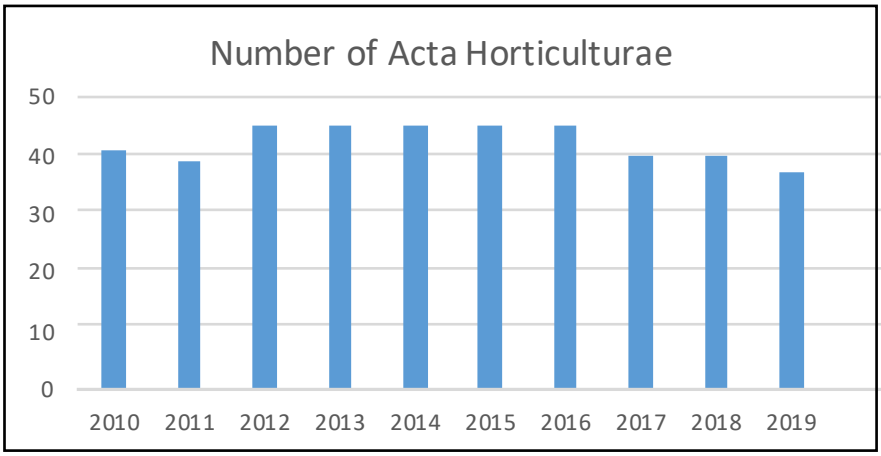

Figure 2. The number of *Acta Horticulturae* published annually since 2010.

meetings broker many new research cooperations at national and international levels and these associations have been missed as we shelter-in-place. Nonetheless, we need to be positive and think that in the near future we will have a chance to reconvene.

Although we are now working from home and have become "experts" in online communication programs, we miss each other and the cultural and social atmosphere of an ISHS symposium. While these digital platforms are effective, they do not compare to in-person discussions, forging new friendships, and feeling a part of the ISHS family. This will only be possible when we meet each other once again face to face. We hope and wish to return to those days soon.

As the ISHS Board, we have put effort into minimizing the impact of COVID-19 on our Society. We would have had the Board, Executive Committee and Council meetings in 2020 prior to AHC2020, however, all were postponed due to the COVID-19 pandemic. We had online Board meetings for the urgent issues, particularly for the disrupted activities. The ISHS symposia are now rescheduled with consensus of the conveners and each Division chair, and possibly more will be postponed in the coming weeks, depending on how the situation changes. Special attention has been given to avoid overlapping meetings on similar topics as much as possible. Not all were moved to 2021. Some symposia were re-assigned to 2022 and 2023. However, IHC will be on time, in Angers in August 2022. We encourage "hybrid" symposia with in-person and online participation in particular for the next year. This would provide an opportunity to our members to attend the meetings using different digital communication tools. We also encourage publication of the proceedings prior to the meeting, to offer on-time publication. The remote attendance option is an opportunity for participants coming from countries where traveling to the meeting venue is expensive or discouraged/prohibited/causing quarantine obligations by local authorities and/or visa issues might have created problems. All these issues will be also discussed at an online Executive Committee meeting soon.

We also are asking our members to contribute to two new initiatives:

- We ask for submissions to *Chronica Horticulturae* about how COVID-19 has affected the horticulture of your area. There are few studies on the impact of COVID-19 on horticulture. Your articles from different regions of the world (any survey, production, supply chain, etc.) are very welcome. If a sufficient number of articles are received, we will prepare a newsletter to be published on the ISHS website. Please submit these to Dr. Kim Hummer, Editor of *Chronica Horticulturae* (hummerk@oregonstate.edu).
- We are working on the possibility of webinars, to share knowledge and expertise of our members that could be placed on a link and shared with ISHS members around the globe. Dr. Jill Stanley, Vice President, will coordinate this. Our Secretariat will provide guidance throughout the process.

This is a very difficult environment and a new situation for all of us. Many changes are expected in our lives but our core focus, "horticultural science", will continue to contribute more abundant and healthy food for the supply chains from the farmer to the consumer. The ISHS will continue to nurture and nourish the scientific environment. A strong immune system that is linked to daily fruit and vegetable intake is a positive step to minimize health risks imposed by the COVID-19 pandemic. Therefore, our ISHS network is more important than ever for the coming months.

Please realize that the UN General Assembly proclaimed 2021 as "the International Year of Fruits and Vegetables (IYFV). The IYFV offers an opportunity for each of us to raise awareness of the important role of "fruits and vegetables" in the human diet, food security, and health. We want to reduce food waste or loss in the supply chain. We will continue to contribute to the UN Sustainable Development Goals. I invite all our members to document any actions on Advocacy and Awareness Raising, Knowledge Creation and Dissemination, Policy Making and/or Capacity Development and Education, and submit it for publication in *Chronica Horticulturae*.

The challenges of these days remind us once more of the importance of our mission "*to nurture and deploy scientific growing knowledge for creating a better world*."

There are opportunities for us to overcome these difficult days soon and we shall innovatively convert these to promote the benefits of horticulture for food security. We will look forward to regaining prosperity at home, at ISHS, and globally, by cooperating closely, and exchanging and sharing our experiences and knowledge.

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› Continuation of excellent service to ISHS: Mr. Peter Vanderborght, Executive Director – beginning 2019

› Kim Hummer

Kim Hummer, Editor, *Chronica Horticulturae*

Editor note: Ir. Jozef Van Assche retired from his position as Executive Director at the end of 2018. Mr. Peter Vanderborgt was proposed by the ISHS Board and appointed by the ISHS Council to succeed Jozef as the new Executive Director beginning 1 January 2019. We take pleasure in reintroducing our long-term colleague in his new position.

Mr. Peter Vanderborght began his career with the ISHS in 1993, under the administration of the previous Secretary General when the headquarters were located in Wageningen, the Netherlands. Peter was recruited from Ernst & Young Brussels office, one of the "big five" audit firms. Peter, with his background as a certified accountant, accepted an ISHS position as an assistant manager, working towards the administrative and financial re-structuring of the Society. Peter's main assignments were to improve the accounting and financial administration processes and to set up and deploy an adequate IT environment to support the membership and publishing related activities of the Society.

After a time, ISHS headquarters was relocated to Leuven, Belgium. The precarious financial situation of the Society at that time required the management to be "inventive." The cash-flow issue even resulted in a lack of budget to pay management wages for extended periods, so that regular staff, printers, and the most important suppliers could be paid. Gradually, over the next decade, the budget turned positive as a result of the careful restructuring and streamlining efforts of the ISHS team led by Jozef van Assche, with Peter and the other staff contributing significantly.

After a few years, the Society became financially healthy, with successful scientific publications, and overall increased membership confidence. This was a rewarding accomplishment for management, staff, and the Society as a whole. The ISHS regained its prestige and respect within the wider scientific community.

› Board meeting at ISHS Headquarters, in February 2019. From left to right: Isaac Aiyelaagbe – Responsible for Outreach and Innovations, François Laurens – President of IHC2022, Sisir Kumar Mitra – Responsible for Publications, Peter Vanderborght – Executive Director, Silvana Nicola – Secretary, Jill Stanley – Vice-President and Scientific Coordinator, Yüksel Tüzel – President, Kim Hummer – Treasurer, Patrícia Paiva – Responsible for Young Minds.

Throughout his time with ISHS, Peter has appreciated his job because of the diverse tasks that it has offered. He also appreciates the international nature of the contacts and the interesting and dedicated people with whom he works.

During the early 1990s, one of Peter's biggest career achievements for ISHS was to recognize the extreme importance of the rapid changes and developments in the field of IT and the burgeoning importance of communication on the 'World Wide Web'.

Peter's vision and early recognition of the huge potential of digitizing publications proved to be the correct choice for the Society and brought about positive change. He began the implementation of a massive scanning and digitizing project of the Society's publications. During this period, Peter managed the conversion and activation of the entire back catalogue of *Acta Horticulturae* volumes from a dormant print status to a digital platform in a full-text searchable electronic format. This project was brought to fruition at a time when most publishers were still primarily focused on print. At that time, the concept of complete electronic libraries was remote.

The new digital *Acta Horticulturae* catalogue that resulted allowed the Society's academic papers to become easily accessible to researchers around the globe. Members, for the first time, had instant and direct access to a wealth of previously hidden or otherwise inaccessible papers right from their desks!

The effect and success of the early implementation of digitizing *Acta Horticulturae* on the overall performance of the ISHS was significant for the success of our Society over the past two decades. This decision offered an accessible and affordable platform to the horticultural science community originating directly from within the community rather than from a commercial conglomerate of publishers.

With regards to ISHS publications, from 2010 to 2018, Peter worked closely with Professor Dr. Yves Desjardins, ISHS Board Member responsible for publications. They introduced

› ISHS Secretariat staff, June 2020, Leuven, Belgium. From left to right: Peter Vanderborght – Executive Director, Dirk Van Holderbeke – Finances and Accounting, Maria Testor – Techical Editor *Acta Horticulturae*, Steven Franssens – Techical Editor *Acta Horticulturae*, Jelle Ollivier – Techical Editor *Acta Horticulturae* and Coordinator eJHS, *European Journal of Horticultural Science* and *Fruits, The International Journal of Tropical and Subtropical Horticulture*, Kantkawee Neraphukieo – Logistics & Publications Services, Kelly Van Dijck – Science Assistant and Associate Editor *Chronica Horticulturae*.

a series of procedures to increase quality, visibility, and accessibility of information in the ISHS horticultural publications hub, implementing state-of-the-art software tools and services to bring ISHS publications to a higher level, in-line with the offer of competing commercial publishers. Because similar industry tools available on the market were beyond the reach of ISHS, due to the limited budget, they decided to develop what is known as the "responsive online system for *Acta Horticulturae* submission and review" (ROSA), which has become a cornerstone in the continued success of the ISHS. This is an integrated and tailor-made ISHS online system for efficient and timely processing of abstract submission and fulltext paper review. Through this new system, conveners can coordinate the receipt and review of submitted manuscripts for their symposia, which is a boon to the conveners, the attendees, and the ISHS membership.

Inevitably, because ISHS by nature is a relatively small learned Society, funding is limited. That has a significant impact on investments in technology, which has increasingly evolved into being the core element of the publishing business. Nevertheless, Peter has always found ways to develop low-cost technological solutions in-house that serve the needs of the community, while staying within the financial capacities of the Society.

Coping with funding limitations has become more challenging amidst the increasing competition and global waves of online commercial publications. Some scientific societies, both large and small, have given up their independent status by integrating with the large commercial publishing houses.

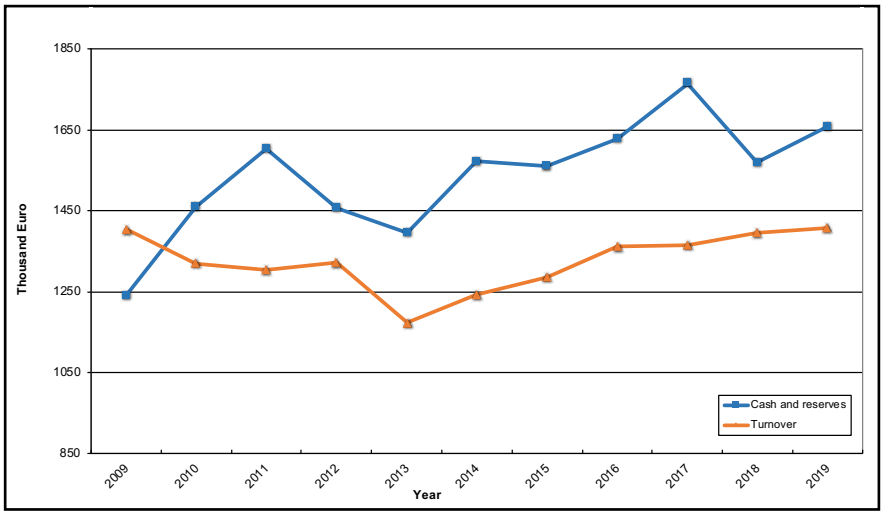
With the support of the ISHS Board and his staff, Peter has great belief in the success that ISHS has as an independent and non-commercial publishing Society. The ISHS community is innovative and has determined publishing procedures with smart yet affordable solutions to help stay on top of the competition, in a climate of ever evolving end-user expectations, and intensive and highly competitive publishing businesses. ISHS has responded to circumstances, including the open access movement, which challenges the existing business models of small publishers on another level.

The first year in his new position of Executive Director has been difficult. Tough decisions were required from the start. With the price of gold, stocks, and bonds fluctuating, Peter, and the ISHS Financial Officer, Dirk Van Holderbeke, took firm grasp of the diverse investments of the ISHS reserves. Their canny decisions during the difficult financial market of 2019 brought the total ISHS reserves back from the negative trend of the previous year (Figure 1). These decisions, with successful *Acta Horticulturae* publications and good membership numbers, brought the ISHS budget to the positive again, with the exception of unexpected retirement costs at the ending of the year. Peter, with the support of the staff of the Secretariat working at the Leuven headquarters, as well as with the great support from the current Board, have kept the Society financially on track.

The year 2020 has brought a separate set of completely unexpected events. Beginning in February, the global coronavirus pandemic erased a year of carefully planned symposia from the 2020 calendar. ISHS members will wistfully recall their travel plans to attend the many great horticultural symposia and congresses that were scheduled for the year, as they safely shelter at home. The postponed meetings for the most part have been rescheduled to fill in the calendars of 2021 and 2022. The staff of the secretariat and the ISHS members are looking forward to returning and meeting again in our time-honored symposia format, once the difficulties of this novel coronavirus are resolved. However, returning to travel in the bigger sense will no doubt be predicated on another year for the development, availability, and acceptance of virus treatments and vaccines. The Board and the staff of the Secretariat are bracing and preparing a backup scenario for a second year of postponements should that be necessary.

In the meantime, Peter together with the ISHS Board, continue to work on alternative solutions to compensate for this year's loss of in-person meetings. Once the global pandemic settles, the ISHS will emerge from this crisis stronger and more resilient. Each crisis is a challenge that offers greater opportunities for the future.

Peter appreciates the trust shown by the Board, the Council, and the Society in his capacities in his new position of Executive Director. He is pleased to have the opportunity to work with the Society officers and membership and expand his management skills and knowledge base to ensure the continued success of ISHS.



■ Figure 1. In 2019, despite difficult market conditions, careful management by the ISHS financial team reversed the negative trend in the cash and reserves. Turnover also trended up.

Some reflection from the Board on why we need the ISHS

Silvana Nicola

Letter to the editor

Silvana Nicola, Secretary of the ISHS Board

We are all sitting at our desk at home, and are discussing business as usual with colleagues, or maybe not. This is not business as usual! This is staring at a screen and seeing the faces of our colleagues who are connected through the internet. We are all grateful that the internet gives us this opportunity: to continue to connect with all our friends, even though we are confined in our remote home. If the COVID-19 pandemic were to occur twenty years ago, we would have felt so alone in the world of billions of people.

We might then think that this could be an efficient way to work, and we could continue to do it in this manner in the years to come. We would save a lot of traveling and troublesome issues of going away from home. Interaction between colleagues could continue online.

In the last months, the Board of the ISHS has met online several times for chunks of 2 to 3 hours at a time for the biannual Board meetings. We have become used to having these e-meetings in recent months and we even managed to shift through different timezones. At the end of each meeting, every Board Member was satisfied with the meeting, and was ready to proceed to the next scheduled task for the institution we belong to – another e-meeting, a lecture to the students, a video class recording, a project report, a project call analysis – or to have breakfast, lunch, supper or go back to sleep. However, something was missing. Something very big: meeting each other! Gathering for a chat, for a dinner, for a walk or even for a gossiping session, maybe for a next project discussion, or ready to go to visit some research institution or horticultural property in the area where the Board meeting was scheduled. Normally, many of us would have our companions (husband, wife, daughter or others) waiting in the lobby of the hotel ready to relax and have some social events.

Expanding this feeling, it is exactly the same for attending an ISHS symposium. These days we follow several webinars and online activities, even symposia, but we do not have any chance to physically interact with the other people, either the speaker or the audience. Many project ideas, new breakthroughs and collaborations are borne during the informal discussions at coffee breaks and dinners, and new life-long friendships established. We can't precisely foresee the time when we will finally be together for a symposium, encountering our old friends and colleagues from around the world, discussing science looking at the eyes of our correspondent (and not into a computer screen), visiting the local fresh market with them, interacting with the local grower or packer. But it will be. We are so thankful that we have a community of some 6000 people who decided that we need physical presence to enjoy life after science and discuss horticulture, who are patiently waiting to meet once again when time permits.

Issues

We are all in this together: reimagining international societies

Norah Keating

These are extraordinary times when the world paused in ways that only months ago we would have thought impossible. We witnessed widespread closures of businesses, of schools, of gatherings—and their economic and social consequences. For those of us whose lives are embedded in science, the rhythm of life changed dramatically. We have seen the cancellation of professional conferences and symposia, research meetings and field trips. The comforting rhythm of our academic lives as professors and postgraduate students has been replaced with uncertainty. We have been grounded, isolated and often solitary.

Such fundamental changes have highlighted resources and contexts that privilege some and exclude others from global professional interaction. Digital platforms have become our meeting places. They remind us of the uneven distribution of technical support and of broadband access. The simple task of scheduling a meeting during "working hours" means that people in some time zones consistently draw the 2am slot. Conference cancellations highlight the loss of rich networking opportunities for those who are usually able to attend.

We speak nostalgically of pre-pandemic ways of meeting and sharing ideas and being part of a global professional family. Yet we also understand that going back may be neither possible nor ideal. Enforced changes in our lives are unsettling; they reduce our sense of what is known and predictable and comforting, but in doing so leave us space to think differently. It is time, I believe, to take this unprecedented opportunity to reimagine our international professional societies, taking the best of the past and learning from the present.

I have spent much of my academic and personal life associated with international professional societies. I believe strongly that good science comes from global conversations and collaboration; that the contexts in which we work are important; and that making the world a better place is the ultimate goal. I endorse the mission of the Sustainable Development Goals of *leaving no one behind*, knowing that such aspirational statements are exceedingly difficult to achieve. I believe though, that we need to give it a try.

My reflections come from longstanding association with ISHS and with the International Association of Gerontology and Geriatrics (IAGG). These organizations have features that position them to make a difference. They have a global reach that comes with enormous responsibilities not least of which are reconciling the tensions between global and local. They are concerned with knowledge creation and must somehow accommodate the uneven playing fields in which we conduct our scientific work. Their mission statements reflect values of social justice:

To nurture and deploy scientific growing knowledge for creating a better world
(https://www.ishs.org/ishs-world-wide-horticultural-network)

To promote the highest levels of achievement in gerontological research and training…with a view of enhancing…quality of life and wellbeing of all people
(https://www.iagg.info/mission)

My comments here have been developed in consultation with colleagues across these organizations. I hope to prompt discussion and debate about what it means to "do global." I take full responsibility for my arguments and any implied admonitions and I welcome your comments.

As we imagine ourselves going forward, what do we need to be and to do to become global actors who create and share knowledge and make a difference? What can we learn about our future engagement in the world from this period in which a global pandemic has separated us in ways that are quite profound?

From international to global

The mid-20th century was an important period in the development of international societies. Many like ISHS were based in Europe and developed during a period of relative prosperity and stability. They were international clusters of countries in the global north who shared similarities in working environments and research questions. Their proximity allowed them to create their traditions of coming together to discuss research findings and develop collaborations.

More than half a century later, society membership has grown far beyond the confines of Europe. The contexts in which our members conduct their research and the places in which that knowledge is used to improve wellbeing are immensely diverse. One of our big challenges is to consider how well we have moved beyond our rather comfortable, bounded, international roots to a global remit.

Authors of a recent article on important qualities of leadership during a pandemic said something that resonated with me. It was that good leaders cultivate a sense that "*we are all in this together*" (https://www.nature.com/articles/s41562-020-0884-z). That seems a good starting point for reimagining what we hold in common and where there are sticky points and how we take leadership to address them.

ISHS members are from more than 120 countries, making it a professional society that is truly global in scope. This global coverage provides tremendous opportunities for network members. A colleague from Latin America noted the importance of being part of an organization that disseminates its expertise in the world. Another who spent a lifetime living and working in many countries, states firmly that societies such as ISHS are very important for global knowledge.

Many believe that science is already global since knowledge is created outside of the messiness of politics and policy and place and thus is universal. Yet *our* science is applied. For it to be relevant and useful in improving the human condition, we must create the evidence in settings that are diverse and where solutions differ while creating a sense that we are working toward a common goal. My completely non-random sample of perspectives on this question suggests that members of our global network don't always believe that their voices are heard. I asked what an organization needs to do to bring in all world regions.

They said:

- enable equitable representation of agendas, perspectives and knowledge from all regions,
- recognize, challenge and overcome barriers to meaningful collaboration with some regions,
- act not as "neo-colonizers" but as those who seek to understand and promote local values.

Strong words. They reflect tensions between global and local. They remind us of historic inequalities arising from colonization and other sources of exclusion. These may have occurred outside of science but their legacies endure. So back to this thorny problem of how we "do global."

Accounting for regional resources, priorities and sensitivities

Both the strengths and the difficulties inherent in taking global seriously lie in the fact that we live, work, create and use knowledge in places that are not the same and with people who have different resources and priorities. How do we embrace these differences while at the same time fostering a belief that "we are all in this together"?

My own views are reflected in the mission statement of the global agenda that I direct: *to foster collaboration and critical thinking at the interfaces of regional issues and global trends* (https://www.iagg.info/gsia). Like the mission statements of our societies, this one may be difficult to achieve but I believe it worthy of pursuing.

One of our reimagining tasks is to articulate what we mean by collaboration. How do we create the connections that bring new ways of understanding the research issues worth pursuing and the ways in which they are grounded in particular places and lives?

A starting premise is that for those who come from positions of privilege, collaboration requires a spirit of seeking connections because you know you have something to learn. For those who are from places with histories of exclusion, it means resisting the inclination to push others away, assuming that they are motivated by self-interest and will take over the agenda. "I never thought of it that way" is a good indicator of openness to the ideas of others that is fundamental to good collaboration.

For leaders of international societies, we must address whether we have articulated our view of collaboration and whether it is reflected in the ways in which we structure our governance and activities. Are there systematic biases in pathways to influence within our organizations and do we have strategies to address them?

Collaboration is rendered more difficult by the unequal distribution of resources. A colleague described funding in Latin America as a major difficulty since there is little government interest in long-term investment in science and technology. Many programs fail because they cannot be sustained once international cooperation is depleted. Scholars must work outside of academia to afford a decent living. This is but one example of how research resources truncate opportunities to be fully engaged in the processes of knowledge creation and application that our societies promote. How can we be watchful of other sources of inequality and act upon them?

› There is joy in the sharing of ideas. Master class on ageism at IAGG European Regional Congress, Gothenburg, Sweden, October 2019. From left to right: back row: Tom Scharf, Charlene Knudsen, Diego Guimaraes de Olivera, Noriko Watanabe, Dorota Matsumotova; middle row: Isabela Thais Machado de Jesus, Mayeso Lazaro, Norah Keating; front row: Kay Shannon, Rebecca Baxter, Mascha Pauelsen, Etienne Duim, Grace Lewis.

I fear that such inequalities will become even more entrenched in light of the global economic downturns resulting from the pandemic. Two examples may offer some principles for moving forward.

The ISHS Global Horticulture Initiative (GlobalHort) was an example of adapting global goals to local contexts. Launched in 2006, it was a consortium of organizations and agencies working to improve well-being in low-income countries through horticulture. GlobalHort promoted innovation for small scale producers, assisting them to make their businesses more viable, thus increasing health and income of producers and their families. Members of GlobalHort were supporters, promotors and mentors who assisted with grant capture and mentored research projects on the effectiveness of the innovations. Training, education and capacity building were a key part of the program.

The IAGG Latin American Social Issues on Ageing (LSIA) aims to address population ageing through increasing academic expertise in social gerontology. Most academics who do research and teaching in ageing are educated in disciplines such as sociology, demography or economics. The LSIA is a consortium of regional social scientists who will develop and offer symposia, master classes and courses on theoretical, methodological and substantive topics in social aspects of ageing for academics in the region. To assist with the visibility of this initiative, The Pan American Health Organization will sponsor a special issue on ageing in Latin America in its journal (https://www.paho.org/journal/en). The journal publishes in Spanish, Portuguese and English.

There are principles in these examples that are part of longstanding practices but need reexamining in light of our changed world.

- The application of research must be grounded in the location where it will be used,
- Resource constraints need to be addressed,
- While global priorities may be shared, solutions are developed within regions,
- Capacity-building takes many forms,
- Language matters.

Supporting global scholars and scholarship when we are grounded

Much of the pressure to reimagine our professional societies comes from the immediacy of pandemic isolation. Just at a time

› Regional meetings showcase ideas and solutions. Opening reception at IAGG Asia-Oceania Regional Congress, Taipei, Taiwan, October 2019. From left to right: Hueng Bong Cha, Past President IAGG; Norah Keating, Director Global Social Issues on Ageing; Cheng-Chieh Lin, Congress President; Prasert Assantachai, Chair, Asia-Oceania Region, IAGG.

when it seems essential to think and connect globally, the world has pulled away with a pandemic closing doors behind it.

Where and how we will gather are questions that are at the front of our minds. World congresses, regional meetings and topic-specific symposia are among our core activities. They bring considerable benefit to those who attend. They provide the setting for creating our "convoy of professional relationships," the group of people that we work with, plan with and trust throughout our professional lives. If we are fortunate, it includes people from around the world who will challenge us, support us and remind us that if we think we know the answers, we aren't trying hard enough. It is here that global scholars are nurtured.

Some of my most satisfying international experiences have come from coordinating master classes for early career scholars (or "young minds" as recently termed in ISHS). These are intensive workshops on topics that are globally relevant but often understood differently across regions. Classes are always structured to include diverse participants who develop skills in collaboration and are mentored by senior scholars. There is joy in the sharing of ideas and in the debates and the closeness that ensues from an intensive experience together. Supporting the next generation of global scholars is one of our most important activities.

Will our future be without world congresses? Many potential losses come to mind if we lose a major platform for our profession: trade shows that connect developers and producers; hearing about the latest scientific advancements from around the world; meeting old friends and adding others to our professional convoy; income to the organization. How much can technology compensate? Digital conferencing platforms help us manage some of our research activities and governance of our professional societies. The planet is just a little bit healthier because we have reduced our carbon footprint. We must be cognizant, however, of how technology excludes and of the tyranny of the chosen time zone. And we must think of how to replace the serendipity that happens at conferences of meeting someone new and learning about their work and sharing a coffee and discussing ideas.

Regional meetings may address some of the constraints of world congresses. They provide a window into regional challenges and a forum for local scientists to show how their research takes global challenges into regional settings. Local producers can meet with the experts and welcome them on field trips to discuss their operations. With potentially fewer time zones, electronic sessions may more comfortably include those who can't travel to the meetings. A colleague noted that keeping fees at approachable levels would increase participation and encourage countries from the region to become members.

While we are doing all of this rethinking, I'd like finally to add language. Is it time to review the choice of English as practical, fiscally prudent and thus largely settled for our international organizations? There is power in language. It can exclude individuals, truncate pathways to leadership, reduce publication success and bypass world regions where English is not spoken. If we embrace the idea that we are all in this together, should effort be spent on encouraging scholars to learn English and helping them with tasks such as writing conference abstracts and editing manuscripts? Alternately, should we accommodate language differences through offering regional meetings in the language of the country? What should I say to an author of an upcoming journal special issue that I am editing who said that he could write in Spanish and it would be more fluent and poetic or in English and it will reach a wider audience?

In a time when our social norms have been radically altered, we need social entrepreneurs. It's going to be an interesting journey.

› Norah Keating

› About the author

Norah Keating is Director of the Global Social Issues on Ageing, International Association of Gerontology and Geriatrics. She has longstanding connections to ISHS through her late husband Norman Looney who was ISHS President from 2002-2010. E-mail: nkeating@ualberta.ca

Spotlight on Honoured ISHS Members

› Víctor Galán Saúco

Position or previous position

Head Department of Tropical Fruits, Instituto Canario de Investigaciones Agrarias, Canary Islands, Spain

ISHS honour

ISHS Honorary Member

› Víctor Galán Saúco, Ian Bally and his wife, Alberto Pinto and his wife at the X International Mango Symposium, Dominican Republic, 2013.

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

I was born in Cádiz, Spain, on 5 December 1946. My father, born in Tenerife, Canary Islands, Spain, was a military man, and when I was only 2 months old my father was assigned to serve at Tenerife. This island is now my home. I love sports. I have enjoyed playing tennis and now I regularly go swimming in the sea. I also enjoy reading. Regarding my family, my wife has a degree in History of Arts and is a corresponding member of The San Miguel Arcángel Royal Academy of Fine Arts of the Canary Islands. I enjoy attending the many art exhibitions and cultural activities that she regularly organises. She has also published papers with Dr. Jules Janick about Horticulture and Arts. During our 51 years of marriage she has accompanied me to many ISHS events and has been a great support for my horticultural career and my life. We have a son with a Ph.D. on Theoretical Physics, a daughter with a degree in Economic Affairs, and two beautiful grandchildren.

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

When I was a child, I spent the summers at the home of my grandparents who had a banana farm in Puerto de la Cruz, Tenerife. They also grew papayas, avocadoes, and other tropical fruits in their garden.

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

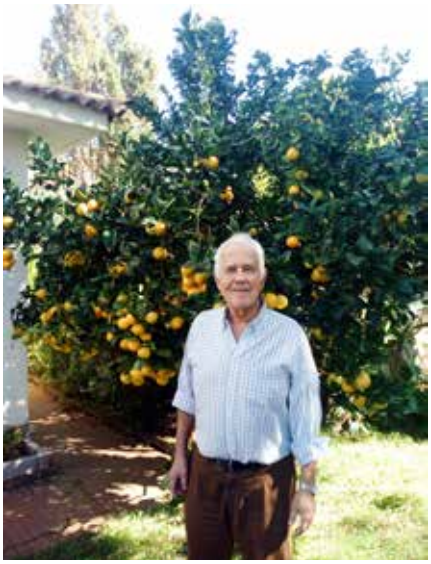
I studied Agronomic Engineering at the University of Madrid, Spain, during the years 1964-1970 and obtained a Master of Science (Horticulture) at the University of Honolulu, Hawaii, in the years 1973-1974 under the supervision of Dr. H.Y. Nakasone. I obtained my Ph.D. degree in the year 1981 at the University of Cordoba, Spain. My Ph.D. thesis, under the supervision of Dr. Luis Rallo, ISHS Fellow, dealt with banana de-suckering.

I first began my professional career as researcher at the Instituto Canario de Investigaciones Agrarias (ICIA), Canary Islands, where I occupied the position of Head of Department of Tropical Fruits between 1980 and 2006. After 2006 I became Research Professor at ICIA without administrative responsibilities, but just to direct and coordinate research projects. After my retirement from ICIA I have continued my professional activities through consultant activities (see below), writing books and/or book chapters on tropical fruits, giving lectures or convening symposia, the last one, now postponed until autumn 2021 because of Covid-19, being the XIII ISHS International Mango Symposium.

› Víctor Galán Saúco during the field visit at the XI International Mango symposium, Australia, 2015.

Simultaneously to these positions, I developed the following activities: President of Spanish Society of Horticulture (1995-2003), Chair of ISHS Section Tropical and Subtropical Fruits (1998-2006), Vice-Chair of ISHS Section Banana and Plantain (2006-2010), Chair of ISHS Working Group Mango (2010-2015), Chair of ISHS Working Group Tropical Fruits (1996-2011) and Co-President of the 28th International Horticultural Congress (ISHS), Lisbon, Portugal, 2010. Finally, I was nominated as ISHS Honorary Member at the 30th International Horticultural Congress held in Istanbul, Turkey in 2018.

During my professional career, I have also realised many short term consultancy missions for the Food and Agriculture Organization of the United Nations (FAO) in research and development of banana and tropical fruits in different countries (Comoros, Bangladesh, Thailand, Malaysia, India, South Pacific – Vanuatu, Western Samoa and Papua New Guinea, Mauritius, Brazil, Turkey and Tunisia), from 1984 to 2010. I have also been consultant for Tropical fruits of the Government of Oman from October 2013 to 2018 and for the National Mango Board (USA) from 2015 until present. I have also acted as con-



› Víctor Galán Saúco at home, 2017.

sultant for different private companies both in Europe, Latin America and South East Asia.

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

I have three significant achievements that I would like to describe. The first was the role that I played in developing tropical fruit culture in Spain, in the Canary Islands and Andalusia. My career of research at ICIA supported the improvement of this fruit production. My next great achievement was being elected President of the Spanish Society of Horticultural Science. The third was my contribution to the development of tropical fruit production in different developing countries of the world through the many symposia that I have conducted or attended as ISHS representative as well as through the many consultant activities listed above.

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

When I finished my academic training, few opportunities for realising a horticultural career in Spain were available. However, some positions were open at the Canary Island Experimental Station from the National Institute of Agricultural Research that later became ICIA. To be selected for this position, the Spanish Government required the candidates to obtain a horticultural degree in a highly accredited foreign university after a preliminary stage of training at the Canary Island Experimental Station. To do this, the Spanish Government, through an agreement with the World Bank, offered a relatively small grant that was variable according to the country of reception. Despite, by then, being married and having two children, I decided to apply to the University of Hawaii at Manoa to get my Master of Science degree in Horticulture. It was physically and financially hard to go there with my family, but despite the economic difficulties at the very beginning of my career, this was one of the best and most enjoyable periods of my life.

It's important to mention that one of the greatest challenges I had at the beginning of my horticultural career was to accept a position to become Consultant for FAO. Dr. Umberto Menini, head of the FAO Division of Plant Production and Protection, offered me that consultancy position after hearing an oral presentation on mangoes that I gave in the NORCOFEL Congress held in the Canary Islands in 1983. It was not easy to convince my Government to allow me to do short annual consultancies as part of my work, but by doing this I learned a lot about the situation of tropical horticulture in many underdeveloped countries of the world.

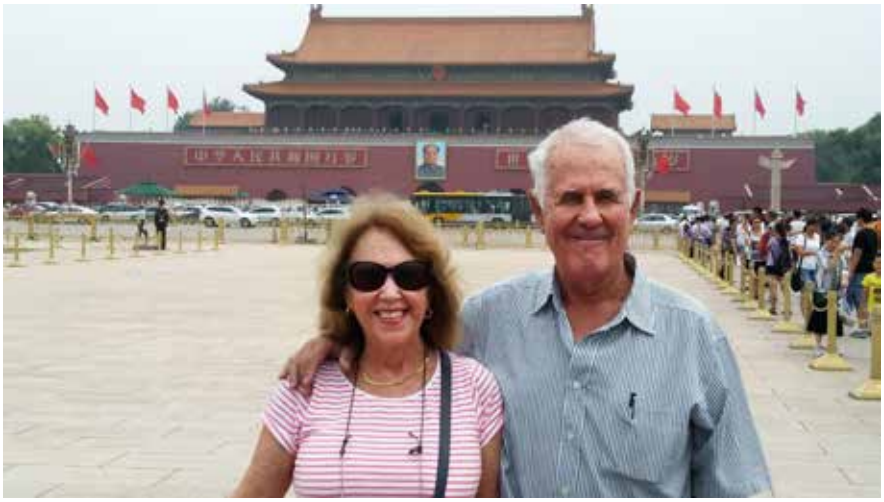
By that time, Dr. Menini had a strong connection with ISHS, attending many ISHS symposia, particularly those of the Commission Tropical Horticulture. I established a good professional and friendly relationship with him and he mentored me in the development of my horticultural career.

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

I could tell many stories, but I am going to describe only a few. The first consultancy that I did for FAO was in the Archipelago of Comoros, in the Indian Ocean. I had to give recommendations for establishing a nursery of tropical fruits on the Island of Anjuan. When I arrived there, I was called to the air company office to inform me that my return ticket from Anjuan to Moroni had been cancelled by an order of the Governor of the island who had said that I could not get it until I visited him. They also told me that an official car, a Mercedes, with a driver was waiting outside the airport to take me to the Governor Palace. I was certainly a bit afraid. Once I arrived there, the Governor stopped all the affairs he was dealing with and told me that he had a problem in his private pineapple farm that I must solve before leaving Anjuan. I was lucky that I could easily spot the problem. The plants had a severe scale infection. He followed my recommendations, but it took some time to resolve the issue. I must also mention that after this, the Mercedes with the driver was at my disposal during all of my stay there. I was invited by the Governor to the best restaurant in Anjuan where I had avocado and lobster. Believe it or not, although I paid my hotel stay with American Express card, the charges never came to my account. Probably he took care of that!

One of my first FAO consultant activities was to improve mango culture in Bangladesh. Among other things, I was asked to elaborate a list of appropriate mango cultivars for the country. I started to write the most productive cultivars that I knew, but Dr. Tindall, who was the head of the mission, and by then, also Chair of ISHS Commission Tropical and Subtropical Horticulture, told me that more important for Bangladesh people was to have trees that can produce not only fruits, but also wood, because the wood was important as a bride's dowry. I certainly learned to look at the world in a different way!

In another FAO consultancy, I was in Mexico City during the great earthquake of 1985. For some reason, for the first time in my life when I arrived at my hotel after a copious dinner that night, I specifically looked where the exit staircase was located. This was a prescient thing to do. Although my hotel was partially devastated, I had to run to the street in underwear from my room on the third floor through the exit staircase that was partly falling apart. Luckily, nothing happened to me and I was able to return after a while to take my things and move to a solid



› Víctor Galán Saúco and his wife Ana Luisa González Reimers in China, 2017.

single story hotel with the rest of the FAO delegates. The evening after the earthquake, the whole FAO delegation, five people in this case, was invited to a dinner at the home of the Minister of Agriculture. It was certainly shocking to go through the devastated city for a dinner but what really frightened me more was to go down to the underground cellar of the home to see his wine collection. Normally, I enjoy good wine very much, but, believe me, on this occasion I just wanted to return quickly to the surface. It took me two days to communicate with my family, because there were no mobile phones at that time and normal phone services were collapsed. After that experience, I don't know why, I quit smoking...

When I arrived at the Cook Islands, also in another FAO mission, there were almost no cars on the Islands and I was offered either a bike or a motorcycle. Since I did not know how to drive a motorcycle, I chose a bike and since the island was only 32 km round, I thought that I could easily manage to get where I needed to go. However, I had forgotten that I had not used a bike for almost 20 years. After cycling 5 km, I was so tired that the next day I learnt to drive a motorcycle and used it for the 2 weeks that I was there. I've never driven one since then. By the way, during this time I had eaten the best chicken ever of my life. The chicken was fed mainly with coconuts.

› Mike Nichols (New Zealand), Víctor Galán Saúco and Navot Galpaz (Israel) in a banana greenhouse, Canary Islands, 2018.

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?

In 1978, I realised the importance that ISHS played in the world of horticulture by attending the International Horticultural Congress in Australia. I immediately saw that being a member of this Society would be of capital importance to get me in touch with what was going on in the tropical fruit world. My presence in ISHS has helped me to establish solid relationships with researchers and leaders in the horticultural world. This has been of crucial importance for my whole horticultural career.

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

I would recommend that they establish as many contacts as possible with people working in horticulture throughout the world. Exchange knowledge and experience with them. In doing this, it is very important to be member of ISHS and participate in as many ISHS symposia as possible.

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

During the confinement, due to COVID-19, consumption of locally produced food has increased. This, no doubt, will reinforce the environmental concerns about the impact of the carbon food print of exported productions on accelerating the expected climatic change. This will give a greater impetus for the public to consume locally produced food. Urban horticulture and protected cultivation will be two areas to benefit from this new world situation.

Breeding for cultivars resistant to new diseases and those that are better adapted to possible climatic change, particularly to scarcity of water and increase of salinity, will become imperative in the future as a consequence of the expected climatic change. Humanity's concern for safe and healthy food will certainly encourage organic cultivation. But I also hope that, sooner or later, genetic engineering, or genetic modification, will become accepted by the public and cause a boom of new developments in horticulture. Genetically modified (GM) food will not only allow to obtain disease and drought-resistant plants requiring fewer environmental resources, such as water and fertilizers, but also will reduce the use of pesticides to produce a larger volume of food and keep a safer, cleaner environment. However, more research should be done for developing sound techniques that solve the safety concerns about GM organisms and serious efforts should be made to study, confirm and instruct the public about the benefit of GM crops.

History

Three decades of service to the ISHS – Ir. Jozef Van Assche, Executive Director, 1995-2018

Ian J. Warrington

Outstanding professional societies grow and flourish under outstanding leadership. Such was the relationship between the ISHS and Ir. Jozef Van Assche.

Jozef was the Executive Director of the ISHS for 23 years (1995 to 2018), having previously been a member of the Secretariat. He served five Presidents and six Boards and led a team of highly competent staff. He will be greatly missed for his experience, savoir faire and engaging personality.

Early years

The selection of Jozef as the Executive Director in 1995 followed a period of considerable turmoil, staffing changes, organisational restructuring and major financial uncertainty given the very considerable debt being carried by the Society at that time. It included relocation of the Secretariat from offices in the Netherlands to the Catholic University of Leuven (KU Leuven) in Belgium. It also involved major revisions of the Statutes and Rules which changed the role and staffing of the Secretariat, the term and responsibilities of the Board, audit protocols and more. These required the adoption of practices and specific wording in order to comply with Belgian law, all of which proved to be very demanding.

"I first met Jozef in 1990 when this young man ran his own restaurant and bar in Leuven and was about to be recruited into the ISHS. He had lived in Japan and spoke fluent Japanese, which proved to be a real asset in the build-up to IHC1994 which was to be held in Kyoto, Japan. His father was a long time ISHS Council member from Belgium, a member of the Executive Committee, a Professor at the University of Leuven and our host for the 1990 Council meeting (Belgium was vying for the 1998 IHC at the time). I was totally impressed with Jozef. From the moment he started work at the ISHS he began to transform the organisation into a 21st century professional society. With his 3-4 years of experience with the ISHS he was able to help with the transition that occurred in 1994 and was readily able to glide into the new position of Executive Director in 1995."

Prof. Dan Cantliffe (former Executive Committee and Council member)

Jozef's negotiation of space for the ISHS at KU Leuven was particularly beneficial to the Society. The offices were almost rent-free for many years and it was only when major refurbishments were carried out in 2010 by the KU Leuven that commercial rents were introduced.

To those on the Boards at that time (Drs. Sansavini and Brickell as Presidents) these changes presented enormous challenges that spanned human resources, financial management, institutional restructuring, property management, and staff recruitment. Credit must be given to Dr. Omer Verdonck who was acting Executive Director from August 1994 to June 1995, for his role in managing some of those transitions. However, it was Jozef Van Assche who established many of the systems and processes that continue to serve the Society well until the present day.

Key to the management of those changes was that the membership was largely unaware of the transitions that were occurring or of the politics that were involved. Membership dues were not changed and membership started to increase. Successful International Horticultural Congresses were held in Kyoto (1994), Brussels (1998), and a World Conference on Horticultural Research was held in Rome (1998) that was jointly organised with the American Society for Horticultural Science. The Congresses continue to be especially important in bringing the breadth and importance of the scientific work of ISHS members to international attention.

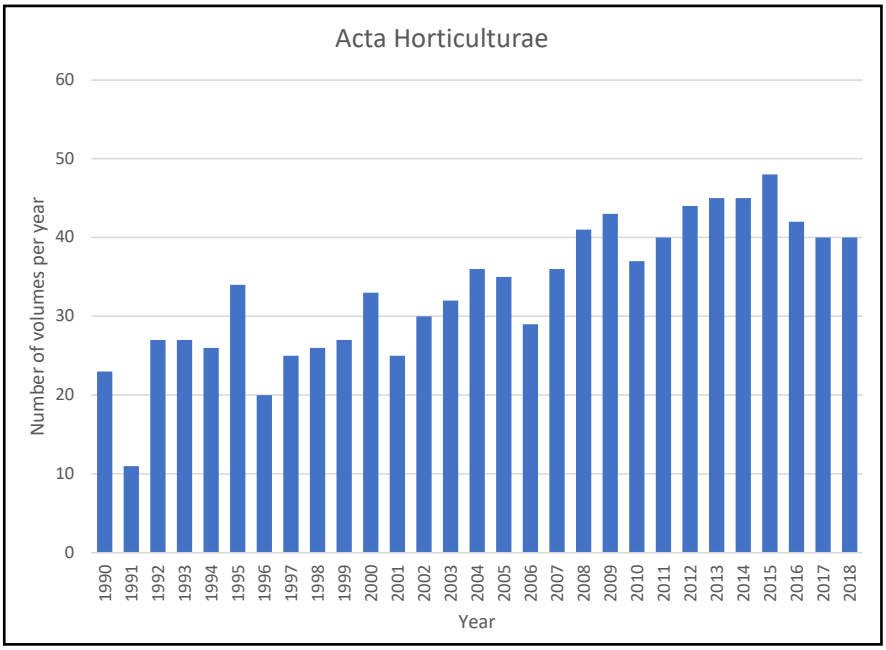
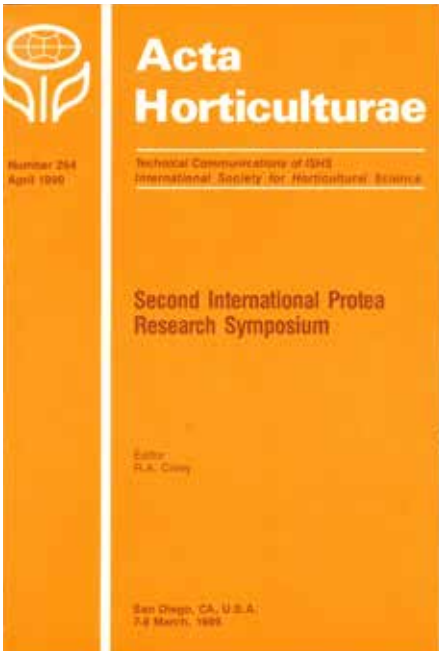


Figure 1. The number of volumes of *Acta Horticulturae* has increased progressively over the past 28 years with the number in the 2010-2018 period being nearly double that of the 1990-2000 period.



› *Acta Horticulturae* was previously a plain publication that was prepared on a specified template using typewriters. It is now a widely cited, refereed, vibrant publication which incorporates modern graphics, good use of colour and word processing software.

Under Jozef's leadership, new computer-based management systems were introduced, emails began to be used, a website was initiated, publications were improved, and, most significantly, the finances of the Society were managed with the previous debt being cleared within 19 months.

"Jozef and I first met in October 1993, at the dinner held following the Board and Executive Committee meetings in South Africa. At the time, we did not anticipate that within a year we would be working closely together for ISHS. When the new Board met for the first time at Leuven in October 1994, I arrived early and we had lunch together. We agreed that our need for collaborative effort would benefit greatly if we got to know one another better. That lunch was the catalyst for our professional partnership and a continuing friendship, one that I cherish more and more as the years go by and one that has grown also to encompass our families."

Dr. Richard Zimmerman (former Board, Executive Committee and Council member)

Publications

The publication of *Acta Horticulturae* has always been critically important to the viability of the ISHS (Figure 1). Revenues from *Acta* have allowed the membership dues to be kept very low and almost unchanged over recent decades. The availability of *Acta Horticulturae* globally has provided those attending ISHS symposia and congresses an outlet for their presentations and the status of *Acta* has enhanced the professional standing of the Society. Many manuscripts in international journals that embrace almost any field of horticultural science will have a citation to an *Acta Horticulturae* paper.

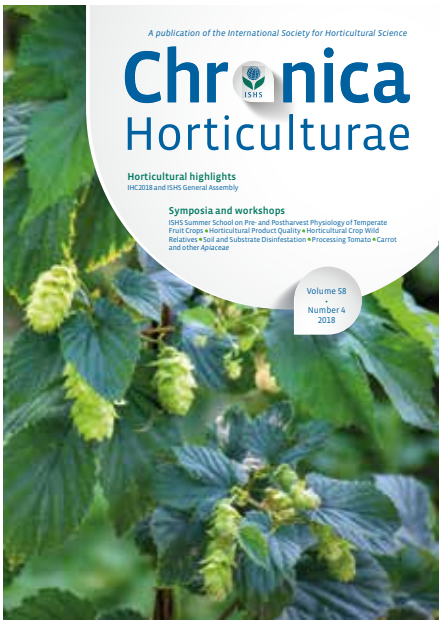
"Jozef van Assche introduced to the 1994-1998 Board the concept that computers and digitisation were the way of the future for the Society. He enlisted the help of two young men from Canada to explain what we should be doing. I think I can speak for fellow Board members by saying that none of us really knew much about what was being proposed, except perhaps we understood that henceforth proceedings of our symposia were to be typed on computer pages that could be easily collated into the form of an Acta. These books could be given to symposium participants and be sold to libraries and individual buyers. It was Jozef's persuasiveness that carried the motion of agreement to proceed, late in the day of a long Board meeting at Brussels. It was a cardinally important decision taken at a time when ISHS was lacking in funds. Jozef did many other good things for ISHS but, like the good businessman he was, he first attended to our cash flow problems."

Dr. John Possingham (former Board Member)

Until the mid-1990s, *Acta Horticulturae* was a plain publication that was based on a strictly enforced typewritten template. Fonts were inconsistent, figures even more so and mathematical equations were handwritten into the text. Everything was black and white, and photographs were seldom included.

One of Jozef's many strengths was his ability to work with the commercial printers who were contracted by the ISHS. Those printers were readily open to change and to the adoption of the new technologies that were rapidly becoming available. In 1996, at one particular Board meeting, Jozef, with his captivating smile, surprised Board members by presenting an *Acta* with a coloured cover. "We cannot continue with an old-fashioned dull cover" he said. The revitalisation of *Acta* was underway.

Consequently, by the late 1990s, *Acta* had adopted word-processing technologies, the content was now standardised to a consis-



› *Chronica Horticulturae* has been transformed over recent years to be an interesting quarterly magazine for ISHS members.

› The 1994-1998 ISHS Board at Bologna, Italy. Left to right: Ir. Jozef Van Assche, Prof. António Monteiro (Secretary), Prof. Silviero Sansavini (President), Dr. John Possingham (Publications), Dr. Richard Zimmerman (Treasurer), Dr. Chris Brickell (Vice-President).

› Ir. Jozef Van Assche (left) looking at table grape production in Bari, Italy, in 2008 with Dr. Norman Looney (President), Prof. Ian Warrington (Vice-President) and the visit host Dr. Anna Maria D'Onghia.

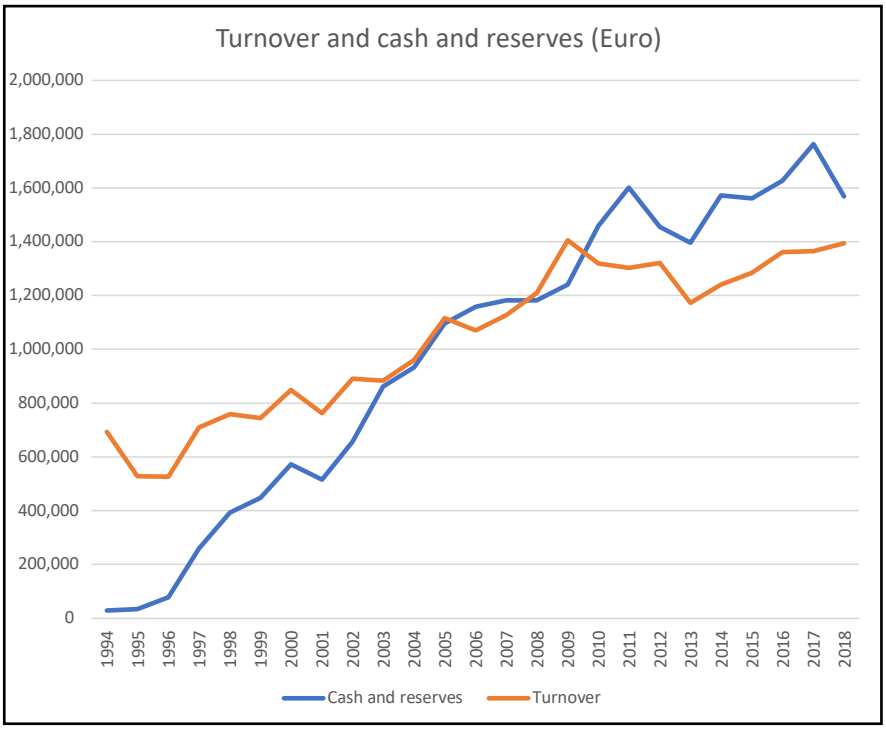
tent font and point size, and colour was introduced to the cover. Subsequently, figures and tables became imbedded in the text. More recently, in the 2010s, the Secretariat, working with the groundwork set in place by Prof. Yves Desjardins, adopted an in-house manuscript management process that includes peer-reviewing of *Acta* manuscripts and their timely management.

Scripta Horticulturae, introduced in 2005, when Prof. Jules Janick was the Publications Chair, filled a gap in the ISHS publication portfolio to allow the dissemination of monographs on specific topics. Twenty volumes have now been published.

Chronica Horticulturae was another publication that was brought into the new era with the adoption of a new format, full use of colour, modern printing and compilation methods, and a more interesting content. Typical of Jozef, he translated the enthusiasm and encyclopaedic knowledge of Prof. Jules Janick into a fully professional magazine which met the technical capabilities of the printer as well as serving the needs of the membership.

The ISHS had always aspired to having its own scientific journals. Caution by earlier Boards as to the competitive nature of this field of commercial activity together with the financial risks around maintaining subscriptions, and the secretarial overheads required for managing publications, meant that the goal was elusive. However, the option to adopt initially the *European Journal of Horticultural Science* (eJHS) and subsequently *Fruits* (now *The International Journal of Tropical and Subtropical Horticulture*) into the ISHS publications portfolio was taken in 2015 and 2017, respectively.

Typical of the leadership position taken by the ISHS for scientific publications, PubHort was established in 2005, as a portal for members to access a wide range of scientific publications that were otherwise difficult to locate. This portal now lists more than 75,000 downloadable articles from publications that include the *Journal of the International Society for Mushroom Science*, the *Proceedings of the International Plant Propagators' Society*, the *Journal of the American Pomological Society*, the *Journal of the Interamerican Society for Tropical Horticulture*, and others. While this can now be taken for granted, a lot of the success in getting these other organisations to commit to PubHort was attributable to the patience, tact, and negotiating skills of Jozef Van Assche. Many of the partner organisations that were involved relied on traditional secretarial services, often provided free-of-charge by university departments, where outdated management practices were being used, and where those involved had a lack of awareness of modern publication techniques. This meant that negotiations with partners were sometimes difficult and protracted as long-standing arrangements



■ Figure 2. The total income of the Society has been driven by growth in both membership and sales of publications. The prudent build-up of financial reserves over the past 25 years means that the ISHS is now well positioned to manage through major disruptions to its business, such as from the impacts of the current COVID-19 pandemic.

were often deeply entrenched. Nonetheless, the current platform is a testament to Jozef's persistence and judgement.

Finances

The financial challenges of the 1990s provided a major incentive for the ISHS to better manage its expenditure and to set aside appropriate reserves. Thus, in 1994 the Board elected to begin accumulating the equivalent of at least one-year's expenditures for that purpose. As the financial situation improved, expenditures grew, but the goal remained the same. The ISHS Boards working with Jozef grew the reserves to €1.763 million by the end of Jozef's tenure as Executive Director (Figure 2). This was achieved by being very conservative in introducing new initiatives within the Society that would lead to any unnecessary increase in expenditure – tempting and all as it was to do just the opposite! They will continue to serve the Society very well as a buffer to the effects of disruptions to normal business activities, such as are currently occurring from the COVID-19 pandemic.

Such reserves required careful management both within the Secretariat and with the various trading banks that were holding ISHS funds. This was another area where Jozef excelled with the negotiation and management skills that were required. This was particularly so in the 2007-2008 global financial crisis where, due to prudent management and careful selection of the appropriate investment options, the reserves were fully protected from losses and the operations of the ISHS were largely unaffected.

Membership

A feature of Jozef's term as Executive Director was the growth in the number of individual members and the increase in the number of countries represented by that membership (now more than 120). Prior to the 1990s, the ISHS was very much a European-based organisation in both its location and its membership. The overall growth and increased diversity in membership was achieved, in large part, as a result of a major outreach by ISHS Boards. The "horticulture for development" initiative led by Dr. Norman Looney was a major success in that regard. In addition, the increase in membership was due to the marked growth and increased range of topics being covered in the scientific program of the Society, accompanied by the global development of industrial horticulture on the world scene. Individual membership increased from around 2000 in 1996, to over 7000 within 11 years (Figure 3). Jozef's multi-lingual abilities were ably applied to breaking down communication barriers and to building partnerships with those countries who were new to the opportunities within the ISHS. His negotiating skills also led to the conclusion of commitments where current financial or organisational circumstances were barriers.

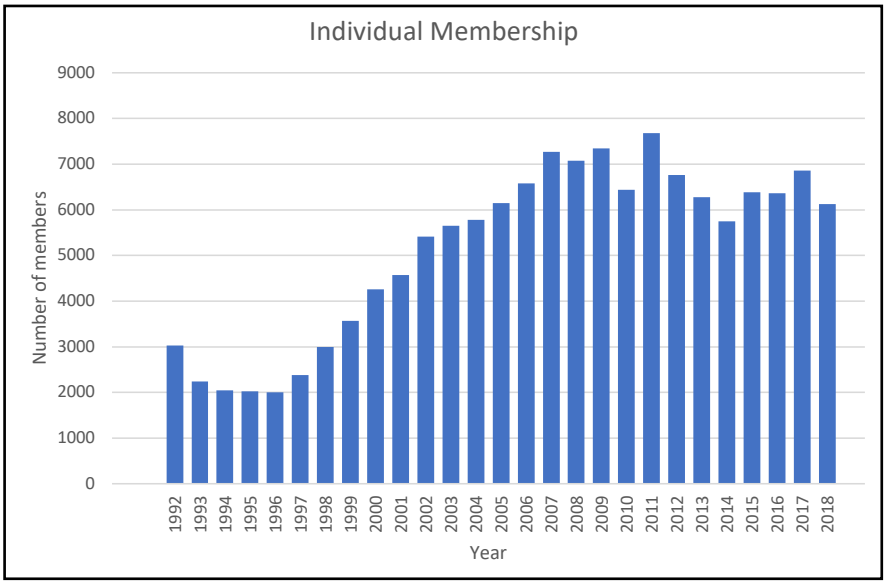


Figure 3. Loss of membership in the early 1990s led to a major restructuring of the Society. Subsequently, a deliberate strategy by successive Boards to broaden the membership across Asia, Africa and South America throughout the later 1990s, and the first decade of the 2000s, saw a greater than three-fold growth in membership. Jozef's multilingual skills, that include Arabic, Dutch, French, German, Spanish and Japanese, assisted greatly in disseminating information about the ISHS. Economic challenges across the globe have made membership retention a challenge over the past decade but enforce the need for good strategic planning and the management of high-quality delivery within events such as congresses and symposia.

"Jozef was committed to providing a message that horticulture is an essential ingredient for a fulfilling life to all people. He encouraged successive Boards and Executive Committees to arrange their regular business meetings in many North and South countries around the globe. In addition, he encouraged local participation of professional horticultural scientists and local business communities in those meetings, always with encouragement for them to support the international efforts of the ISHS. He also strongly encouraged the development of Corporate membership as part of integrating the chain from production through to appropriate consumers. His multi-language ability, together with his gregarious personality, business acumen and wide range of contacts throughout the world, magnified his success in highlighting the significance of horticulture to satisfy a wide range of human needs."
Prof. Errol Hewett (former Board and Executive Committee member)

Jozef was committed to ensuring that all the Secretariat staff, including himself, were accessible to the membership, commercial partners, and other professional groups who were associated with the ISHS. Key to that accessibility was the strong presence of the Secretariat at ISHS Congresses and other major meetings around the world, such as those at FAO, CGIAR meetings, regional congresses and others. The booths were always highly visible and efficiently laid out to effectively present the activities of the ISHS. The high rates of engagement of members and exhibitors with Jozef and his staff were testament to the open and effective engagement that occurred.

"Jozef was always committed to having the Secretariat feature strongly at ISHS Congresses. Many of the Secretariat team, each assigned with a specific function, attended the well-presented ISHS booths. Jozef made himself freely available to meet people from all over the world, to discuss new projects and to develop new collaborations with them. His prodigious memory allowed him to remember not only the name of the visitors but also the last time that they had met. He would ask about news from their institutions or families, share in their successes and offer to assist with finding solutions to any problems that they might have encountered. Jozef knew everyone but all the congress participants also knew Jozef and would often visit the ISHS booth just to say hello. People are the most important component of a professional scientific society and Jozef focused strongly on developing those personal relationships. The ISHS has benefited immensely from his innate capacity to communicate."
Prof. António Monteiro (former President and current Council member)

Presenting to the world

The digital age means that it is more important than ever to be electronically connected and to be as up-to-date and as relevant as possible both to members and to the wider public.

The development and management of the ISHS website over recent decades has been a critical part of the success of the ISHS. This involved a huge amount of effort by Jozef and the executive staff, to present current information of importance to members, such as the up-to-date schedule of about 70 symposia in the 3-4 years ahead. However, it was also important to record information of historical importance over the life of the Society.

Jozef arranged for the re-design and roll-out of a new logo for the Society in 2006 to better reflect the modern graphics available and that was more relevant to the new developments that were occurring within the ISHS at that time.

Mentor and leader

Throughout his 23-year tenure, Jozef was often the "face" of the ISHS. He collaborated with successive Boards throughout that period, provided considerable input to Executive Committee meetings and often provided highly valued background to issues being addressed by the Council. Significantly, he provided the corporate memory in situations where there was a high turnover in membership and little knowledge of the history of the ISHS amongst each of these governance groups. Jozef had a wonderful ability to inform without attempting to influence the direction of any particular debate, making it clear that the decision-making was the responsibility of the particular group involved. He also led a group of highly professional and competent staff within the Secretariat who supported those in various leadership roles and the membership at large.

› Jozef and his wife Mieke at the ISHS Council Meeting in Istanbul, Turkey, August 2018, after being awarded a very decorative vase as a farewell gift in recognition of his extraordinary contributions to the ISHS. Jozef and Mieke have three adult children – Kerlijn, Laureen and Andreas.

› Visit to the Botanical Gardens of Bonn University and inspection of the world's largest flower, *Amorphophallus titanium*; April 2009. From left to right: Dr. Walter Müller (Internal Auditor), Prof. Georg Noga (Treasurer) and Ir. Jozef van Assche.

Jozef's diplomacy, knowledge and broad skill set also made him invaluable in dealing with relationships with organisations external to the ISHS.

"He exercised strong leadership, but always acted as a team player within the ISHS. He consulted with individual members, the Council and the Board, shared information and expertise with them and built team spirit. His communication of very demanding subjects and ability to bring them to a point of conclusion was excellent and always directed to the service of the Society. Over many years, Jozef contributed in a unique way to make the organisation flourish with his impressive skills. ISHS now has a fantastic knowledge base, a strong service culture and a platform for innovation across basic and applied horticultural research, bringing together science, industry, business and economics for the benefit of all. Jozef's dedication, commitment and accomplishments, often under challenging circumstances, were extraordinary. I am very grateful and proud to have served the ISHS as companion of Jozef over many years."

Prof. Georg Noga (former Board and Council member)

"Jozef Van Assche was and is a people person, the reason he helped so many members, and the reason ISHS had so many members. He was always available to advise Council on all and any ISHS fronts. Jozef Van Assche made being associated with ISHS in any capacity FUN!"

Prof. Dan Cantliffe (former Executive Committee and Council member)

"When I met Jozef for the first time at an ISHS Council meeting in the mid-1990s, I was overwhelmed by his kindness, his open-mindedness and the empathic way in which he welcomed me. He immediately made me feel like an old friend and part of the big, highly dedicated ISHS community. It was not only me who had this special experience – it was extended to all. Jozef's personality, his unique charisma, dynamic style and infectious charm is absolutely impressive! And his ability to remember names and faces is incredible! We soon became very close, real friends."

Prof. Georg Noga (former Board and Council member)

A faithful servant to the ISHS, a mentor and personal friend to many, we recognise and thank him for his many contributions to the Society.

(Jozef can be reached at Jozef@atolo.eu)

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› Ian J. Warrington

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Emeritus Professor Ian J. Warrington served on the ISHS Council (1990-2002), the ISHS Board as Vice-President and Chair of the Executive Committee (2002-2010) and was IHC2014 Congress Co-Chair (2010-2014). He is a Fellow and Honorary Member of ISHS. Before retirement he was Deputy Vice-Chancellor of Massey University and, previously, Chief Executive of The Horticulture and Food Research Institute (HortResearch, now Plant & Food Research) in New Zealand. He is currently the editor of Horticultural Reviews, serves on several charitable trusts and runs courses on scientific writing and publishing around the world. E-mail: I.Warrington@massey.ac.nz

Ecuador demonstrates a sustainable way forward for small farmer producers

William Viera and Trevor Jackson

Background

Sustainable agriculture is defined as the production of adequate amounts of food to satisfy the human demand while emphasizing the efficient use of natural resources. This practice generates incomes for farmers with less impact to the environment (Galarza, 2016).

Small farmers in the developing world face many problems due to low value of their crops, rising costs, environmental degradation due to soil and chemical overuse, as well as climate change (Padilla, 2016). Yet small farmers can provide the key to a brighter future and the chance to meet the Sustainability Goals put forward by the United Nations (2016).

The South American country of Ecuador has a large rural population spread between the cool highlands at more than 2000 m (Figure 1) and the tropical lowlands. It also contains stunning natural environments preserved in national parks as diverse as the Galapagos Islands, the high volcanic mountains, and the Amazon rainforest. This location makes agriculture a good option to take advantage of the natural resources to produce crops throughout the year, particularly in the off-season (Altieri and Nicholls, 2009).

Despite these abundant natural resources, Ecuador's rural populations are among the poorest in Latin America. Over the past decade things have begun to change for the better. Rural roads and infrastructure have improved and the government has become more decentralised (Naranjo et al., 2016). The provinces have more power and actively support programmes for rural development. These programmes have the goal of obtaining high quality products for local markets and exportation (Figure 2).

Figure 2. Organic banana produced in Ecuador for exportation.

Figure 1. The Ecuadorian highlands – a patchwork of small farms on volcanic soils.

The focus of the development programmes is "clean agriculture," which is good for farmers, consumers and the environment (Martínez et al., 2019). Progress along this pathway has been a reaction to the previous indiscriminate use of chemical pesticides and a growing awareness of the environment. People now have a nostalgia for traditional foods, even among the more affluent, rapidly growing urban populations.

To enhance a sustainable agriculture in Ecuador, as part of the New Zealand Aid Programmes Partnership Programme, AgResearch has been working with the National Institute of Agricultural Research (INIAP) and the Inter-American Institute for Cooperation on Agriculture (IICA), to develop and provide the underlying technologies to support more sustainable agricultural practices (Viera and Jackson, 2019).

Bioproducts

Ecuadorean producers are enthusiastic about the adoption of integrated pest management (IPM) techniques instead of chemical control. Consequently, experimental tests have been carried out to develop the standards required for efficacy to eliminate diseases and pests (Viera et al., 2018). In addition, Ecuadorian authorities, INIAP, academic institutions, and other organizations are developing a registration system that certifies standards and increases user confidence in the biocontrol products (Barriga, 2017; AGROCALIDAD, 2019; Ruales and Barriga, 2020). Key to product improvement is an awareness of required product standards and the establishment of quality control systems. AgResearch (New Zealand) provided the initial training in the development of quality control protocols that are now managed through a Biological Control Laboratory established at the Santa Catalina Research Station (Figure 3). This laboratory specialises in products based on beneficial micro-organisms (Báez et al., 2019).

The laboratory acts as a training centre for local biocontrol producers. It is also a repository for key strains of microbes and a centre for development of new formulations and applications (Figure 4). Currently, this laboratory performs research about biological control and formulation, offers services for farmers and bioproducers, and trains scientists and technicians. The training is offered to a network of representatives from INIAP, IICA, Ministry of Agriculture, the Phyto and Zoosanitary Regulation and Control Agency (AGROCALIDAD), universities, and private companies such as flower growers, and small

Figure 3. Laura Villamizar (AgResearch) demonstrating microbial formulation procedures at the INIAP biocontrol laboratory.

Figure 4. Stefan Jaronski (USDA) discusses microbial production with Antonio Leon, Microtech Services.

Figure 5. William Viera and Aníbal Martínez (INIAP) discuss blackberry production with local grower of the Tungurahua Province.

Figure 6. Trevor Jackson (AgResearch) and Alex Delgado (IICA-INIAP) visit the Asoguabo cooperative (suppliers to All-Good Fair Trade bananas).

and medium bio-producers. The next step will include scaling up the formulation developed during the project's research activities. This will be carried out through agreements with companies interested in investing in this technology and commercializing their bio-product in the agricultural sector.

Agricultural applications

Development of the biocontrol sector in Ecuador has been stimulated by the floriculture industry where many producers have their own, on-site, microbial production facilities to provide the organisms for biological control. Other small bio-control producers supply a range of operations including flowers, vegetables and fruit crops. In all cases, the emphasis is on use of materials that are safe for the workers and provide a high quality, healthy product to the consumer.

Small farmers are included in the process of developing cleaner agriculture through their cooperatives and community organisations. They are reaping the benefits of using biological systems by producing for niche markets with greater return to the growers. These can be through local farmers markets where premium prices are given for organic and natural products, and through organic and fair trade chains for export produce (Reynolds, 2000).

Blackberries

INIAP is working with small farmers producing local fruits in the Andean Highlands (Figure 5). A local blackberry, the "mora" (*Rubus glaucus*), grows well at 2500-3000 m. This blackberry became infected by diseases causing collapse of the plants when grown with inadequate management (Iza et al., 2020; Villarés et al., 2016). INIAP has developed an IPM system to maintain high productivity of the fruit while incorporating the beneficial fungus *Trichoderma*, as a growth stimulant/disease suppressant. This use results in higher yield of fruit and consequently higher income for the growers (Viera et al., 2019, 2020). Other biological alternatives for disease control are also used (Racines et al., 2019; Acosta et al., 2020), and provide an opportunity for the biocontrol producers.

Ecuador currently has around 5000 ha of blackberry under production. Most of this production is grown on family plots of small areas in the Tungurahua Province (Alwang et al., 2019). These kind of farms are used to produce fruit crops in areas similar or less than 0.5 ha (Viera et al., 2017). Even these small areas can provide a good source of income for rural families. There is a large demand

for the fruit for local juices. This crop has the potential for a strong export market with frozen fruit pulp. Blackberry production is usually managed by the women in the family, and integrates well with production of minor species of animals.

Bananas

In contrast to the cool conditions of the Andean highlands, work is being done in the Litoral region with organic banana producers in the humid lowlands. The organic sector is principally made up of small farmer producers with 4-6 ha under production. Producers are organised into cooperatives (Figure 6), and currently receive a 50% premium for fruit meeting the organic standards (Vásquez et al., 2019). However, pests and diseases are a threat to the system and can cause large production losses and rejection of damaged fruit. Methods for organic production have been developed, validated, and growers are now in training to prevent fruit loss with methods that are acceptable in both organic and conventional systems (Delgado et al., 2017). The application of *Trichoderma* enhances root biomass, which is beneficial for the banana productivity (Navia et al., 2017). In addition, products permitted under organic regulations have been tested to control economically important pests such as thrips. Thrips can cause red spot, which affects fruit quality (Delgado et al., 2017; Arias de López et al., 2020). The demonstrated success in the organic sector will lead conventional growers to adopt production techniques with reduced chemical contaminants in the environment.

Conclusion

Successful adoption of biological controls in the production systems of small farmers has shown to be a benefit for farming-systems. This approach leads to economic development in poor rural communities, and the development of access to local and international markets. The opportunities (and problems) were defined by the communities. The rural workers, extension specialists, and scientists collaborated to determine the solutions for these local problems. The key ingredients for success are the integration of processes along the whole production chain. In addition, critical evaluation and emphasis on quality control were needed at each step in the production process. Through adoption and promotion of biological production systems, Ecuador is able to promote its farming sector not only for production but also as an attractive place for eco- and community tourism. In no small part, this agricultural development has allowed Ecuador to work from within towards success in achieving the UN Sustainability Goals.

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› Trevor Jackson

About the authors

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Trevor Jackson is an entomologist/microbiologist with expertise in development of biological control systems for integrated pest management (IPM). His research focus has been on development of insect pathogens as biopesticides and inoculants for the control of insect pests, particularly those that live in the soil or other concealed environments. He has led development projects and training programmes in insect pathology/pest management in the Pacific, Asia and Latin America and has worked with industry in development and use of beneficial microbes in plant protection. Trevor is currently a Principal Scientist at AgResearch, New Zealand. E-mail: trevor.jackson@agresearch.co.nz

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Genetic data improve management and use of apple genebank collections

Gayle M. Volk and Nicholas P. Howard

Figure 1. Locally-grown apple cultivars sold on the roadside in Kazakhstan.

Apple (*Malus* L.) genebank collections conserve vast amounts of genetic diversity, including wild species, heritage, and modern cultivars. These collections make a wide range of genetic resources available to end-users (research and breeding programs, industry, and sometimes even the public) on a local, national, and/or international level. Genebanks are perhaps most often recognized as sources of novel diversity for breeding and research programs that use collections to develop new cultivars that are pest and disease resistant, high quality, have high yield, and can be efficiently produced. Local cultivars within these collections may have regional and historical interest to growers, researchers, and members of the public (Figure 1; Bramel and Volk, 2019). Due to strict quarantine regulations, it is usually time-consuming and expensive to share non-seed apple genetic resources across international borders. Thus, access to apple genetic resources may be limited to varieties available within apple genebanks within national (or regional) borders. As a result, it is critical that apple varieties within genebank collections (referred to as "accessions") have desired levels of diversity, are true-to-type, and are well-documented (Figure 2).

Figure 2. A row of accessions in the USDA National Plant Germplasm System Apple collection.

It is difficult to compare apple accessions within and among apple collections using descriptive (phenotypic) data due to the effects rootstock and environment have on vegetative and fruit traits. In addition, trait data have often been collected using many different methods under non-replicated conditions across multiple years. These attributes have also made it challenging to provide data that can be directly applied by end-users (Bramel and Volk, 2019).

Genetic data have informed and aided the management of apple genebanks by helping to understand collection content, coverage, diversity, and opportunities for end-users. Recent genetic analyses have made use of several marker types including simple sequence repeats (microsatellites), single nucleotide polymorphism (SNP) arrays, genome-based sequencing (GBS), as well as DNA sequence data. Each of these data types have benefits and drawbacks with respect to their use in apple genebanks, which are discussed herein.

Microsatellite data

Genetic information for apple genebanks using simple sequence repeats, or microsatellites, has been compiled for collections over the past twenty-five years. The relatively low-cost, high level of cultivar-specificity,

Figure 3. *Malus sieversii* is a progenitor species of *Malus* × *domestica*. Seeds from wild *Malus sieversii* populations in Kazakhstan have been collected and are made available from the USDA National Plant Germplasm System.

and ease in analysis of microsatellite data have made the data particularly useful to identify putative duplicates within collections, sport families, and to develop genetic fingerprint reference sets for large numbers of apple cultivars. Microsatellite data have been most widely used for cultivars of *Malus* × *domestica*, as well as crop wild relatives *Malus sieversii, Malus sylvestris*, and *Malus orientalis*. Some significant disadvantages of microsatellite data collected for apple genebank collections are the difficulty of comparing datasets collected in different laboratories and the inconsistent use of the same marker sets among collections (Figures 3 and 4; Evans et al., 2011; Gross et al., 2012b).

Microsatellite data have provided key information with regard to confirming cultivar identities within apple collections. Microsatellite data have identified synonyms (two varieties that have the same genetic fingerprint and different names), misidentified cultivars (varieties that were believed to be unique, but in fact share a genetic fingerprint with a rootstock or other known cultivar), and sport families (varieties that have the same genetic fingerprints but have different phenotypes, often resulting from sport mutations) within apple collections (Evans et al., 2011; Gross et al., 2012b; Urrestarazu et al., 2016; van Treuren et al., 2010). Access to this information has allowed curation teams to confirm trueness-to-type and to classify misidentified accessions within genebank collections (Gross et al., 2012b). The use of a common set of 16 microsatellite markers in the European FruitBreedomics project allowed for these comparisons to be made across germplasm collections in France, Italy, Belgium, Czech Republic, United Kingdom,

Figure 4. *Malus sylvestris* is native to Europe and has been collected from the wild for conservation in genebanks.

Sweden, Finland, Spain, Switzerland, Russia, and Kyrgyzstan (Urrestarazu et al., 2016). The assignment of unique identifier codes, formerly named Fruit Breedomics Unique (FBUNQ) codes in Urrestarazu et al. (2016) and now termed *Malus* unique (MUNQ) codes in Muranty et al. (2020), for each distinct SSR profile has greatly facilitated this type of cross-collection communication.

Microsatellite data have also been used to assess the diversity of wild *Malus* species as well as relationships between wild species and cultivars with respect to domestication, introgression, and hybridization. These data describe genetic diversity for wild species such as *Malus sieversii* and *M. orientalis* in their native habitats (Richards et al., 2009; Volk et al., 2008) and guide plant exploration teams by informing sampling efforts to broaden the range of diversity conserved within genebank collections. The data can also reveal instances whereby cultivated apples hybridized with wild species (Gross et al., 2012a). This is particularly valuable within genebanks, where users expect accessions labeled as particular species to be correctly identified.

Apple genebanks have used microsatellite data (and sometimes phenotypic data as well) to identify core subsets of accessions that capture diversity of specific species and/or collections as a whole (Gross et al., 2013; Lassois et al., 2016; Liang et al., 2015; Volk et al., 2005, 2009). Core subsets offer a wide range of diversity within a limited number of accessions, and as a result, core subsets may have more associated genotypic or phenotypic data than is available for the entire collection. In some cases, replicated trials are possible because core collections have been planted at multiple locations (Luby et al., 1998; Potts et al., 2012).

Genetic fingerprint reference sets made with microsatellite data are available for cultivars within collections. These reference sets have been used to identify heritage cultivars for which the original names are no longer available. This has been particularly useful for projects that seek to conserve and protect historic orchards on public lands (Figure 5; Routson et al., 2009). Access to genetic data about cultivars in collections has also been used to propose additions to collections that may be of interest due to historical, cultural, novel, or commercial potential.

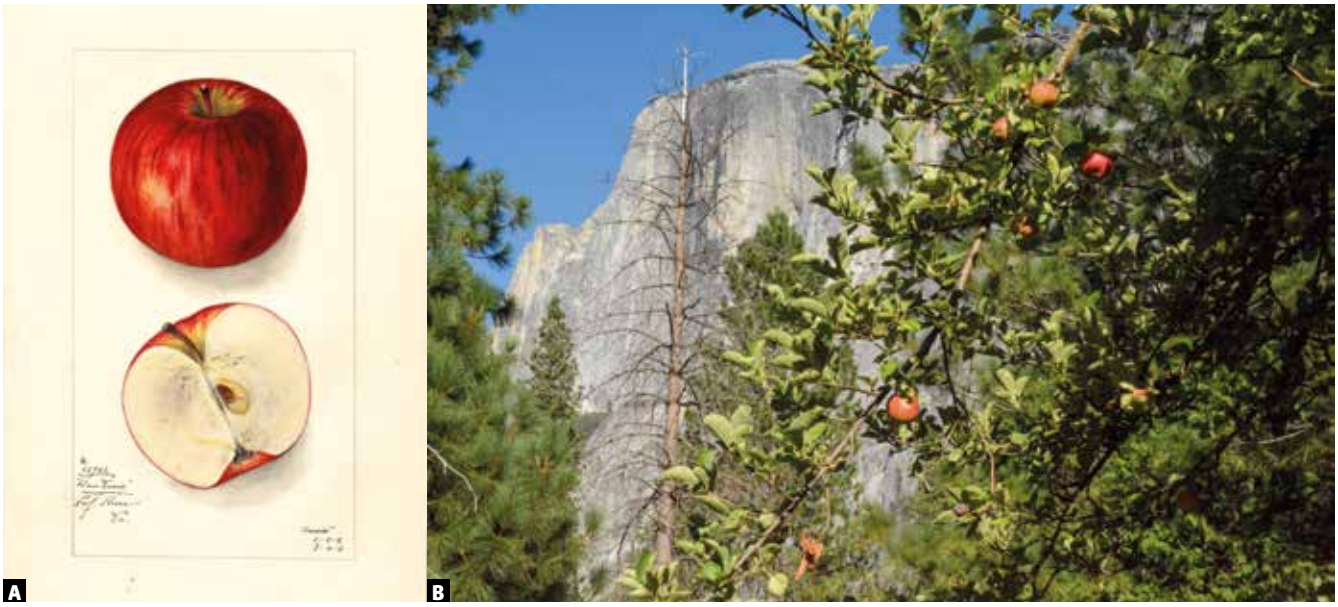

Figure 5. Heritage apple cultivar 'Ben Davis' (National Agriculture Library) (A) has been identified in historic orchards in Yosemite National Park (B) in the United States through the use of microsatellite data.

Single nucleotide polymorphism (SNP) data

Analyses using single nucleotide polymorphisms (SNP), made possible with the 8K (Chagné et al., 2012) and 20K (Bianco et al., 2014) Infinium, and 480K Axiom (Bianco et al., 2016) Apple SNP arrays, have provided new and exciting opportunities for apple collections, breeding, and research programs. Although more expensive to acquire, SNP data have greater genomic coverage and offer much higher levels of resolution than microsatellite data. Additionally, the quality and consistency of the SNP array data collected across facilities provide unambiguous information and facilitate cross-collection communication regarding duplication and true-to-typeness of accessions (Howard et al., 2018; Muranty et al., 2020). However, SNP data require the use of complex bioinformatic pipelines and computing resources for their analyses to achieve these higher resolution results (e.g. Vanderzande et al., 2019).

As with microsatellite data, SNP array data can be used to identify accessions with duplicate genetic profiles and the higher level of granularity of SNP arrays has made it possible to identify and/or confirm pedigrees of cultivars (Howard et al., 2017; Muranty et al., 2020; Vanderzande et al., 2017). SNP data can also be used to generate haplotype data, making it possible to identify pedigree relationships more distant than parent-offspring. Methods for conducting more complex pedigree reconstruction using haplotype data from apple SNP arrays are under development. Communicating information on SNP-confirmed pedigrees for germplasm accessions can facilitate more targeted application of germplasm by end-users of collections. For example, breeders can compare the results of quantitative trait loci (QTL) studies that indicate the ancestral sources of desirable alleles (e.g. Van de Weg et al., 2018) alongside pedigree and underlying haplotype data from accessions held in genebank collections to determine which accessions have alleles of interest.

Availability of pedigree and haplotype data from SNP arrays can serve other purposes in genebank collections. Identifying relationships among locally adapted/grown cultivars (which may not be available elsewhere) and internationally recognized cultivars may be elucidated, thus justifying the maintenance of local cultivars (Howard et al., 2017). SNP haplotype data can also identify the specific cultivar source of introgression in wild-domestic hybrid accessions (Howard et al., unpublished), which is key in understanding genebank accessions and whether they are representative of wild species. Information about introgression is important for making in-situ conservation decisions and for confirming identity and classification ex situ.

Figure 6. Wild apple species *Malus transitoria* (A) and *Malus zhaojiaoensis* (B) are native to China. They are examples of species diversity available in genebanks.

Genome based sequencing data

Genome based sequencing (GBS) genetic analyses provide many more SNPs than SNP array data; however, GBS data cannot be as consistently applied across studies because the larger datasets differ in their extent of genome coverage. GBS data also require high levels of bioinformatic expertise and infrastructure to process. Like SNP arrays, GBS data are most applicable to domesticated *Malus*, close crop wild relatives and progenitor species. Despite these challenges, GBS data, like SNP array data, can be used to assess population structure, pedigree relationships, and ploidy levels in germplasm collections, such as has been done at the Pometum gene bank in Denmark (Larsen et al., 2018). The larger numbers of SNPs from GBS, compared to SNP array data, provide genetic information that gives greater depth of results in genome-wise association studies (GWAS) of genebank accessions, thus increasing the utility of the collection (Amyotte et al., 2017; Larsen et al., 2018; Lee et al., 2017). GBS was used to perform GWAS with accessions in the USDA National Plant Germplasm System apple collection and possible SNPs linked to harvest date and fruit skin color were identified (Migicovsky et al., 2016). The USDA apple collection was also the source of materials used to identify QTL for blue mold resistance in apple using GBS (Norelli et al., 2017). Studies that link markers identified through GBS analyses to genebank accessions increase the value of genebank collections as genetic resources for marker-based breeding programs, in addition to the more traditional genebank role as sources of plant material.

Sequence-based data

Genomic sequence data have identified allelic differences among genebank accessions and may offer new opportunities for breeding programs. Access to specific allelic data increases the value of genebank collections as resources for allele mining. Genomic sequence data obtained from *Malus* accessions in the Chinese Institute of Pomology of the Chinese Academy of Agricultural Sciences and USDA genebanks revealed domestication relationships between wild *Malus* species and Chinese landraces (Duan et al., 2017). Gene sequence data revealed relationships between *Malus* × *domestica* and progenitor species *Malus sieversii, Malus orientalis*, and *Malus sylvestris* (Velasco et al., 2010). An understanding of the relationships between domesticated apples and related landraces and progenitors may help genebanks and user communities identify novel genetic resources that can be easily integrated into breeding programs. In addition, chloroplast sequence data have provided insights with regard to genetic relationships among species, particularly *Malus* species that are distant from *Malus domestica* (Nikiforova et al., 2013; Volk et al., 2015). These species-level genetic relationships help identify gaps in collections for improved collection management and targeted collection expansions (Figure 6).

Data availability

Many published studies have produced genetic data for *Malus* accessions held in genebank collections and some of these projects have made their data available as supplementary information or have their data hosted by the Genome Database for Rosaceae (GDR) (https://www.rosaceae.org) (Jung et al., 2014). Other genetic data may be more difficult to obtain if it has not been submitted to public databases; as a result, it may not be easily accessed by user communities. Public access to organized accession-level genetic data produced using consistent markers or platforms will greatly enhance communication between germplasm collections, which in turn will improve application by end-users.

Conclusion

Apple genebanking, research and breeding communities are integrally linked. In 2019, a Global Strategy for the Conservation and Use of Apple Genetic Resources was released (Bramel and Volk, 2019). This strategy included results from a survey that compiled information from apple collections in 34 coun-

tries from all continents (except Antarctica). Some collections were based in countries that have wild *Malus* species conserved in situ (Europe, Central Asia, East Asia, etc.) and others had many landrace cultivars (Eastern Europe, China, Russia, etc.). A global platform was proposed whereby collection composition, standardized phenotypic and genotypic information, as well as methods for genebank management and breeding could be shared (Bramel and Volk, 2019). The use of a common set of genetic markers, such as the set of SSRs used in Urrestarazu et al. (2016) and a common set of robust and accurate SNPs, such as those used in Howard et al. (2018) that integrate data from two different SNP array platforms, will facilitate these collection comparisons and collaborations.

Genebanks are a critical source of plant genetic resources and genetic data for genebank accessions have been key to developing new, more efficient breeding technologies. Availability of genetic data increases the value of genebank collections by providing information that improves management practices and guides collection users. Genetic data also allow accessions within collections to be compared, which improves collaborations among research programs and access to correctly identified materials. Ongoing efforts to make genetic data for apple genebanks publicly accessible using standardized formats will improve the quality and utility of these important collections of genetic resources.

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› Tackling postharvest losses in mango among resource-poor farmers in Kenya

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Smallholder farmers in Kenya have the enormous task of feeding the rising population. With the adequate amount of appropriate input (certified seed, fertilizers, and water), the farmers could create great success; to produce enough food to feed 40 million Kenyans and have surplus to export. Nonetheless, many smallholder farmers have limited resources at their disposal. What is more, much of the food produced in Kenya is frequently lost along the supply chain before reaching the consumer. According to FAO reports, 30% of food produced for human consumption is lost or wasted before it can be eaten. In fruits and vegetables, the losses may be as high as 40-50% of the total production.

For horticultural farmers, the losses are aggravated by the perishability of their products. Fruits must be harvested for sales or utilization upon maturation. The plight of mango farmers in Kenya is of particular interest because of the seasonality of the crop. Fruiting in the major producing regions occurs between November and March, with the peak between January and February. For many farmers, mango is their primary cash crop. The trees need to be tended throughout the year to protect the farmer's major source of livelihood. These farmers are at the mercy of middlemen or brokers, given the high perishability of mango fruits. Once the fruits mature and ripen on the tree, they must be harvested. Otherwise fruit will fall off the tree and rot. In 2017, survey results during the mango season revealed that while most traders buy mangos at a paltry 3-5 Kenyan shilling (1 KSH = 0.01 US$) at the farm gate, the same fruits retail for as high as 60 KSH in Nairobi's retail outlets that include supermarkets. Without cold storage facilities, which could be used to slow down the deteriorative processes and extend the marketing, the farmers are left with few options: they either sell their fruits at the throw away price (3-5 KSH), or leave the fruits to rot away on the trees and earn nothing.

A University of Nairobi Postharvest Project team is set to change this narrative, with support from the Rockefeller Foundation (RF). The goal of the intervention is to aggregate smallholder farmers and processors. Over the years, farmers have been encouraged to form or join cooperative groups as a strategy to enhance their bargaining power for selling their produce and avoid exploitation by traders. Farmers have responded positively by forming groups that have upscaled into cooperative societies. These groups have enhanced the farmers' access to better training and extension services. Unfortunately, market access remains as a major challenge for most of them. Aggregation of smallholder farmers into these groups is essential to meet the quantity, quality, and consistency of produce required by the buyers.

Given the situation, RF, under the "Yieldwise" initiative, is collaborating with partners to demonstrate the potential of smallholder aggregation and processing. Through a joint project, implemented by a team of researchers from the University of Nairobi, Jomo Kenyatta University of Agriculture and Technology, and RF, two aggregation centers have been established. Another pro-implementing partner is TechnoServe Kenya.

One center has been established in Machakos County for the Masii Horticultural Farmers' Cooperative Society. It is an off-grid center, meaning that electricity is not required. At this stage, the center is designed mainly for collection and storage of fruits and vegetables. The center is equipped with an evaporative charcoal cooler (ECC) and a series of zero-energy brick coolers (ZEBC). The ECC and ZEBC operate on the principle of evaporative cooling. When water evaporates from the wet charcoal and sand in the ECC and ZEBC, respectively, the heat is removed from the surrounding environment and the stored produce remains cool. Evaporating water results in a cooling effect and increases the relative humidity around the stored produce. This slows down spoilage of the stored fruits or vegetables. The evaporative cooling facilities in this center have the capacity to hold 2-3.5 tonnes of mango fruits. The group has already benefited from training on improved production and postharvest handling technologies and practices from the project team. This group has been monetarily benefiting from the aggregation facility by negotiating for bet-

› Mango fruits in an evaporative charcoal cooler in the Karurumo Smallholder Aggregation and Processing Center, Embu County, Kenya.

› Mango fruits in a zero-energy brick cooler in the Karurumo Smallholder Aggregation and Processing Center, Embu County, Kenya.

ter prices for their collective produce. In the most recent mango season, they were able to sell their mango fruits to buyers for 6-10 KSH per piece. This is an improvement from the farm gate price of 3-5 KSH offered by most buyers during the previous peak season. The group hopes to enlarge their efforts by adding processing. Although mango is the main commodity in the area, the group has been encouraged to take advantage of the facilities to aggregate other commodities such as tomatoes, French beans, and papaya (*Carica papaya*), which also grow in the area.

A second center, this one on-grid, has been established in Karurumo, Embu County, and is owned by the Karurumo Horticultural Self-Help Group. It is a full-scale aggregation and processing center with facilities for both storage of fresh produce and also small scale wet and dry processing. The installed facilities include ECC and ZEBC similar to those in Masii. In addition, the center has a Coolbot® cold room, which is a low-cost alternative to a conventional cold room. Based on best practices for horticultural produce handling and cold chain management, when the produce is received at the center, it is sorted and graded based on the market destinations. Thereafter, the produce is precooled in the evaporative coolers to remove the field heat prior to storage. The center is also equipped with facilities for small scale wet and dry processing of fruits and vegetables. For example, mango, which is the main regional fruit, can be wet-processed into diverse products, including pulp (puree), mango concentrate, and ready to drink juice. Besides wet processing, fruits (and vegetables) received at the center can be dried into high quality products. To do this, the center has two tunnel solar dryers, each of which has capacity to dry about 1 tonne of high quality dried fruits in one loading. Processing provides an alternative of transforming unsold fresh fruits (and vegetables) into shelf-stable products. Without processing facilities, farmers are often at the mercy of intermediate supply chain managers who take advantage of their desperation to buy the fruits and vegetables at very low prices. This situation will change. Farmers do not have to sell their fruits fresh because they have the option of processing. Moreover, with access to markets, processed fruits and vegetables have better returns than fresh (unprocessed) produce.

The aggregation and processing centers have provided researchers with an opportunity to ensure that their research outputs benefit the end users "from lab to land." The centers are expected to serve as one-stop shop where farmers and other stakeholders can see postharvest technologies and innovations at work.

The two centers in Machakos and Embu Counties have been introduced on pilot scale with the goal of replicating them in other regions and Counties in Kenya. The vision for this initiative is that smallholder aggregation centers will serve their intended purpose of delivering high quality and quantity fresh and processed horticultural products for the market. This will ensure better returns for farmers while reducing postharvest losses in horticultural supply chains. Furthermore, small-scale processing has the potential to spur growth of cottage industries in rural areas, thereby driving rural industrialization and benefitting the local population.

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Vegetable seed sector in France

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Introduction

Vegetable production in France (Box 1) has developed since the 19th century from traditional "vegetable belts" along the fertile river plains near urban centers, such as the valleys of Seine and Loire, Rhône and Var rivers (Figure 1a). Intensive production developed from the beginning of the 20th century in areas with favorable soil and climate, in particular in French Flanders (St Omer, for cauliflower and winter vegetables), upper Seine valley (asparagus and "green" vegetables), central France (Orléans and Sologne, for asparagus, strawberry, cucumber), Brittany (St Malo basin for cauliflower, potato), western France (Nantes basin for carrot, corn salad, leek, lily of the valley), and southeastern France (Provence and Hyères region, for Mediterranean vegetables).

From 1950 onwards, several areas became specialized: Normandy (carrot, turnip, leek and winter vegetables), Brittany around Roscoff and Plougastel (cauliflower, onion and shallot, potato, strawberry, tomato), Limagne plain (garlic, shallot), southwestern France (tomato from Marmande, beans and strawberry from Villeneuve-sur-Lot, melon), Camargue (melon, tomato), and around Perpignan (chicory, lettuce, tomato). More recently, highly mechanized open field crops have developed: melon in the Charentes, carrot in the sandy soils of the Landes, onion in the Beauce plain. Production under glass or plastic cover, which ensures early production, progressed from 1960 onwards because it secures also the visual quality of the product. The use of plastic and cellulose-fiber protecting materials contributed to the intensification. The original notion of "primeurs" has been altered because internationalized production carried by lorries now supplies Europe all year round.

The production of vegetables for food processing is progressing with varieties adapted to highly mechanized technical routes (bean, broccoli, celery, gherkin, onion, pea, spinach, sweet corn, tomato), produced in northern and southwestern France, Brittany, Saône and Rhône valleys.

Seed quality (germination vigor, grading coating and priming) and variety adaptation (hybrid vigor in particular) have enabled precision sowing in the field to become widespread. For crops grown under cover and field crops with transplanted seedlings, seed quality and sanitary requirements have contributed to the widespread use of seedlings

Box 1. Economic data on vegetable production in France

French vegetable production (7,500 ha under cover, 210,000 ha in the open field) amounts to 6 million tons (Mt), 30% of which are industrially processed (Oberti et al., 2020). The huge matching seed market for growers is supplied by French and many foreign companies (particularly Dutch, American, Japanese, Italian companies), as well as multinationals.

More than 1 billion tons of vegetables are produced per year in the world, 72% of which are produced in Asia (China alone produces 400 Mt). France ranks third as vegetable producer in the European Union (EU) and exports 1 Mt (Lor, 2015). Importations of tomato (500,000 t), carrot, squash, melon, onion, and salad mostly originate from Spain, Italy and Morocco, for a total of 1.9 Mt. Annual consumption (mostly carrot, tomato, lettuce, melon, bean and brassicas) is about 126 kg per capita, over 50% of which are supplied by supermarkets. It is a lower consumption than in Turkey (first consumer in Europe), Italy and Spain (the two first consumers in the EU).

The share of family gardened production fell significantly from 1980 onwards, but has risen up in recent years: 16.5 million gardeners produce vegetables in France. This represents a substantial amateur seed market.

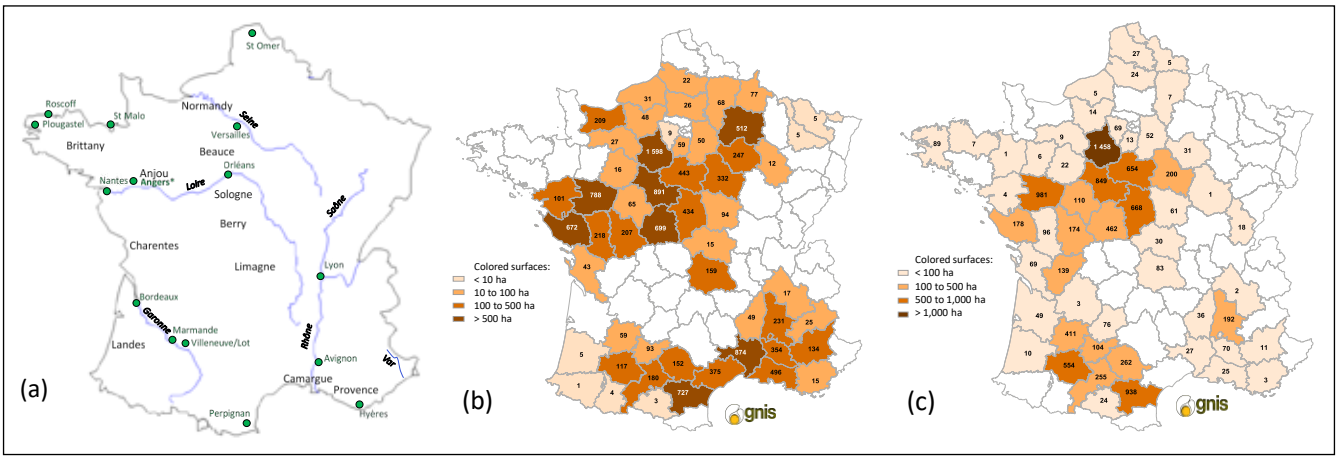

Figure 1. Geographic distribution of vegetable and seed production in France: a) Historical vegetable production areas. Rivers (blue), towns (green) (* place of IHC2022) cited in text; b) Total seed production of small seed vegetables, 9,675 ha in 2019; c) Total seed production of pulses, 12,205 ha in 2019 (Source: GNIS).

› Uniform radish (A) (Photo ©INRAe), fennel (B) and turnip (C) hybrids (Photo ©HMClause).

and the development of an industrial seedling production chain (1,500 nurseries, GNIS, 2016).

Until the end of the 19th century, vegetable growers traditionally cultivated and sometimes improved their local varieties. From then, selections and new varieties were increasingly released by private seed companies. As early as 1950, breeders and seed producers jointly invested in genetic improvement and seed technology to make available high-performance varieties coupled with high quality seed produced in selected regions. Supported by public research, technical institutes, extension services, networks of agro-technicians and high quality agricultural education, the vegetable seed sector achieved a high level of organization and technical performance that serves as a model throughout the world since 1980.

Since 2000, there is a public concern for setting up environment friendly production practices and for producing healthy food. The vegetable seed sector participates in the development of agro-ecological and organic agriculture in France, Europe and elsewhere.

The strength of the French vegetable seed sector is based on several assets, among which public regulations, public and private research and partnership as well as a diversity of soils and climates.

This article reviews the main characteristics, since 1950, of vegetable species breeding, of vegetable seed industry organization in France in terms of market, research and teaching, of seed production and the contribution of the vegetable sector to the agro-ecological transition.

History of vegetable breeding and vegetable seed companies

France is known throughout the world for its seed companies

The de Vilmorin family began seed selection at the end of the 18th century. It created in France, in a significant way, a dynamic seed production and breeding activity, which took off at the end of the 19th century. From the 1960s, the companies Clause, Tézier, Caillard, Société de Production Grainière (SPG), later Gautier Semences, and many others developed into a vast network of 400 vegetable seed companies (breeders, producers and seed brokers) spreading from the Loire valley (Boret, Brivain, Camus, Cesbron, Curis, Fautrat, France Graines, Giladeau, Godineau, Griffaton, Guillard, Hodebourg, Moreau, Toumelin), Paris basin and the north (Blondeau, Cayeux, Lecouf-Maillet, Mollard-Sanrival, Peltier, Séminor, Simon Louis), the east (Denaiffe, Fabre, Lafitte, Voltz), to the Rhône valley (Bourget Sanvoisin, Blain, Ducrettet, Genest, Girerd, Gondian, Mirabel, Ribot & Faure, Rivoire-Lavergne) and the southwest (Catros Gérand). There are still 80 vegetable seed production and marketing companies in France in 2020.

Conservative breeding of heirloom varieties

During the 20th century, these establishments, in contact with vegetable growers, collected, maintained, improved and produced several hundreds of varieties and local populations formerly created by the vegetable growers. These are the old varieties and populations from the public domain, the specific heritage of French vegetable growers, maintained by conservative selection, still available to the sector (Box 2).

Creative selection

Until 1960, Vilmorin and Clause were the pillars of vegetable breeding thanks to their research sections dedicated to varietal creation and production techniques. Vilmorin breeders created improved varieties, including the first F_1 hybrid tomato variety in France, 'Fournaise' (1956). From 1955 onwards, the National Institute for Agricultural Research (INRA[1]), in partnership with private seed companies, also became involved in research and creative breeding. As early as 1970, these actors created modern varieties, hybrids or not, that met the technical criteria required by large scale producers and marketers. The vegetable distribution sector requires homogeneous products that

› Capsicum pepper: rectangular and horn types with diverse colors (Photo ©R. Brand)

Box 2. Ancient varieties and populations in the public domain

Thanks to the quality of French conservative breeding, vegetable growers have access to healthy and well germinating seeds of old populations, selections (formerly called "races") created in the 19th and the first part of the 20th century. Until 1970 this conservative selection focused on uniformity and adaptation of the varieties to market requirements. Examples include open pollinated varieties of carrot (e.g., Nantaise, Colmar), population varieties of cauliflower in Brittany, leek (e.g., d'Eté, d'Automne, de Gennevilliers, de Carentan, Bleu de Solaise), onion (e.g., de Mulhouse, d'Auxonne, de Roscoff, de Trébons, de Lézignan), which still provide an economic alternative to hybrids. As early as 1980, the seed companies joined together to form the Union of Vegetable Variety Maintainers (SMVP), in order to continue and harmonize the maintenance work. Nowadays, other structures carry out this work (e.g., the Carrot Crunchers Association). The varieties are registered in the French Official Catalogue and the list of official maintainers is available at GEVES (Group for the Study and Control of Varieties and Seeds; www.geves.fr).

[1]INRA became INRAE the 1st of January 2020 (https://www.inrae.fr/en/about-us)

are easy to pack and transport, and that are adapted to mass production, whether mechanized or automated. Breeders took these objectives into account and added an essential agronomic component: resistance to bio-aggressors. Indeed, the intensification of vegetable production favors the incidence of many diseases and parasitic attacks that generate heavy damage in the field and post-harvest. In order to reduce the phytosanitary burden, breeders introduced resistance genes into new varieties by cross-breeding.

INRA and IRAT (which later became part of CIRAD, Centre de Coopération Internationale en Recherche Agronomique pour le Développement) also worked on vegetables adapted to tropical zones, either in research stations located in the French West Indies (adaptation of tomato to humid and hot climates, resistance of tomato to begomoviruses, resistance of tomato and eggplant to bacterial wilt), in New Caledonia, and in La Réunion island (improvement of "lontan" vegetables, resistance of solanaceous crops to bio-aggressors), or in partnership with public institutions in Africa (work on 'Galmi' onion in the 1960s in the Niger valley).

A true international industrial force

Vilmorin integrated the Limagrain seed cooperative group in 1975, and was joined later on by other vegetable seed companies such as Harris Moran, Clause and Tézier, all of them forming the group Vilmorin & Cie. With the acquisition of Ferry Morse, Nickerson, Kyowa, Hazera, Henderson and Mikado, the group became, in 2019, the world leader in vegetable seeds. Other French vegetable seed companies, such as Gautier Semences, ASL (melon), Hoquet (chicory), Darbonne and Marionnet (strawberry and asparagus), are becoming European leaders. Other forms of economic organizations also develop vegetable breeding activity such as agricultural cooperatives (Top Semences, Unisem, Sicail and GIE Ail drômois for garlic and shallot), grower groups (Organisation Bretonne de Sélection (OBS) for shallot and *Brassicaceae*), and family businesses (Technisem for tropical markets, Agrosemens for organic seeds). In 2020, about 30 French companies are breeding and/or marketing new varieties of vegetables. This high concentration of seed companies is due to the internationalization of markets and the high cost of research. Many foreign companies set up their research stations in France to select, produce and sell vegetable seeds in France or for world markets: Syngenta, Bayer-Monsanto, BASF-Nunhems, Rijk Zwaan, Enza Zaden, Bejo, Sakata, Takii, are present in the lower Rhône and the Loire valleys, and in the southwest. Their vegetable breeding research centers located around Avignon and Angers are part of the European seed centers, together with Den Haag-Enkhuisen in the Netherlands, Latina in Italy, Valencia and Almeria in Spain.

During the last fifty years, seed production in France has been concentrated in a few geographical areas such as Loire, Rhône, and Garonne valleys, and Beauce plain. Seed crops under tunnel are developing in France (e.g., lettuce, and carrot, cauliflower, cucurbit and solanaceous hybrids) to guarantee a high level of sanitary quality together with parental lines security. Seed production also moved far abroad (Australia, Americas, North and East Africa, India, China) for cost efficiency reasons.

After a period characterized by "captive" seed markets such as North Africa for historical reasons, seed markets became increasingly international from 1980 onwards and mobilized the French breeding teams. This trend began with the development of vegetable production basins in the Canary Islands, Morocco, Italy and Spain. The seed market extended progressively to other large scale production areas such as Eastern Europe, Turkey, Middle East, and further on to the USA, South America, India, South-East Asia, and China. This global change contributed to a genetic mixing between the cultivated types of most crop species. It accompanies the diversification of vegetables and contributes to a rapid renewal of research themes.

This market widening is reflected in increased profits of the French seed industry, which competes with the USA, the Netherlands and Japan: in 2019, France was the first European seed producer and the second European seed exporter (see section on Vegetable seed production in France).

The dynamism of public-private research & breeding

In 2020, more than 20,000 varieties of about 40 vegetable species are registered in the European catalogue and satisfy the EU market, out of which more than 2,500 varieties are registered in France (200 new varieties per year). Since the 1950s, French breeding has been characterized by a strong partnership between public and private research, which has led to considerable progress in terms of yield regularity, visual uniformity and appearance, adaptation to packaging, physiological adaptation to a diversity of cropping systems and environmental conditions, and resistance to bio-aggressors. In 2016, the French seed sector invested €116 million in research, i.e. 25% of its turnover (GNIS, 2016).

Very early on, public research accompanied the development of the seed vegetable sector, with the creation, in 1965, of the Association of the Creators of Floral and Vegetable Varieties (ACVPF), chaired by INRA. This association provided training for breeders, and until 1978 instilled a dynamic of cooperation between its members for the evaluation and use of genetic materials created by INRA. Then, public research became increasingly financed by short term contracts and compartmentalized programmes, accessible via competitive calls for tenders. Outstanding public researchers have succeeded each other in managing the genetics and vegetable breeding programmes at INRA Avignon, Rennes, and Versailles. The seed companies have grouped together within the National Federation of Vegetable Grains and Seeds (FNGSP), which became the French Seed Union (UFS), with a plant breeding section, and at the European level in the European Seed Association (ESA). The French Breeders Association (ASF since 1962), and the European Association for Research on Plant Breeding (Eucarpia since 1956) ensure the continuous training and network meetings of breeders (www.selectionneurs.asso.fr and www.eucarpia.org, respectively).

The preservation of genetic resources

Facing the growing importance of varietal selection, and genetic erosion of crop heirloom diversity, the French public authorities set up in 1995 a national system for a mutualized management of genetic resources, in the form of networks for species of economic interest. Partners are institutional organizations (INRA, GEVES, agro-engineering schools, CIRAD for tropical and subtropical species), seed companies, seed banks and other national, regional or local organizations acting in the field of genetic resources conservation. Coordination is ensured as follows:

- Fruit *Solanaceae* and melon: INRAE Avignon,
- Artichoke and cardoons, chicory, onion, lettuce: GEVES Angers and Cavaillon,
- *Brassicaceae* and carrots: Agrocampus Ouest Rennes and Angers,
- Grain legumes: INRA Dijon,
- Strawberry: CIREF Bergerac.

These networks operate under the aegis of the national coordination structure for plant genetic resources (www.geves.fr/plant-genetic-resources/national-coordination/national-coordination-structure/). They maintain, describe and evaluate more than 15,000 ancient or foreign varieties, genotypes of particular interest, together with wild forms and relatives. Their objectives are to secure and maintain the genetic integrity of the collections over the long term, to mutualize regeneration, conservation, description and evaluation efforts, and to space out regeneration cycles. Other priorities include the visibility of the collections and their valorization, through an increased use in research

and breeding programs. A challenging question concerns the conservation of the genetic diversity and progress created over the last decades as F_1 structures. A source of genes for breeders, these collections are outstanding materials for deciphering the molecular structure of genetic diversity, as done in particular for tomato, pepper and carrot.

European collaboration for genetic resources is facilitated via the long term input of the European Cooperative Programme for Plant Genetic Resources (www.ecpgr.cgiar.org/), as well as via EU time limited projects devoted to genetic resources management and conservation (Daunay et al., 2011).

Research at the cutting edge of plant biotechnology

Since 1950, methods and tools have undergone major developments, first in cell biology and in vitro culture: micropropagation, somatic embryogenesis, haplodiploidization via androgenesis or gynogenesis, rescue of embryos from interspecific crosses, protoplast fusion (Daunay et al., 2007). Some major works carried out in France are worth mentioning:

- Control of the propagation of garlic and shallot by meristem culture (INRA Avignon and Ploudaniel), in vitro propagation of asparagus (INRA Versailles) and artichoke (INRA Avignon), which led in particular to the vegetative propagation of commercial material such as certified *Onion yellow dwarf virus* (OYDV) free plants of garlic and shallot, and hybrid structures of leek and asparagus,
- Control of somatic embryogenesis in carrot (seed companies),
- Haplodiploidization in *Solanaceae* and cucurbits (INRA Avignon), in *Brassica* (INRA Versailles) and umbelliferous plants (seed companies),
- Rescue of embryos resulting from interspecific crosses in *Solanaceae* and *Cucurbita* spp. (INRA Avignon),
- Fusion of protoplasts in *Brassica* (University of Orsay, INRA Versailles and seed companies) and chicory (University of Lille and seed companies).

French research has been at the forefront in developing these techniques for the improvement of many vegetable species. One of the major contributions of biotechnology is probably the deadlock break of intergeneric and interspecific hybridization (Box 3).

The burst of molecular techniques in the 1990s and their continuous evolution has revolutionized genetics, although the extent of their use in breeding schemes varies from one crop to another, and concerns mostly high cost return crops. Mapping and marking of genes and QTLs associated with traits of agronomic interest have allowed the development since the 2000s of marker-assisted selection (MAS) for disease resistance, male sterility, and pollen compatibility. Functional characterization of target loci involved in fruit quality, stress resistance and durability of resistance, access to allelic diversity thanks to sequencing, and genome wide techniques widen the way to an increasingly technical breeding.

Box 3. Hybridization of genera and species

In *Cichorium intybus* (chicory and bitter leaf chicory) and *C. endivia* (plain and curled leaf chicory), cross-breeding between species has been carried out on a few genotypes to create plain and curled leaf with tuberous roots suitable for production in growing chambers.

In zucchini, *Cucurbita pepo*, partial resistances to *Zucchini yellow mosaic virus* (ZYMV, genus *Potyvirus*), *Watermelon mosaic virus* (WMV, genus *Potyvirus*), *Cucumber mosaic virus* (CMV, genus *Cucumovirus*) and powdery mildew have been introduced from *Cucurbita moschata*, *C. okeechobeensis* or *C. ecuadorensis*.

In lettuce, *Lactuca sativa*, wild species were used to introduce:

- the *L. virosa Nr* gene of resistance to the black aphid (*Nasonovia ribis nigri*) by using *L. serriola* as a bridge species,
- *Bremia* resistance genes from *L. saligna* and *L. virosa*.

In tomato and pepper, wild species are commonly used to introduce disease resistance traits.

In *Brassica* spp. for which the resource of cross-compatible species is large, innovative crosses are being made (e.g., multi-jet broccoli, cabbage). Interspecific crosses allow also the introduction of tolerance to cabbage hernia (*Plasmodiophora brassicae*).

French breeding success due to genetic improvement

Several publications review French vegetable breeding since 1955: Pitrat (2002), Pitrat and Foury (2003), Doré and Varoquaux (2006), Brand and Audergon (2013), Pitrat and Audergon (2015). We provide some examples of genetic advances and new released varieties originating from INRA and partners.

Conservative and sanitary selection of commercial material

Conservative breeding maintains genetic material as conform to itself and free of seed and plant transmitted bio-aggressors. It is successfully applied to the maintenance of open pollinated varieties and commercial or hybrid parental lines. Sibling crosses or in vitro culture are used for the maintenance of low vigor lines of allogamous species (e.g., asparagus, artichoke, onion, leek).

For most sexually propagated species, sanitary selection (choice of seed mother plants) and methods of prophylaxis during propagation (under insect-proof tunnel) are used to avoid seed-borne pests. As early as the 1960s, the production of healthy seeds was established on:

› Protected seed production of hybrid cabbage in Anjou (Photo ©E. Laurent).

- bean for the bacteria *Pseudomonas savastanoï* pv. *phaseolicola* and *Xanthomonas axonopodis* pv. *phaseoli*,
- lettuce for *Lettuce mosaic virus* (LMV, genus *Potyvirus*),
- spinach and corn salad for late blight (*Peronospora* spp.),
- tomato for *Tobacco mosaic virus* (TMV, genus *Tobamovirus*), *Pepino mosaic virus* (PepMV, genus *Potexvirus*), and *Clavibacter michiganense* subsp. *michiganensis*.

In 2015, 260 bio-aggressors were regulated worldwide, including 40 in the EU, to guarantee healthy seed trade, in accordance with the recommendations of the ISPM38 standard of the International Plant Protection Convention on international movements of seeds.

Vegetatively propagated species (garlic, shallot, artichoke, asparagus, strawberry) are subject to sanitary selection, with or without meristem culture. Mother and commercial plants are certified under the control of the Official Control and Certification Service (SOC). France is one of the major players in the world for marketing certified healthy plants of:

- garlic and shallot free from *Onion yellow dwarf virus* (OYDV, genus *Potyvirus*), *Leek yellow stripe virus* (LSV, genus *Potyvirus*), nematodes and *Sclerotinia* (performed by INRA Avignon and Landerneau) (Messiaen et al., 1993),
- strawberry free from nematodes, *Phytophthora cactorum* and *Verticillium dahliae* (performed by Centre Technique Interprofessionnel des Fruits et Légumes, CTIFL).

Diversification

Breeders continuously improve the genetic material to make it match as closely as possible the requirements of producers and marketers, in a diversified context of "terroirs", growing conditions (from open field green belts to off-ground crops, mechanized crops for food processing industries), and marketing techniques.

Diversification of the harvested products concerns mainly *Solanaceae* (tomato, pepper, eggplant), cucurbits (melon, zucchini, cucumber) and lettuce, species for which the selection effort has been the most important in France since 1985 (in terms of number of new registered varieties).

- Tomato for the French and European market. The plant has been adapted to the various agro-climatic environments of protected crops (aptitude for fruit setting, root vigor, homeostasis). The fruit has been diversified in terms of color, shape, firmness, homogeneity, even if the French market is still globally dependent on two ideotypes (sizes 150 and 200 g, firm, smooth, red fruit, without green collar).

› Uniformity in hybrid carrots in Sologne, France. A. Carrots nearly ready for harvest (Photo ©Vilmorin), B. Processing factory (Photo ©HMClause).

- Melons of Charentais, Spanish, Italian netted, "Galia", American, Korean or Japanese types. Sugar content, firmness, proportion of flesh, homogeneity of fruit presentation have been improved by genetic crosses between these types.
- Quadrangular peppers. The plant has been adapted to the various agro-climatic environments of sheltered cultivation (ability to set fruit, root vigor, homeostasis), thickness of the pericarp has been increased and fruit color has been intensified. The Mediterranean market is now interested in the horn type.
- Lettuce varieties. The plant has been adapted to various agro-climatic environments, in particular resistance to bolting and short day head formation, and new types have been proposed (e.g., semi heading, anthocyanin, oak leaf).

Diversification also significantly created new ideotypes for plain and curled leaf chicory (resistance to bolting), cabbage broccoli (large-spray plant), bean and pea (adaptation to mechanical harvesting), cucumber (gynoic, smooth epidermis fruit, now "beth alpha" types), zucchini (color).

Innovations

The technical conditions of production changed profoundly between 1960 and 1990 in the open field (precision sowing, mechanization). Seed quality was improved thanks to seed production techniques (e.g., quality, size, uniformity, health status). This changing environment induced profound changes in breeding objectives, and the creation of new varietal types, which we illustrate below with several examples.

Transforming the production system and the product: chicory endive

Chicory endive is the most significant example in France, for which breeders proposed around 1970 a technique transforming the traditional process of forcing outside in winter, in a pit with topsoil, with difficult working conditions, into a mechanized forcing system in air-conditioned growing rooms and hydroponic conditions, with varieties specifically adapted to form the endive without topsoil. The breeding effort was valorized in the form of F_1 hybrids, first created with the pollen competition system, and later on with the geno-cytoplasmic male sterility issued from the industrial chicory group (initially obtained by fusion of protoplasts with sunflower). Targeted traits included the ability to produce soilless "chicons" (the apical bud), and to produce roots physiologically suitable for hydroponic forcing, including under low input conditions, uniformity of presentation, postharvest storage of the endive, yield, brown axis tolerance, reduced bitterness, diversification of the earliness of the material to expand the production schedule, and herbicide tolerance.

Creating material adapted to intensive production: hybrids for allogamous species

The objective was to create uniform and vigorous varieties, adapted to mechanized production, capable of resisting climatic hazards and bio-aggressors, and productive. Breeding programs have targeted cross-pollinated vegetable species such as *Brassica* (Box 4), carrot, onion, radish, leek, turnip, fennel and beetroot.

In carrot, the improved varieties derived from traditional populations achieved remarkable yields until around 1975 (e.g., selections of improved 'Nantes half-long red', 'Touchon', 'Bureau', 'd'Amsterdam'). From 1980 onwards, the improvement of sowing techniques (switch from scattered to precision sowing), ensuring a better expression of the potentialities of each plant, made it possible to enhance the homogeneity provided by the F_1 hybrids. The use of three-way hybrids facilitated seed production by increasing seed productivity of the female parent. The genetic structure of hybrids allows the cumulation of many traits of interest, including resistance genes to various pathogens (*Alternaria dauci*, powdery mildew, cercosporiosis), resistance to bursting, root strength, resis-

Box 4. Hybrid structures in *Brassica* (Source: R. Prieur, Harris Moran-Clause Company)

In *Brassica*, the allogamy needed to maintain the heterogeneous population varieties was a hindrance to the development of homogeneous short-cycle production. European and Japanese breeders have opted for an F_1 hybrid structure thanks to the discovery of self-incompatible S alleles. The gain in homogeneity and vigor was significant, and hybrid formulations were developed for several *Brassica* species: head cabbage, cauliflower, cabbage broccoli, kohlrabi. However, selection work with S alleles required compatibility testing, and further self-incompatibility was not completely reliable.
Hence, innovation continued with the creation of F_1 hybrids of cauliflower and broccoli using male sterility, first of nuclear origin, then of cytoplasmic origin. This latter, found in Japan in radish "Ogura", was transferred by protoplast fusion to other vegetable *Brassica* as well as rapeseed. From the end of the 1990s, di-haploid lines, derived from in vitro culture of microspores of cauliflower and broccoli, were widely used as hybrid parents. Today, cytoplasmic male sterility in *Brassica* is widely used worldwide. Its use in Europe has contributed to the development of global markets for French and Dutch companies for cauliflower and head cabbage.

tance of foliage to mechanical harvesting, earliness and hardiness, high early yield and reduction of waste rate. Root quality was also improved: smooth and shiny epidermis, fine pivot, uniform color between xylem and phloem, absence of green collar. More recently, di-haploid lines are being used in hybrid parental combinations to increase the level of homogeneity of such varieties.
Seed technology (e.g., grading, vigor, ability to emerge at high summer temperatures) has accompanied the success of this varietal renewal, which is spreading worldwide. French and Dutch companies are still the leaders in these hybrid carrot global markets (Brand and Audergon, 2013).

Breeding for quality traits

Organoleptic and nutritional quality, dear to French gastronomy, is a lock that has been persistently ignored by breeders. For a long time, agronomists, producers and marketers have minimized the importance of this criterion by putting forward the concept of societal demand, which prioritized vegetables easy to transport and preserve, quick to process. Such criteria are far away from fruit organoleptic and cooking qualities. Let us quote some counter-examples where breeding has been convincing, by using empirical selection methods:

- for a quality product: example of French bean
  Breeding achievements on reduction of beans parchment and string is exemplary. The development of a quality bean industry, inherited from the French "filet" bean harvested by hand just before the string develops, led French breeders as early as 1975 to improve the "mangetout" bean for the fineness and straightness of the pod, and to adapt the architecture of the plant and its flowering to mechanical harvesting (crossing between crop groups including wild progenitors). Thus improved, a new bean type was born: the "wireless net" bean ("filet sans fil"). This new type currently concerns more than 50% of the beans sown in France for industry, and it is also appreciated by gardeners. However, there is a limitation to this improvement, because in the absence of string, growers, gardeners and consumers have a wrong perception of pod age. Too old fresh pods are frequently marketed, stringless and straight but containing nearly mature grains that are detrimental to pods palatability.
- for taste: examples of strawberry, melon and tomato
  Strawberry varieties combining the taste of wild strawberries and agronomic criteria of industrial strawberries have been created (INRA, CIREF - Interregional center for research and experimentation on strawberry, Darbonne and Marionnet breeding companies). Such varieties derive from the proof of concept named 'Garriguette' (INRA, 1972) and 'Mara des Bois' (Marionnet, 1992), and combine outstanding flavor and aromas together with yield, fruit firmness and preservation.
  For melon, breeding programmes for taste have been set up (e.g., sugar content), based on the use of genitors identified for their taste quality. In cucumber, lettuce, chicory endive and eggplant, breeding programs have focused on reducing bitterness.
  For tomato, INRA and French breeders worked from 1956 to 1985 to improve the traditional French tomato types ('Saint Pierre' and 'Marmande'). INRA focused on improving the fruit (red color homogeneity, elimination of spots, regularity of locules number, sugar/acid balance, resistance to cracking, slight firmness) and the plant for its plasticity of adaptation to various environments. They had a large success (from 'Montfavet H.63.5' to 'Ferline', and varieties released by the private sector). After the "long shelf life" period (see below section "Improving long storage ability"), a fundamental research program on fruit quality was developed in the 2000s by Dr. M. Causse at INRA. Measurement methodologies, genetics of quality traits, and material suitable for MAS were released (Navez et al., 2016).

Recently, the vegetable industry focused on improving the content of components favorable to human health, such as: enrichment of glucosinolates in cabbage broccoli, provitamins, vitamin C, flavonoids and carotenoids in pepper, provitamin A, vitamin C, β-carotene and lycopene in tomato and carrot, and selection for antioxidant properties of melons used in cosmetics.

Breeding for adaptation to glasshouse production

Adapting crops to greenhouses, heated or not, and more generally to unfavorable conditions (short days, low light intensity, low temperatures, high humidity) has mobi-

› Shapes and colors of commercial tomato varieties released in 2015 (Photo ©R. Brand).

lized breeders since the 1970s. Some French achievements deserve to be mentioned:

- Breeding of lettuce able to form heads in short days and low light succeeded as early as the 1960s (initial Dutch work exploited by Dutch and French seed companies). It generated European production of lettuce under glasshouses and tunnels during winter. An equivalent work was carried out on radish (INRA Avignon and seed companies).
- Breeding of solanaceous crops for "cold temperature, short days, low light intensity" conditions and for disease resistance. From 1956 to 1970, breeders at INRA Avignon, relayed by those in the private sector, improved the fruiting capacity of tomato genotypes under cold conditions (pollen with better germination), in the field as well as in greenhouse, with aerated vegetation limiting foliage parasites. This work led to the creation of hybrids of the 'Montfavet 63-5' type (INRA, released in 1963, listed in 1973), then from 1975 onwards, of many hybrids from seed companies (e.g., 'Lucy', 1973, 'Carmello', 1979) that were successful in Europe, the Mediterranean area and the Middle East. An equivalent work was carried out on pepper (e.g., 'Lamuyo', 1973, 'Sonar', 1980) and eggplant (e.g., F_1 Bonica, 1973). These new genotypes contributed to the explosion of industrial greenhouse production in Spain, Italy and Morocco, from 1975 to 1985, with also the high contribution of Dutch, Italian and Spanish seed companies. Partial parthenocarpy was also used in tomato and eggplant. These programs were updated regularly to respond to the evolution of these markets, up to now. Hundreds of varieties were bred for these markets, with regards to firmness and later for organoleptic quality.

Intensification of glasshouse cultivation has induced serious soil microbiological imbalances, which breeders have addressed with varieties and rootstocks resistant to soil-borne pests and pathogens, particularly in tomato (e.g., *Fusarium oxysporum* f. sp. *lycopersici* (FOL), *F. oxysporum* f. sp. *radicis-lycopersici* (FORL), nematodes, *Pyrenochaeta lycopersici*, *Verticillium dahliae*), pepper (e.g., nematodes, *Phytophthora capsici*) and melon (*Fusarium oxysporum* f. sp. *melonis*). Since the 2000s, in a context of drastic reduction of chemical soil disinfection, breeding programmes mobilize genetic resources to meet this challenge. Rootstocks are selected, either within the crop species, from interspecific crosses, or from wild species. Targeted traits are root system vigor, resistance to pests and pathogens, suitability for long-lasting cultivation with low heat requirements (Torres and Brand, 2015). Since 2018, investigation into root vigor and

› Alonso' released in the 2010s by HM-Clause for the "charentais" melon market (Photo I. Mazal ©INRAe-GEVES).

architecture of solanaceous crops and melon genetic resources, has been undertaken (INRA Avignon and seed companies).

Controlling sexuality and its genetic determinants

In melon, monoecy was introduced in Charentais type from the variety 'Cantaloup d'Alger', at the beginning of the 1980s (work at Tézier company). Proof of concept was released as a smooth, non-netted, early, monoecious 'Charentais' type. Monoecy allows the economy of castration in the manufacture of commercial hybrids. Further, monoecious genotypes develop female flowers on the main stem, thus improving production earliness and reducing manual pruning cost. Gradually, the defects associated with monoecy (e.g., vitrescence, elongated fruit shape tendency) were reduced. Monoecy then extended to all types of melon in the world.

Such drastic changes of genetic structures and reproduction mode also occurred with nearly uniform seed propagated hybrids,

- for artichoke (INRA Avignon, Nunhems) replacing the traditional vegetative clones,
- for asparagus (INRA Versailles, Vilmorin, Darbonne, Marionnet) replacing OP populations.

Strategic turns

Breeding has taken several strategic turns over the past 70 years. We illustrate three of them: uniformity of varieties, resistance to bio-aggressors and improvement of vegetables postharvest.

Uniformity of varieties

The last 50 years were marked by a strong increase in variety uniformity, based on the spread of pure lines, exploited for themselves or as hybrid parents, and of clones for vegetatively propagated species. Hybrid structures have been created and became almost generalized for species with suitable floral biology and seed yield (Daunay, 2009). For some species, the control of male sterility has enabled industrial production of hybrid seeds. First used in solanaceous crops and cucurbits, male sterility was abandoned because of its cost and slight expression instability depending on agro-climatic conditions. Quite the contrary, hybrid seeds production with a male sterile component became widespread in *Brassicaceae* (INRA Versailles, INRA Rennes, seed companies), and *Umbelliferae* (INRA Avignon, seed companies).

Resistance to bio-aggressors

Vegetable production is affected worldwide by 10 to 50% of losses because of bio-aggressor damages. As early as the late 1950s, breeding began to create genetic material resistant to major bio-aggressors. Breeding

› Mechanical harvesting of onion inflorescences to extract seed in Poitou-Charentes, France (Photo ©F. Pavy).

for genetic resistance to fungi, viruses, bacteria, and insects deals nowadays with some 150 host/pathogen combinations (about 40 crop species), i.e. 240 research programmes in France to date. A national network managed by GEVES is responsible for the maintenance and distribution of crop reference and control materials as well as of pathogenic strain reference collections (MATREF network). French and European research teams have had great successes in introducing resistances in their commercial varieties.

Although the risks of circumvention of monogenic resistances by pathogens are well documented (e.g., lettuce/*Bremia lactucae*, pepper/*Tomato spotted wild virus* (TSWV), pea/*Ascochyta* and *Fusarium oxysporum* f. sp. *pisi*), they are still widely used and many of them have not been circumvented (e.g., the bean *Are* gene of resistance to *Colletotrichum*, the tomato *Tm2²* gene of resistance to any strain of TMV virus and the pepper *L1, L2, L3, L4* alleles (L locus) of resistance to TMV race 0 and *Pepper mild mottle virus* (PMMoV), all used for over 60 years.

Combining polygenic resistance mechanisms to monogenic ones, and/or to other protecting strategies remains a major challenge that mobilizes breeding teams. Research tracks are diversifying:

- Gene pyramiding. In pepper for example, the major gene *pvr2* of resistance to potyviruses, which decreases the virus population in the plant, is associated to a particular QTL which decreases the probability of appearance of viral mutants and thus delays the circumvention phenomenon,
- Identification of natural defense stimulators (NDS),
- Resistance management, such as alternating resistance genes in time and space, in order to limit host selection pressure on the pathogen.

French research is currently focusing on partial genetic resistance, whether or not associated with production techniques. Polygenic partial resistances are supposed to be more "sustainable" than monogenic resistances. Their use is relevant in the background of agroecology (Torres et al., 2018), where crop rotations, clay-humus complex, biological life of the soil, surrounding environment and production basin are considered all together.

Improving long storage ability

For tomato, since 1980, the specialization of production areas far from the French and North European consumer markets (e.g., Sicily, Spain, Canary Islands, Morocco) has led marketers to favor products with a long shelf life and resistance to transportation. For tomato in particular, fruit firmness was introduced from the early 1980s in INRA and seed company breeding programs, leading to the creation of French varieties derived from 'Ferline' F_1 (1986), and of hybrids for Mediterranean markets ('Cristina', 1990, then 'Elena'). Later on, the introgression of the *rin* gene in heterozygous state was generalized, among other reasons because of the world success of 'Daniela' (1989), and its numerous diversifications. The *rin* gene reduces ethylene production, carotenoid biosynthesis, fruit softening and aroma development. As a consequence, fruits are too firm, insufficiently colored (in autumn France glasshouse conditions) and lack of taste. Hence, *rin* has been replaced from 2005 onwards by polygenic constructions that allow external and inter-carpellar walls thickening and offer acceptable taste quality. These improved genetic types supplied the markets, first in the two caliber sizes sought after by supermarkets, then in new varieties resulting from diversification (Italian tomato, cherry, bunch, elongated, green, yellow, black types). However, from 2010 onwards, the soft so-called "authentic" old types (heirloom varieties) reappeared, such as 'Marmande', 'Ox heart', 'Pineapple', 'Crimean Black', 'Rose of Bern', mostly produced for local markets.

For melon, the Charentais type is characterized by a climacteric crisis leading to aromatic fruits of short term conservation. By successive crosses with Spanish types, French breeders managed to create Charentais type melons deprived of climacteric crisis. Hybridized with other firm melons from the United States (Eastern and Western types) and Japan, they created a new ideotype bearing sweet fruit with netted skin and a fruit shelf life of 5-6 days considered suitable for the market.

From the 1950s to the present, France has played a major role in the genetic improvement of vegetable species to satisfy a worldwide demand for high-quality varieties and seeds. This results from a fruitful partnership between public (INRA, CTIFL, universities) and private research supported by several internationally invested seed companies driving the sector. This partnership must now accompany the transition of French and European markets towards agro-ecology, organic farming and territorialized food systems, in a context of less intensive production. This is essential for reducing the deleterious consequences of high production-oriented agriculture on human health and environment.

French model of professional organization for the vegetable seed sector

Structuring and regulation

For vegetables, the French professional organization set up very early close collaboration between public institutions and private seed companies, as a strategy of synergy between actors of the sector, in order to support research, innovation, industrialization and internationalization. As early as 1950, in order to organize the market and monitor the rights of variety users (farmers, industrialists and consumers), studies on marketed varieties were conducted, within the framework of the Permanent Technical Committee for Plant Breeding (CTPS) of Ministry of Agriculture, i) at INRA, ii) at the Ecole Nationale Supérieure d'Horticulture (currently Agro-Campus Ouest, Angers) in collaboration with seed companies. These studies led to the creation of the first official national catalogue of vegetable and strawberry varieties (1960).

From 1960 onwards, registration of varieties and seed lots quality control was structured within the CTPS, which is responsible for advising the Ministry of Agriculture on the regulation rules concerning their marketing. Variety registration was first delegated to INRA then to GEVES (1970). The "seed lot quality" section was delegated to the Official Control Service (SOC) whose management is entrusted to the National Interprofessional Seeds Group (GNIS). These bodies report to the CTPS, which gives its final advice and proposal to the Office in charge of varieties and seeds within the Ministry of Agriculture. This latter takes the official decision for registering a variety. European consultation and harmonization are being built within the Standing Committee on Seeds of the European Union, ensuring a free market for seeds and varieties in European territory. Other studies are also conducted at the National Seed Testing Station (SNES, https://www.geves.fr/about-us/national-seed-testing-station/) to characterize the quality of commercial seed lots. As a consequence, the seeds and varieties market is cleaned up and offers a quality guarantee to its actors.

In order to protect the rights of breeders of new plant varieties, the legislator introduced a Plant Variety Protection Act, in 1970 in France, which gives the breeder a reliable and time-limited right. This system is managed in France by the national plant variety office (Instance Nationale des Obtentions Végétales, INOV). An equivalent European right is granted by the Community Plant Variety Office (CPVO), which confers the right in the EU territory. The world Union for the protection of new varieties of plants (UPOV, established in 1961), harmonizes the technical and legal aspects in the form of inter-

national recommendations. France is very active in these bodies. The Director of INRA at that time was one of the active creators of the Plant Variety Right established by the Paris Convention in 1961.

The organization of national seed production and marketing is carried out by GNIS, which provides a forum for dialogue, exchange and decision-making between the professional actor groups concerned with seeds and seedlings, from the breeding of varieties to the use of seeds and seedlings. GNIS also provides a contractual framework for relations between seed companies and seed multiplication farmers. Its technical service, the SOC, is in charge of the quality control of seeds and seedlings by the French State (Box 5). GNIS also plays a role in promoting the vegetable sector in France and abroad.

The National Federation of Seed Multiplier Farmers (FNAMS) is the national structure that runs economic and technical aspects of seed production by farmers, and represents them at the economic and trade union level. FNAMS acts as a technical institute for seeds, the actions of which are financed by the inter-profession.

Since 1960, the French vegetable seed sector has evolved through a strategy of concertation with the French and European public authorities, both to promote contract research and to regulate the markets and guarantee a high quality level of varieties and seeds. The CTPS facilitated the matching between economic demands and interests of the actors, and relayed the syntheses and conclusions to the State's decision-making authorities. Since 1990, the French and Western European model has spread to Eastern Europe, the EU, the Mediterranean and African countries. It has strongly contributed to French and Dutch leadership in the world.

One question is whether this model is capable or not of adapting to the rapid all-scale changes induced by the global challenges. These include the agro-ecological transition, the adaptation of the regulation of varieties, seeds, and plant variety protection to the specificities of developing countries, as well as the necessity to guarantee food, nutritional and health security to human populations. The French vegetable sector has taken up these questions.

Research and education

State and professional bodies have structured plant breeding research and teaching at national level. As seen above, INRA has heavily invested in the vegetable sector by creating research units in plants genetics and breeding (stations in Versailles, Rennes, Avignon, Guadeloupe) and biotechnology (fruit and seed biology in Bordeaux). Other institutions have contributed to specific efforts on tropical vegetables (CIRAD), strawberry (CTIFL), chicory (CTIFL, Lille University), carrot, cabbage and cauliflower, crosne (*Stachys affinis*), sea crambe, tuberous celery (AgroCampus Ouest Angers and Rennes).

Agricultural education specific to vegetable breeding and grain crops has been organized to train:

- growers and technicians (BTS level in France, BSc in the Anglo-Saxon system): i) for vegetable production (e.g., agricultural high schools of St-Germain-en-Laye, Sainte-Livrade, Albi), and ii) breeding and seed production (e.g., agricultural high schools of Valence, Castelnaudary, Lille-Genech, Nermont, Pouillé),
- executives (BSc+1, MSc, PhD) in agro-engineering schools and universities (e.g., Paris, Rennes, Montpellier, Toulouse, Clermont-Ferrand, Beauvais, Angers, Lyon). For example, AgroCampus Ouest Angers and the University of Angers deliver a Master's degree in plant biology for seed and seedlings, supported by the Research Institute of Horticulture and Seeds (IRHS).

Vegetable seed production in France

The French vegetable seed industry is characterized by its know-how and the great involvement of its members. The various agro-climatic conditions available in France are suitable for producing seeds of many species. This production is carried out mainly in the open field, but also in insect-proof tunnels for pollination control. GNIS terminology for qualifying vegetable seeds distinguishes vegetable species that are harvested fresh and gathered under the generic epithet of "small seed vegetables" from pulses that are harvested as dry grains (garden pea, bean, lentil, chickpea, faba bean, etc.). Small seed vegetables include species belonging to the families *Apiaceae* (carrot, parsley, coriander, etc.), *Chenopodiaceae* (garden beet, spinach, Swiss chard, etc.), *Brassicaceae* (cabbage, radish, rocket, etc.), *Cucurbitaceae* (gourd, squash, melon, etc.), *Valerianaceae* (corn salad), *Asteraceae* (lettuce, chicory, etc.) and *Solanaceae* (tomato, eggplant, pepper).

France is the first producer and second exporter in Europe

With nearly 22,000 ha of multiplication in 2019, including 9,700 ha of small seed vegetables and 12,200 ha of pulses, France is the leading producer of vegetable seeds in the EU. Thanks to its recognized know-how in terms of quality, France is also the second largest exporter in Europe and has a positive trade balance of more than €260 million, in a highly competitive international environment. World trade in vegetable seeds was €3.6 billion in 2015. Europe, North America, and the growing Asian markets are the most profitable.

Seed production relies on a network of 2,500 farmer-multipliers and 96 seed companies that ensure rigorous monitoring, traceability and controls at every production stage. Nearly 1,500 nurseries throughout the territory also produce vegetable seedlings for growers and gardeners. Every year, more than 2,000 million seedlings are marketed, 90% of which are for the professional market. For certified crop plants, forty companies are specialized in the production of garlic, shallot and strawberry

Box 5. Vegetable variety and seed lot quality control

The official quality of a vegetable variety is assessed in France by two complementary systems. The variety is subject to mandatory standardized tests at European and world (UPOV) levels to verify its identity, uniformity and stability (D.H.S. test). Its identity card is drawn up with its main characteristics, including its genetic resistance to diseases. At the end of these tests carried out by GEVES, and on the proposal of the CTPS, the variety is registered in the Official Catalogue of Varieties and the Community Catalogue, which gives it a marketing authorization in the EU territory.

Its qualities of yield and adaptation to the agro-climatic and economic market context in France are tested in a non-obligatory manner by technical institutes: CTIFL, Union Nationale Interprofessionnelle des Légumes de Transformation (National Interprofessional Union of Vegetables for Processing, UNILET), regional stations as well as producer groups.

The quality of seed lots produced in France is controlled by the SOC in approved laboratories, on the basis of quality criteria such as species purity, germination and vigor, with harmonized tests at EU and OECD levels. GEVES-SNES coordinates these laboratories, especially for securing the application of the recommendations of the International Seed Testing Association (ISTA), in order to guarantee the exportations and importations out of the EU. Once a year SOC reports to the CTPS for its activity.

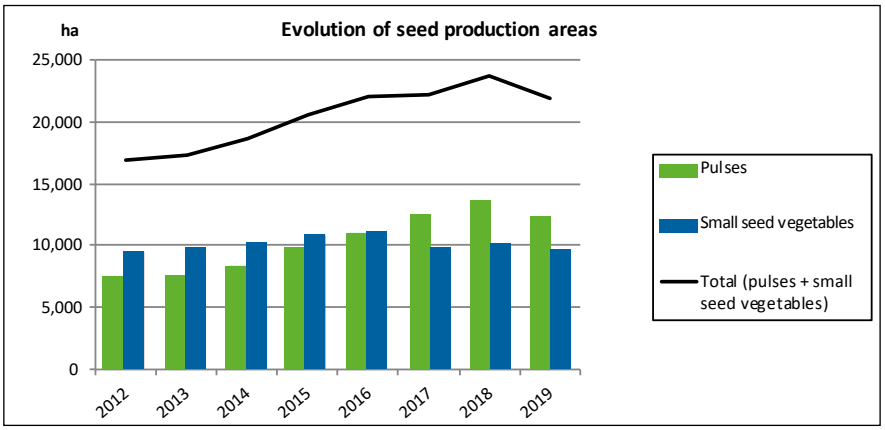

Figure 2. Evolution of acreage (in ha) of vegetable seed production in France between 2012 and 2019. Source: FNAMS.

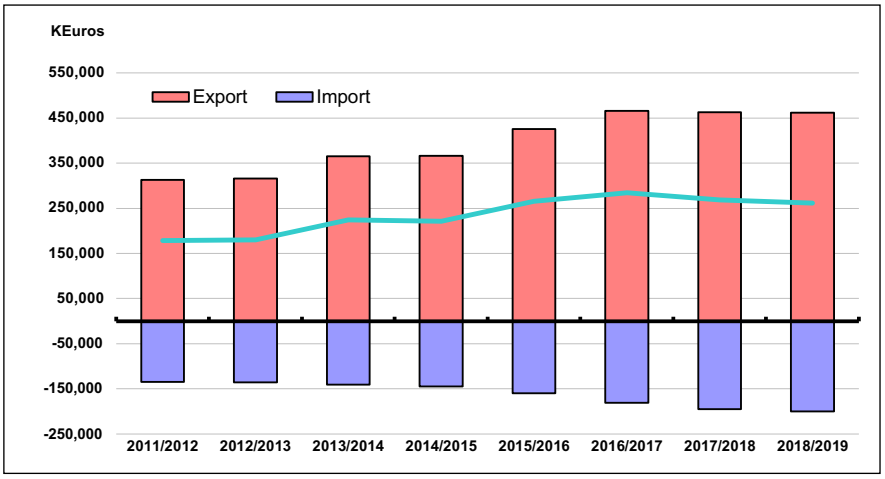

Figure 3. Evolution of the French net commercial balance (in kEuros) in vegetable and flower seeds between 2012 and 2019. Source: GNIS.

plants and asparagus claws. This activity represented 1,400 ha of multiplication in 2019.

Vegetable seed multiplication is spread throughout France in multiplication zones (Figure 1b,c). Each zone has specific soil and climatic conditions and "terroirs" favorable to 73 species: garden pea (4,300 ha), chickpea (4,050 ha), onion (1,990 ha) and carrot (1,530 ha) take up the largest areas. The total area devoted to vegetable seed production has increased steadily since 2012 (Figure 2), except a brief decrease in 2019, explained by 2017-2018 exceptional harvests.

Seed companies continue to rely heavily on the economic development of vegetable seeds. They invest 25% of their turnover in research and development, in order to create the varieties of tomorrow adapted to markets and environmental challenges.

The export value of vegetable and flower seeds, although stagnating in 2018/2019 compared to the previous seasons, jumped by 48% from €313 million to €462 million between the 2011/2012 and 2018/2019 seasons. During the same period, imports increased by 49% from €134 million to €200 million. The trade balance for vegetable seeds remains largely in surplus with a positive balance of €262 million, 92% of which is related to small seed vegetables (Figure 3).

Important technical work that contributes to the excellence of the sector

The results of the vegetable seed sector can be explained by important assets:

- a solid organization of the sector, which allows the production of quality seeds,
- favorable "terroirs" and climatic conditions,
- a structured network of farmer-multipliers with recognized technical know-how and specific equipment,
- a climate of trust between players in the sector regarding the confidentiality of multiplied varieties,
- rigorous monitoring of production by seed companies,
- close collaboration between farmer-multipliers and beekeepers, to ensure pollination of seed-bearing crops,
- sanitary control of production, with crops grown under insect-proof tunnels to avoid viral diseases, or in protected areas at high altitude. The sanitary control of the seeds produced implements numerous tests to guarantee the absence of 112 fungi, 42 bacteria, 71 viruses and viroids, 27 insects and 5 nematodes mainly on *Brassica*, beans, pepper and tomato.

Additionally, the production of vegetable seeds follows strict rules with controls at all stages, from multiplication to marketing, in order to provide quality seeds that meet the requirements of vegetable growers, nurseries and gardeners.

Each year, the GNIS vegetables and flowers section defines a program of technical activities meant to improve the production and quality of seeds multiplied throughout the territory, in terms of sanitary quality and specific purity (absence of seeds of other species). This program, implemented by FNAMS, aims at maintaining the competitiveness of the French industry.

In recent years, this program has focused on alternative methods for weeding and controlling diseases and pests: mechanical tools, robotics, biocontrol products, and integrated biological protection. This shifted orientation was accentuated in 2019 with part of the pro-

Box 6. Organic agriculture (OA) vegetable seeds to boost the development of OA

With changes in food consumption habits, and the growing concern of consumers for signs of product quality, the production of "organic" vegetables is strongly increasing in France, as indicated by the surface areas doubling over the last six years. Responding to this fast-growing market represents a challenge for the seed sector. The production of OA seeds is complex because it must meet a double requirement: the respect of the rules and standards applied to seeds, together with the respect of the OA specifications. Although the multiplication of OA vegetable seeds still concerns limited surfaces, it is constantly increasing. The production represented 740 ha in 2019 (333 ha in 2014) and mainly concerned lentil, chickpea, onion, radish, beetroot and carrot. With multiplications also carried out abroad, the range of OA vegetable seeds is growing strongly: in 2019, more than 1,250 varieties were sold by 35 seed companies. The seed sector aims at continuing this development and supporting farmer-multipliers in these more complex productions for further technical and economic success.

gram devoted to the control of vegetable seed production for organic agriculture (OA), from the time the crop is planted (Box 6). Results are regularly communicated to seed companies and to farmer-multipliers through technical meetings, technical circulars, brochures, a bimonthly magazine and the websites of GNIS and FNAMS (www.fnams.fr/produire/production-de-semences/potageres/).

Computerized management of crop location to ensure seed varietal quality

Among the qualities expected, the seed lot must correspond exactly to the chosen variety (conformity and purity). Varietal purity is directly related to pollination, which requires minimum isolation distances between propagation plots to avoid the arrival of undesirable pollen on the seed carrier field. Isolation distances take into account the floral biology of each species: autogamy (self-pollination) vs. allogamy (cross-pollination), entomophily (pollination by insects) vs. anemophily (wind pollination). Distances range from 100 m (for pea) to 5,000 m (for certain types of carrot).

In order to facilitate the management of isolations, the sector has acquired a computerized mapping tool. It allows the remote declaration of crops before they are planted, with the precise location of the plots on an IGN (National Geographic Institute) map. These locations, which can be consulted by stakeholders in the sector via an internet interface, are validated, after verification of the isolation distances between plots, during regional meetings attended by representatives of companies and farmer-multipliers. After validation, the plots can be planted. This tool, which is appreciated by the sector, currently concerns 23 species, representing more than 3,000 plots mapped on the territory and a dozen regional meetings per year to validate the locations.

Varieties and seeds more respectful of human health and of environment

Since 1980, seed companies have been marketing old varieties or varieties derived from them, which are of interest to gardeners and growers targeting direct distribution: consumers are rediscovering tastes and textures from a wider genetic diversity.

A national brainstorming is ongoing since 2000, and action strategies have been initiated to lead to vegetable and grain production practices that are more respectful of human health and environment, particularly with regard to nutritional quality and biodiversity preservation. At the same time, the criterion of uniformity becomes less of a priority, and thanks to the short food circuits that are progressing at the same time (particularly for vegetables), the notion of conservation and resistance to transport hazards is becoming less important.

Economic and agronomic models are also reviewed, particularly with regard to selection methods (participatory selection, farm-saved seed production) and their efficiency. Contextual questioning is taken into account: for example, would a too strong varietal uniformity limit adaptability? What is the cost/benefit ratio of hybrids compared to populations? Is the cost of biotechnology in research consistent with its agronomic and social utility? Participatory breeding programs, inserted in European networks, take up such questioning, such as the *Brassica* programme at INRA Rennes (Chable et al., 2020).

Some seed companies have taken the turn, by adopting these stakes. They contribute to the development of seed production systems that respect the OA specifications, and/or they deliver a greater genetic diversity on the seed market. This is the case of Sativa and Zollinger in Switzerland, KulturSaat and Bingenheimer Saatgut in Germany, and Agrosemens, Germinance, Graines Del Pais, le Biau Germe, Essem Bio as well as some twenty seed craftsmen in the French regions. The Farmers' Seed Network (Réseau Semences Paysannes) coordinates actions in this direction. Industrial seed companies are also developing OA seed production to target a market that in 2019 corresponded to 8% of French sales (5% in 2015).

The released varieties are phenotypically diversified, and depending on market segments, they are:

- modern varieties, hybrids or not, intended for intensive OA,
- old known or "forgotten" varieties, including those from other continents (e.g., Seed Savers in the USA),
- varieties specifically created for the OA context (e.g., Sativa, KulturSaat), such as populations (Box 6).

In short, agricultural concepts and production systems are evolving, thanks to the growing consideration of agro-ecological and sanitary principles. Meanwhile, new actors (e.g., towns, regions) are taking up food-related issues in territories such as localized food systems, food sovereignty and security, nutrition and health that need to be taken into consideration in both seed systems and breeding strategies. A number of priorities can be defined that address such agricultural and food global challenges:

- Maintain farmer's and researcher's access to genetic variability and biodiversity in a globally recognized system of exchange with equitable benefit sharing,
- Strengthen the eco-systemic sustainability of vegetable production, including the development of crops where varieties and food systems are reasoned in an integrated manner,
- Encourage production systems that promote innovation both upstream and downstream and reward genetic progress according to new selection criteria including sustainability.

Conclusion

Since the 1960s, the context of vegetable species selection has undergone profound changes: vegetable production became more specialized and technologically advanced; it became deseasonalized and was developed on new territories in France (metropolitan and overseas) as well as in the Mediterranean region. Crop intensification has led to a strong development of sanitary constraints. In response to these background changes, specific organization and research on varieties, seed technology and production systems have evolved. Scale changes occurred: breeding teams have acquired expensive biotechnological tools, which necessary profitability has led breeding companies i) to strengthen their collaboration with public research, ii) to grow up through purchase of, or fusion with competitors, and iii) to internationalize their commercial activities.

By means of its efficient public research and of a strong national organization of the vegetable sector, the French State has created the conditions that led to the development of a dynamic and conquering French seed industry. The area of influence of the economic players of the vegetable sector has extended worldwide. Asia, which has the largest vegetable cultivation area in the world, and Africa, whose domestic market has not yet been fully explored, are the next key partners in research and training as well as for industrial and commercial developments. This potential partnership will be brainstormed at the XXXI International Horticultural Congress in Angers, France (www.ihc2022.org), by addressing the major challenges of food crop quality, nutritional security and health to worldwide representatives of the vegetables sector. So far, breeding has only partly met these challenges in a context of production intensification that has reached its limits. Socio-cultural considerations now need to be linked to environmental challenges (climate change and biodiversity loss) for developing rapidly agro-ecological production systems and "alternative" seeds and varieties adapted to resilient and sustainable food systems.

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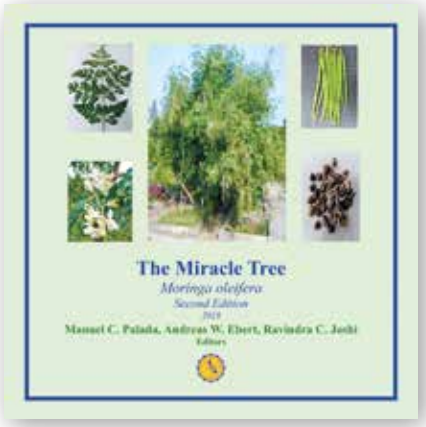
New Books
Websites

› New books, websites

Book reviews

The books listed below are non-ISHS-publications. For ISHS publications covering these or other subjects, visit the ISHS website www.ishs.org or the *Acta Horticulturae* website www.actahort.org



Palada, M.C., Ebert, A.W., and Joshi, R.C., eds. (2019). The Miracle Tree - Moringa oleifera, 2nd edn (Bloomington, IN, USA: Xlibris), pp.494. ISBN 978-1-7960-4454-6 (softcover) / 978-1-7960-4453-9 (e-book). $241.99 (softcover) / $5.95 (e-book). www.xlibris.com

Acquiring information and scientific knowledge is one of human's characteristics. This is achieved through personal communications and library resources. In this book, the distinguished editors, along with 46 eminent authors, provide readers with the latest references and a comprehensive collection of information on the various aspects of moringa. The book is useful for the growing moringa industry. This book covers four main areas: a) botany, genetic resources and cropping systems, b) nutritional quality, medicinal potential and benefits, harvesting, postharvest technology and agro-industry, c) insect, mite pests and diseases, and d) global perspective. The authors provide readers with both basic and applied research findings and the necessary background to enrich and enlighten the understanding of moringa cultivation and agro-industry. Most chapters end with a summary, conclusions, future prospects providing readers with specific web links and the latest literature.

The first chapter focuses on informative introduction and why moringa is considered as a "Miracle Tree". It provides readers with information about why moringa trees have great potential in combating extreme poverty and hunger. Detailed botanical information is given in chapters 2 and 3. The authors then provide information on the economic aspects of moringa. Then information on the climate, soil, and cultivation are discussed along with high density (HD) planting cropping systems, and several methods and practices involved in harvesting, postharvest technology, and processing of moringa. Chapter 9 provides a comprehensive overview of the insect and mite pests and pollinators and their management. Diseases of moringa and their management are next. Genetic resources, diversity, and moringa crop improvement with an insight into nutritional quality and health benefits of moringa follow. The medicinal potential and health benefits encompassing traditional and modern medicine are described followed by the potential of moringa for livestock production. The agricultural and industrial potentials of moringa, the account of moringa leaf extract as a natural bio-stimulant, and the benefits of moringa as an active ingredient for the cosmetics industry are summarized. The readers are provided with detailed information on farmer participatory and community livelihood projects in different parts of Africa. Finally, the book provides a comprehensive review of the potential of moringa with regard to climate change, sustainable livelihoods, and food security. This book provides a global perspective of moringa around the world and gives a future outlook on the challenges ahead.

Reviewed by Mahmoud A. Sharafeldin, Chair ISHS Working Group Moringa

From the Secretariat

› New ISHS members

ISHS is pleased to welcome the following new members:

New Individual Members

Australia: Dr. Peter Jolly, Femi Olutayo, Dr. Megan Star, Ms. Sue-Anne Steer, Dr. Daryl Stevens; **Brazil:** Dr. Eduardo Girardi; **Cambodia:** Mr. Chhengly Heng; **Canada:** Carolyn Barrette, Jason Chamney, Ms. Diomiho Monique Dembélé, Bradley McDonald; **Chile:** Mr. Benjamin Maruri, Mr. Alejandro Toro; **China:** Assoc. Prof. Hongmei Du, Dr. Rueychi Jao, Prof. Dr. Xingjiang Qi; **Chinese Taipei:** Dr. Marco Wopereis; **Cote d'Ivoire:** Ms. Marie France Kouadio; **Dominican Republic:** Dr. Gustavo Armenteros, Mr. Guillermo Guerrero; **Ecuador:** Mr. Duaja Gerencia, Assoc. Prof. Diego Villaseñor; **Egypt:** Prof. Dr. Montaser Fawzy Abdel-Monaim; **France:** Ms. Fatma Benani-Zerrouki, Dr. Armelle Braud, Dr. Frederic Feder, Dr. Louisa Sherman; **Germany:** Dr. Suputtra Hegele, Dr. Olaf Muehling, Ms. Christina Niedermann, Prof. Dr. Georg Petschenka; **India:** Dr. Venkatram Ambotu, Assist. Prof. Rajani Dodlolla, Assist. Prof. Suhasini Lingala, Assist. Prof. Harika Maddu, Ms. Kapoor Sadhana, Ms. Priya Shankar, Dr. Shailesh Kumar Singh, Mr. Sukhjinder Singh, Dr. Manish Srivastav, Dr. Chaitanya Vanam; **Iran:** Ms. Elham Esmaili; **Ireland:** Dr. Lael Walsh; **Israel:** Mr. Boyan Dulitz, Mr. Pablo Ibanez; **Japan:** Mr. Keito Kobayashi, Mr. Masaru Kurokawa, Paul Miles, Ms. Aika Yoshimoto; **Kenya:** Mr. Emmanuel Amwoka, Ms. Judith Kiptoo, Ms. Esther Mujuka, Ms. Winnie Nyonje, Ms. Penina Yumbya; **Korea (Republic of):** Mr. Jae Woon Kim, Dr. Iyyakkannu Sivanesan, Mr. Jong Chan Song, Jie Xiao; **Malaysia:** Dr. Emelda Rohani; **Mali:** Rokiatou Traore; **Mauritius:** Mr. Mark van Beuningen; **Mexico:** Ma. Claudia Castaeda-Saucedo, Dr. Didiana Galvez-Lopez; **Morocco:** Dr. Zhor Abail, Basma Abbouch, Dr. Abdelaziz Bouizgaren, Dr. Youssef Brouziyne, Dr. Bouchra El Amiri, Ms. Soumia Fahim, Dr. Hasnaâ Harrak, Reda Meziani, Mr. Jamal Mitta, Dr. Yamna Ouguas, Mr. Lhassane Sikaou; **Netherlands:** Marjolein Hunck, Xiaohan Zhou; **New Zealand:** Melony Bencetti, Mr. Jeffrey Smiht; **Nigeria:** Assoc. Prof. Olabisi Adekola, Ms. Esther Tolulope Akinyode, Francisca Oteri; **Norway:** Dr. Andreas Thorvaldsen; **Panama:** Ms. Clementine Reynaud; **Peru:** Roberto Liendo Seminario; **Portugal:** Assist. Prof. Natália Marques; **Qatar:** Mr. Yousuf Noman; **Saudi Arabia:** Mr. Khalid Alghimlas; **Senegal:** Dr. Raphael Belmin, Mr. Falilou Diallo, Prof. Nicole Dossou, Dr. Awa Ndiaye, Papa Mamadou Sylla; **Slovenia:** Marinka Brglez Sever; **South Africa:** Ms. Chanel Daniel-Swartland, Ms. Mary Duncan, Ms. Monja Gerber, Dr. Thirupathi Karuppana Pandian; **Spain:** Mr. Héctor Alonso Miguel, Diego Gómez de Barreda, Pedro Antonio Guerra; **Switzerland:** Dr. Juan Herrera; **Thailand:** Mr. Wuthichai Pipatmanomai, Mr. Prasong Suphachadiwong; **Turkey:** Mr. Doruk Ipekgil, Hakan Pizrenli; **United Kingdom:** Ms. Noémie David-Rogeat, Rupert Harbinson, Mr. Charlie Paton; **United States of America:** Dr. Yosvanis Acanda Artiga, Glenn Alers, Phillip Baker, Ms. Kalenga Banda, Dr. Neriman Tuba Barlas, Mr. Dominic Carmassi, Dr. Jose Guillermo Chacon Jimenez, Dr. Bruce Chalker, Dr. Nicolas Champouret, Carlos Fear, Jorge Ferreira, Yoel Gebrai, Mr. John Gose, Casey Hubbs, Michael Norell, Dr. Raymond Remmel, Christopher Rocklyn, Nick Sagnella, Nico Siniscalchi, Diane Sommers, Benjamin Vacca, Romaric Waguia, Dr. Jessica Waite, Dr. Selina Wang, Stephanie Wedryk; **Zambia:** Mr. Peter Deary

› 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

- 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)55-772-1919, E-mail: brjeong@gmail.com Web: http://www.isgo2020.org
- December 15-17, 2020, Bangkok (Thailand): **III Asian Horticultural Congress - AHC2020.** Info: Mr. Ananta Dalodom, Horticultural Science Society Thailand, Department of Agriculture, 50 Paholyothin Rd., Chatuchak, Bangkok 10900, Thailand. Phone: (66)29406578, Fax: (66)29406579, E-mail: ananta.dalodom@gmail.com E-mail symposium: ahc2020bangkok@gmail.com Web: http://ahc2020.org/

Year 2021

NEW

- March 2-5, 2021, Giarre, Catania (Italy): **VIII International Conference on Landscape and Urban Horticulture.** Info: Prof. Daniela Romano, Universitá de Catania, Dip. DOFATA, Via Valdisavoia 5, 95123 Catania, Italy. Phone: (39)095234306, Fax: (39)095234329, E-mail: dromano@unict.it or Dr. Francesca Bretzel, CNR, IRET Istituto di Ricerca sugli Ecosist, Via G. Moruzzi 1, Pisa 56124, Italy. Phone: (39)0506212485, Fax: (39)0506212473, E-mail: francesca.bretzel@cnr.it or Dr. Stefania Toscano, Via Valdisavoia 5, 95123 Catania(CT), Italy. Phone: (39)0954783303, E-mail: stefania.toscano@unict.it E-mail symposium: info@luh2021.it Web: https://www.luh2021.it/
- March 2-5, 2021, Giarre, Catania (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/
- March 8-12, 2021, Stuttgart (Germany): **IV International Symposium on Horticulture in Europe - SHE2021.** 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-ihs-fav2020.de/
- March 8-12, 2021, Stuttgart (Germany): **VIII International Symposium on Human Health Effects of Fruits and Vegetables - FAVHEALTH2021.** 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-ihs-fav2020.de/
- March 8-12, 2021, 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-ihs-fav2020.de/
- March 14-19, 2021, Brena Baja (La Palma) & La Laguna (Tenerife) (Spain): **XIV International Protea Research Symposium.** Info: Prof. Dr. Juan Alberto Rodríguez Pérez, Àrea de Producción Vegetal, Universidad de La Laguna, Calle Dinamarca 29, 38300 La Orotava, Tenerife, Spain. Phone: (34)666695267, E-mail: jarodrip@ull.es Web: https://proteas2020.asocan.net
- March 21-24, 2021, Lemesos (Cyprus): **III International Symposium on Soilless Culture and Hydroponics: Innovation and Advanced Technology for Circular Horticulture.** Info: Assist. Prof. Nikolaos Tzortzakis, Dept. Agricultural Sciences, Biotechnology, Food Science, Cyprus University of Technology, 3036, Lemesos, Cyprus. Phone: (35)7 25002280, Fax: (35)7 25002838, E-mail: nikolaos.tzortzakis@cut.ac.cy or Prof. Dr. Silvana Nicola, University of Turin, Dept. of Agric., Forest and Food Sciences, Leonardo Da Vinci 44 (L.Paolo Braccini, 2), 10095 Grugliasco (TO), Italy. Phone: (39)0116708773, Fax: (39)0112368773, E-mail: silvana.nicola@unito.it Web: https://www.hydro2020.com/
- March 29 - April 1, 2021, Dakar (Senegal): **IV All Africa Horticultural Congress - AAHC2020.** Info: Dr. Moctar Fall, Cluster Horticulture, 2,5 km Route de lAéroport, Immeuble MSA - BP 25 852, Dakar, Senegal. Phone: (221)776389171, E-mail: directeur@agroseed.sn Web: http://www.aahc2020.org
- April 11-16, 2021, 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, Calcada 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
- April 18-22, 2021, Davis, CA (United States of America): **VIII International Symposium on Rose Research and Cultivation.** Info: Dr. Deborah Golino, 2828 Loyola Dr, Davis Ca 956181633, United States of America. Phone: 5307548102, E-mail: dagolino@ucdavis.edu or Brent Pemberton, Texas A&M, Agric. Research & Ext. Ctr., PO Box 200, Overton, TX 75684, United States

of America. Phone: (1)9038346191, Fax: (1)9038347140, E-mail: b-pemberton@tamu.edu Web: https://ucanr.edu/sites/ISHS/

- April 19-22, 2021, Murcia (Spain): **III International Symposium on Beverage Crops.** Info: Rocio Gil Muñoz, Avda Ntra Sra de la Asunción N24, 30520 Jumilla, Spain. E-mail: mariar.gil2@carm.es or Prof. Dr. Encarna Gómez-Plaza, Universidad de Murcia, Fac. Veterinaria, Dep. Tecnología Alimentos, Campus Espinardo, 30071 Murcia Murcia, Spain. Phone: (34) 868887323, E-mail: encarna.gomez@um.es or Prof. Dr. Cristina Garcia-Viguera, Phytochemistry and Healthy Foods Lab, Dept Food Science Technoloy CEBAS-CSIC, Campus Espinardo 25, Espinardo, 30100 Murcia, Spain. Phone: (34) 968396200, Fax: (32)9686213, E-mail: cgviguera@cebas.csic.es Web: https://www.bevcrops21.es/
- April 28 - May 1, 2021, Toluca (Mexico): **V International Conference on Postharvest and Quality Management of Horticultural Products of Interest for Tropical Regions.** Info: Prof. Dr. Omar Franco Mora, Laboratory of Horticulture, Faculty of Agriculture, Universidad Autónoma del Estado de México, Toluca, México, 50140, Mexico. E-mail: franco_omar@hotmail.com E-mail symposium: convener@pqmhp2021.com Web: https://pqmhp2021.com/
- May 1-5, 2021, Rimini (Italy): **IX International Strawberry Symposium.** Info: Prof. Dr. Bruno Mezzetti, Dip.Sci. Agrarie, Alimentari ed Ambientali, Università Politecnica delle Marche, Via Brecce Bianche, Ancona 60100, Italy. Phone: (39)0712204933, Fax: (39)0712204856, E-mail: b.mezzetti@univpm.it or Prof. Dr. Maurizio Battino, Dept of Clinical Sciences, Sect Biochemistry, Università Politecnica delle Marche, Via Ranieri, 65 - 60100 Ancona, Italy. E-mail: m.a.battino@univpm.it or Dr. Gianluca Baruzzi, Council for Agric. Research & Economics, via La Canapona, 1 bis, Magliano, 47100 Forlì, Italy. Phone: (39) 543 89566, Fax: (39) 543 89077, E-mail: gianluca.baruzzi@crea.gov.it Web: https://www.iss2021.com/
- May 2-6, 2021, Tel Aviv (Israel): **I International Symposium on Protected Cultivation, Nettings and Screens for Mild Climates.** Info: Dr. Avi Sadka, ARO, The Volcani Center, Department of Fruit Trees Sciences, 68 HaMaccabim Rd., P.O. Box 15159, Rishon LeZion 7528809, Israel. Phone: (972)3-9683343, Fax: (972)3-9669583, E-mail: vhasadka@volcani.agri.gov.il or Mr. Itzhak Esquira, Ministry of Agriculture, 34 Burla Street, Apt. 2, 69364 Tel Aviv, Israel. E-mail: esquirai@gmail.com
- May 20-24, 2021, Beijing (China): **IX International Cherry Symposium.** Info: Prof. Dr. Kaichun Zhang, Beijing Academy of Forestry & Pomology Sci., Jia 12, Ruiwangfen, Xiangshan Str, Haidian, Beijing, 100093, China. Phone: (86)1082596007, E-mail: kaichunzhang@126.com E-mail symposium: cherrysymposium9@126.com Web: http://2021.cherries.cn

NEW

- May 24-28, 2021, Almeria (Spain): **VI International Symposium on Papaya.** Info: Prof. Dr. Julian Cuevas González, University of Almería, La Cañada de S. Urbano s/n, 04120 Almería, Spain. Phone: (34)950015559, Fax: (34)950015939, E-mail: jcuevas@ual.es E-mail symposium: papaya2020@ual.es Web: http://www2.ual.es/VI-simposium-on-papaya/
- May 24-28, 2021, Almería (Spain): **International Symposium on Models for Plant Growth, Environments, Farm Management in Orchards and Protected Cultivation.** Info: Prof. Dr. Francisco Domingo Molina Aiz, Universidad de Almería, CITE II-A, Despacho 1.07, Carretera Sacramento s/n, 04120 Almería, Spain. Phone: (34)950015449, Fax: (34)950015491, E-mail: fmolina@ual.es or Dr. Lorenzo Leon, IFAPA Centro "Alameda del Obispo", Avda. Menendez Pidal s/n, E-14004, Córdoba, Spain. Phone: (34)671532697, Fax: (34)957016043, E-mail: lorenzo.leon@juntadeandalucia.es E-mail symposium: horchimodel2021@ual.esWeb:http://www2.ual.es/horchimodel2021/
- May 30 - June 3, 2021, Limassol/Lemesos (Cyprus): **VI International Symposium on Postharvest Pathology: Innovation and Advanced Technologies for Managing Postharvest Pathogens.** Info: Assist. Prof. Nikolaos Tzortzakis, Dept. Agricultural Sciences, Biotechnology, Food Science, Cyprus University of Technology, 3036, Lemesos, Cyprus. Phone: (35)7 25002280, Fax: (35)7 25002838, E-mail: nikolaos.tzortzakis@cut.ac.cy Web: http://web.cut.ac.cy/postharvestpathology2021/
- May 31 - June 4, 2021, 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 Assoc. Prof. Sammar Khalil, Dept. of Biosystems and Technology, SLU, Box 103, 23053 Alnarp, Sweden. E-mail: sammar.khalil@slu.se E-mail symposium: ISHSLight2020@slu.se Web: https://www.ishslight2020.se/
- May 31 - June 4, 2021, Naoussa (Greece): **X International Peach Symposium.** Info: Prof. George Manganaris, Anexartisias 57, PAREAS Building, P.O. Box 50329, 3603 Lemesos, Cyprus. Phone: (357)25002307, Fax: (357)25002804, E-mail: george.manganaris@cut.ac.cy or Dr. Athanassios Molassiotis, Pomology lab, Faculty of Agriculture, AUTH, 54 124 Thessaloniki, Greece. Phone: (30)2310 998882, Fax: (30)2310 998882, E-mail: amolasio@agro.auth.gr Web: https://www.fruitsciences.eu/peach2021

NEW

- June 1-5, 2021, Moscow (Russian Federation): **XV International Symposium on Virus Diseases of Ornamental Plants.** Info: Dr. Tatiana Mitiouchkina, 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 6-9, 2021, Cordoba (Spain): **XV International Asparagus Symposium.** Info: Juan Gil, Plaza de la oca, 1, 2-1, Córdoba, Spain. E-mail: juan.gil@uco.es Web: https://www.ias2021.com/
- June 7-10, 2021, Lugo (Spain): **VII International Chestnut Symposium.** Info: Prof. Santiago Pereira-Lorenzo, Universidad de Santiago de Compostela, Escola Politécnica Superior de Ingeniería, Avda. Benigno Ledo sn, 27002 Lugo (Galicia), Spain. Phone: (34)982823128, E-mail: santiago.pereira.lorenzo@usc.es E-mail symposium: ChestnutLugo21@gmail.comWeb:http://chestnutsymposium.com/
- June 7-10, 2021, Oslo (Norway): **IV International Symposium on Plant Cryopreservation.** Info: Dr. Dag-Ragnar Blystad, NIBIO - Norwegian Institute of Bioeconomy R, Division of Biotechnology and Plant Health, Høgskoleveien 7, No-1431 Ås, Norway. Phone: (47)90872588, E-mail: dag-ragnar.blystad@nibio.no Web: https://nibio.pameldingssystem.no/cryo-2021
- June 20-25, 2021, Davis, CA (United States of America): **VIII International Symposium on Almonds and Pistachios.** Info: Dr. Louise Ferguson, 2037 Wickson Hall, Plant Sciences Department Mail Stop II, UC Davis 1 Shields Ave. Davis CA 95616, United States of America. Phone: (1) 559 737 3061, Fax: (1) 530 752 8502, E-mail: lferguson@ucdavis.edu or Dr. Thomas M. Gradziel, Department of Pomology, University of California, 1 Shields Avenue, Davis, CA 95616-8683, United States of America. E-mail: tmgradziel@ucdavis.edu or Bruce Lampinen, Dept of Plant Sciences, University of California, 1 Shields Avenue, Davis, CA 95616, United States of America. E-mail: bdlampinen@ucdavis.edu Web: https://ucanr.edu/sites/Almond_Pistachio_2021/

- June 27 - July 1, 2021, 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

NEW
- July 12-14, 2021, Bangkok (Thailand): **IX International Scientific and Practical Conference on Biotechnology as an Instrument for Plant Biodiversity Conservation (physiological, biochemical, embryological, genetic and legal aspects).** Info: Dr. Kanchit Thammasiri, Department of Plant Science, Faculty of Science, Mahidol University, Rama VI Road, Phyathai, Bangkok 10400, Thailand. Phone: (66)89-132-7015, Fax: (66)2-354-7172, E-mail: kanchitthammasiri@gmail.com E-mail symposium: biotech2020thailand@gmail.com Web: http://plantscience.sc.mahidol.ac.th/biotech2020

NEW
- July 12-16, 2021, Hangzhou City, Zhejiang Province (China): **III International Symposium on Fruit Culture along Silk Road Countries.** Info: Prof. Dr. Yuanwen Teng, Dept. Of Hort., College of Agric.& Biotech., Zhejiang University, Zijingang Campus, Hangzhou 310058, China. Phone: (86)571-88982803, Fax: (86)571-88982803, E-mail: ywteng@zju.edu.cn or Prof. Dr. Zhen-Hai Han, Institute for Horticultural Plants, China Agricultural University, No. 2 Yuanmingyuanxilu, 100193 Beijing, China. Phone: (86)1062732467, Fax: (86)1062734391, E-mail: rschan@cau.edu.cn or Prof. Dr. Xingjiang Qi, No. 298 Desheng Middle Road, Hangzhou, China. E-mail: qixj@zaas.ac.cn Web: http://www.silkroad2021.org/
- July 20-22, 2021, 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 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
- August 1-6, 2021, 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://2021orchardsystems.com/

NEW
- August 15-18, 2021, Leuven (Belgium): **XIII International Controlled and Modified Atmosphere Research Conference - CaMa2021.** 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/

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- August 18-22, 2021, 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/
- August 22-27, 2021, Ghent (Belgium): **II International Symposium on Growing Media, Soilless Cultivation, and Compost Utilization in Horticulture.** Info: Dr. Bart Vandecasteele, ILVO, Plant Sciences Unit, B. Van Gansberghelaan 109, 9820 Merelbeke, Belgium. Phone: (32)92722699, E-mail: bart.vandecasteele@ilvo.vlaanderen.be E-mail symposium: info@growingmedia2021.comWeb:https://www.growingmedia2021.com/
- August 22-26, 2021, Corvallis, OR (United States of America): **X International Congress on Hazelnut.** Info: Prof. S.A. Mehlenbacher, Department of Horticulture, 4017 ALS Bldg., Oregon State University, Corvallis, OR 97331-7304, United States of America. Phone: (1)5417375467, Fax: (1)5417373479, E-mail: mehlenbs@hort.oregonstate.edu Web: https://hazelnut2021.org/
- August 28 - September 2, 2021, 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 13-16, 2021, 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 13-16, 2021, 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 14-17, 2021, 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
- September 20-24, 2021, Riva del Garda, Trento (Italy): **XIV International Symposium on Plant Bioregulators in Fruit Production.** Info: Dr. Fabrizio Costa, Via Mach 1, 38010 San Michele all'Adige, Trento, Italy. Phone: (39)0461615563, E-mail: fabrizio.costa@fmach.it Web: https://eventi.fmach.it/ISHS-2021
- September 22-26, 2021, 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
- September 24-26, 2021, 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, Boulevar B.Clinton bb, 10000 Prishtina, Kosovo. E-mail: skenderkaciu@yahoo.com E-mail symposium: contact@ishs8.org Web: https://ishs8.org/

- September 27 - October 1, 2021, Malaga (Spain): **XIII International Mango Symposium.** Info: Dr. J. Ignacio Hormaza, EE. La Mayora - CSIC, 29750 Algarrobo-Costa, Malaga, Spain. Phone: (34)952552656, Fax: (34)952552677, E-mail: ihormaza@eelm.csic.es or Dr. Víctor Galán Sauco, Isaac Albéniz 17, 38208 La Laguna, Tenerife, Canary islands, Spain. Phone: (34)922261647, E-mail: vgalan46@gmail.com E-mail symposium: mango2020@ihsm.uma-csic.es Web: https://en.mango2021.es/
- September 27-30, 2021, Yalova (Turkey): **X International Symposium on Kiwifruit.** Info: Dr. Arif Atak, Horticultural Central Research Institute, Department of Viticulture, 77102 / YALOVA, Turkey. Phone: (90)2268142520, Fax: (90)2268141146, E-mail: atakarif@gmail.com E-mail symposium: secretariat@kiwifruit2021.org Web: http://www.kiwifruit2021.org
- October 4-6, 2021, 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: viton.savino@gmail.com E-mail symposium: info@certfruit2020.org Web: http://www.certfruit2020.org
- October 4-7, 2021, York (United Kingdom): **III International Symposium on Carrot and Other Apiaceae.** Info: Ms. Coral Russell, BGA House, Nottingham Road, LN110WB Louth, United Kingdom. Phone: 07792893336, E-mail: coral.russell@britishgrowers.org
- October 24-28, 2021, Cancun (Mexico): **Greensys2021: International Symposium on New Technologies for Sustainable Greenhouse Systems.** Info: Dr. Irineo Lopez Cruz, Postgrado en Ingeniería Agrícola, Universidad Autónoma Chapingo, KM 38.5 Carretera Mexico Texcoco, 56230 Chapingo, Mexico. Phone: (52)5959521551, Fax: (52)5959521551, E-mail: ilopez@correo.chapingo.mx or Prof. Dr. Efrén Fitz-Rodríguez, Universidad Autónoma Chapingo, Ing. Mecánica Agrícola/ Posgrado IAUIA, km 38.5 Carretera México-Texcoco S/N, Texcoco, Edo. de México C.P. 56230, Mexico. Phone: (52)5959521500x6252, E-mail: efitzr@taurus.chapingo.mx E-mail symposium: greensys2021@gmail.com Web: http://www.greensys2021.org

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- October 28-30, 2021, 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 Web: http://ipps2020.org/
- November 8-12, 2021, Montpellier (France): **I International Symposium on Reproductive Biology of Fruit Tree Species.** Info: Dr. Evelyne Costes, INRA UMR AGAP, 2, place Viala, 34060 Montpellier Cedex 1, France. Phone: (33)499612787, Fax: (33)499612616, E-mail: evelyne.costes@inrae.fr or Dr. Henryk Flachowsky, Pillnitzer Platz 3a, 01326 Dresden, Germany. E-mail: henryk.flachowsky@julius-kuehn.de Web: https://symposium.inrae.fr/reproductive-biologyfruittree/
- December 1-3, 2021, Chiang Mai (Thailand): **V Asia Symposium on Quality Management in Postharvest Systems.** Info: Prof. Dr. Varit Srilaong, Posth.Tech., School of Biores.&Technology, King Mongkut's Univ. of Technol.Thonburi, 126 Pracha-Uthid Road, Bangmod, Thungkru, Bangkok 10140, Thailand. E-mail: varit.sri@kmutt.ac.th E-mail symposium: asqp2021@kmutt.ac.th Web: http://www.asiapostharvest2021.kmutt.ac.th/
- December 14-17, 2021, 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/

Year 2022

NEW

- March 7-11, 2022, San Juan (Argentina): **XVI International Symposium on Processing Tomato - XIV World Processing Tomato Congress.** Info: Dr. Luca Sandei, SSICA, Tomato Department, Viale f.Tanara 31/a, 43121 Parma (PR), Italy. Phone: (39) 0521795257, Fax: (39) 0521771829, E-mail: luca.sandei@ssica.it or Dr. Cosme A. Argerich, Instit. Nac. de Tecnol. Agro., C.C. Nro. 8, La Consulta, 5567 Mendoza, Argentina. Phone: (54)2622470304, Fax: (54)2622470753, E-mail: argerich.cosme@inta.gob.ar E-mail symposium: symposium@worldtomatocongress.com Web: http://www.worldtomatocongress.com
- March 25-28, 2022, Guangzhou (China): **IV International Orchid Symposium.** Info: Prof. Dr. Genfa Zhu, Enviromental Horticulture Research Inst., Guangdong Academy of Agricultural Sciences, No. 1 East Jinying Street 1, Wushan Road, Tianhe district, 510640 Guangzhou, China. E-mail: genfazhu@163.com
- May 23-26, 2022, Pula (Croatia): **VIII International Symposium on Edible Alliums.** Info: Smiljana Goreta Ban, Institute of Agriculture and Tourism, Department of Agriculture and Nutrition, Karla Huguesa 8, 52440 Porec, Croatia. E-mail: smilja@iptpo.hr
- June 6-9, 2022, Almeria (Spain): **X International Symposium on Soil and Substrate Disinfestation.** Info: Dr. Miguel de Cara, IFAPA-Centro La Mojonera, Camino San Nicolás, 1, 04745. La Mojonera, Almería, Spain. Phone: (34)671532026, Fax: (34)950558055, E-mail: franciscom.cara@juntadeandalucia.es
- August 14-20, 2022, Angers (France): **XXXI International Horticultural Congress: IHC2022.** Info: Dr. François Laurens, INRA, Centre d'Angers, 49071 Beaucouzé, France. Phone: (33)2 41 22 56 00, Fax: (33)2 41 22 57 55, E-mail: francois.laurens@inrae.fr E-mail symposium: info@ihc2022.org Web: https://www.ihc2022.org/

Year 2023

- January 22-26, 2023, Stellenbosch (South Africa): **XIV International Pear Symposium.** Info: Dr. Elke Crouch, University of Stellenbosch, Horticulture, Consumer Sciences Building, Private Bag X1, 7602 Matieland, South Africa. Phone: (27)218084763, Fax: (27)218082121, E-mail: elke@sun.ac.za or Prof. Karen I. Theron, Department of Horticulture, University of Stellenbosch, Private Bag X1, Matieland 7602, South Africa. Phone: (27)218084762, Fax: (27)218082121, E-mail: kit@sun.ac.za
- March 10-14, 2023, Athens (Greece): **II International Symposium on Protected Cultivation, Nettings and Screens for Mild Climates.** Info: Dr. Dimitrios Savvas, Agricultural University of Athens, Laboratory of Vegetable Production, Iera Odos 75, 11855 Athens, Greece. Phone: (30)2105294510, Fax: (30)2105294504, E-mail: dsavvas@aua.gr or Assoc. Prof. Thomas Bartzanas, Agricultural University of Athens, Laboratory of Farm Structures, Iera Odos 75, 11855, Athens, Greece. Phone: (30)2105294045, Fax: (30)2105294045, E-mail: t.bartzanas@aua.gr

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