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**The Outcomes of
“Avocado Brainstorming 2011”**

Since 1999, an Avocado Brainstorming conference has been held in conjunction with the World Avocado Congress. The purpose of Avocado Brainstorming has been to provide an international forum for detailed scientific discussions on current topics relevant to avocado industries worldwide, at a level more detailed than is possible at the World Avocado Congress.

Participation in Avocado Brainstorming meetings has helped researchers build networks and new relationships with international science groups involved with avocado and other fruit sectors. This networking ensures that the most effective and up-to-date scientific approaches are used when attempting to find solutions to industry problems. Experienced researchers, industry stakeholders, as well as students have attended these meetings.

The first Avocado Brainstorming was held over three days in 1999 in California at the University of California (Riverside), following the IV World Avocado Congress in Uruapan, México. The vision of this initial Avocado Brainstorming was to bring California growers and international researchers and students together in a more intimate setting



to share ideas and experiences regarding the issues facing the California industry. The meeting was a great success and that momentum led to a second meeting, held again in California in 2003 following the V World Avocado Congress in Málaga, Spain. Again the meeting had participation by both growers and international researchers, and students. Both of the California meetings were organized jointly by the Hofshi Foundation and the University of California, with sponsorship provided by the California Avocado Commission along with other organizations and private individuals. Although both meetings were successful, it was decided that future Avocado Brainstorming meetings would be more “research” focused, rather than grower interactive, since that is one of the specific goals of the World Avocado Congress; to provide the venue for research/grower/industry interactions.

The third Avocado Brainstorming meeting was held in 2007 in Panquehue, Chile following the VI World Avocado Congress in Viña del Mar, Chile. This meeting was attended by 66 researchers and students working on avocados worldwide. Additional speakers from outside the avocado sphere were invited to address specific topics. This meeting was organized jointly between the Hofshi Foundation, the University of California, GAMA (a private consulting/research firm in Chile) and Jorge Schmidt (an avocado grower in Chile). After this third meeting, all participants agreed that the ideal format had been identified; an intense 3-day meeting where the science of avocado could be discussed, argued, and new working collaborations established.

The fourth Avocado Brainstorming was held in 2011 on Wai-

heke Island in New Zealand, just prior to the VII World Avocado Congress in Cairns, Australia. It was attended by 63 individuals representing Australia, Brazil, Chile, Israel, Mexico, New Zealand, South Africa, Spain, and the United States. One of the goals in inviting participants was to insure a mix of “seasoned” researchers and young researchers new to avocados. We accomplished this goal with several of the participants new to avocado research enthusiastically bringing their talents to address the problems facing global avocado production and fruit quality. The meeting was organized by the Hofshi Foundation, Plant & Food Research and the University of California. Numerous organizations generously helped to sponsor the meeting, representing several countries:

Australia: Delroy Orchards, Jasper Farms

Chile: Agrícola Los Lilenes S.A., Cabilfruit; Santa Cruz Exporters, Soc. Agrícola Vista Hermosa Ltda.

New Zealand: New Zealand Avocado Industry Council, Plant & Food Research

United States: California Avocado Commission, California Avocado Society, Del Rey Avocado, Hass Avocado Board, Index Fresh Inc.

The meeting was divided into seven sessions over two and a half days. A summary of the highlights of each session is provided below.

Session 1 - What’s new on the avocado frontier – The avocado genome

Speakers: **Robert Schaffer**, Plant & Food Research, Auckland, New Zealand; **Luis Herrera**, Departamento de Ingenieria Genetica de Plantas, Unidad Irapuato, Irapuato, Guanajuato, México

Session Highlights:

Dr. Herrera reported on the state of the Mexican avocado genome project which is being funded by the Mexican government (US\$4 Million) and the avocado growers of México (US\$2 Million). This is a joint program with Dr. Alejandro Barrientos (Universidad Autonoma Chapingo, Chapingo, México) who is heading up the avocado breeding

portion of the project. Dr. Herrera reported that they anticipate completing and submitting for publication the first phase of this work, the genome sequencing of a Méxican criollo avocado, by the end of 2011. In subsequent work they plan to sequence other varieties including ‘Hass’. Dr. Schaffer discussed in general terms what needs to be done next and how to use the genome data. There was a lively discussion regarding this topic including Ray Schnell (USDA-ARS, Miami, FL) describing his work with David Kuhn (USDA-ARS, Miami, FL) on a SNP chip with 6000 markers which is now available. By the end of the meeting several collaborations had been formed to utilize these breakthroughs in avocado genetics and breeding.

Session 2 - Alternate Bearing: Internal tree limitations (resources)

Speakers: **Stuart Tustin**, Plant & Food Research, Havelock North, New Zealand; **Samuel Salazar-Garcia**, Campo Experimental Santiago Ixcuintla, INIFAP, Nayarit C. P., México.

Session Highlights:

The session chairs discussed internal factors within the plant that can influence alternate bearing. Dr. Tustin spoke about research on apples in New Zealand and how reducing floral bud density by artificial spur extinction at pruning prior to budbreak can increase fruit set on the remaining buds. Dr. Salazar-Garcia discussed the avocado and his work on flowering, fruit set and yield in México and other growing regions in Central and South America. His message was that carbohydrates are not the driver of alternate bearing but they do influence the quantity and quality of flowering. He also stressed that the tree needs to be in balance in order to minimize alternate bearing and that a healthy root system is imperative.

Session 3 - Alternate Bearing: External factors (pollination, temperature, soil)

Speakers: **Michael V. Mickelbart**, Purdue University, West Lafayette, IN, USA; **Iñaki Hormaza**, CSIC, Malaga, SPAIN

Session Highlights:

Dr. Mickelbart discussed environmental factors that modulate

the ability of the avocado tree to assimilate carbon and how these responses are influenced by alternate bearing. The data presented stimulated a discussion about how one can manipulate the tree to achieve maximum carbon assimilation and theoretically reduce alternate bearing. Dr. Hormaza presented data regarding flower behavior and flower quality (starch) and how successful flowering is influenced by external factors. Dr. Hormaza also presented data that suggests that the use of pollinizer varieties needs to be carefully considered – the pollinizer variety and also



whether pollinizers in a given locale are actually needed. This prompted a lengthy discussion about pollinizers, the importance of starch in the style as an indicator of flower quality and how to improve the probability of a flower setting a fruit and remaining on the tree until harvest.

Session 4 - Alternate Bearing: Molecular approaches

Speakers: **Abhaya Dandekar**, University of California, Davis, CA, USA;
Harley Smith, University of California, Riverside, CA, USA

Session Highlights:

Dr. Dandekar presented several ideas taken from his work with citrus, walnuts and other tree crops to discuss how to approach alternate bearing using molecular techniques. He built upon Dr. Herrera's presentation on the avocado genome to discuss several approaches towards functional mapping of avocado genes once the genome sequence project

is completed. This included defining the genes associated with alternate bearing. Identifying biomarkers and correlates associated with alternate bearing, identifying targets for “therapy” and finally developing/deploying these therapeutic strategies to overcome alternate bearing. He cited examples where similar approaches had been used to study diseases affecting walnuts and citrus, and argued that using this approach to solving alternate bearing, while promising, will likely be very complex. Dr. Smith covered the same topic from the direct perspective of the avocado tree, and presented a discussion on the various theories regarding alternate bearing and preliminary data he has collected that support/refute these various theories. Both presentations stimulated much discussion regarding the potential for using gene mapping to study alternate bearing and the understanding of the avocado tree that could be achieved through this process.

Session 5 - Breeding and genetics - pest and disease resistance breeding

Speakers: **Jose Chaparro**, University of Florida, Gainesville, FL, USA; **Neena Mitter**, Principal Biotechnologist - Queensland Alliance for Agriculture and Food Innovation, Australia; **Fernando Pliego**, Universidad de Málaga, Spain

Session Highlights:

This session started with Dr. Chaparro discussing integration of genomic data into avocado breeding. He discussed the need for mapping populations and the importance of remaining focused in prioritizing traits of utmost importance as compared to those that may be important but not essential. Dr. Pliego followed on these comments by reviewing his and others work on the potential of biotechnology (transformation) in avocado plant improvement. He covered the progress that his group has made in this area and discussed the potential use of “cisgenic” (a genetic modification in which genes are only transferred between closely related organism) vs. “transgenics” (genes may be transferred from non-related genera). His talk was followed by a short but lively presentation by Dr. Mitter who is pursuing the approach of RNA silencing technology to solve the problem of avocado root rot. There was much discussion following these presentations and much questioning of where the future of avocado plant improvement was headed and how likely in the near

term would biotechnology techniques could be used to improve avocado plant performance.

Session 6 - Fruit quality - the importance of the skin

Speakers: **Ian Hallett**, Plant & Food Research, Auckland, New Zealand; **Kerry Everett**, Plant & Food Research, Auckland, New Zealand; **Peter Hofman**, Department of Primary Industries, Nambour, Queensland, Australia

Session Highlights:

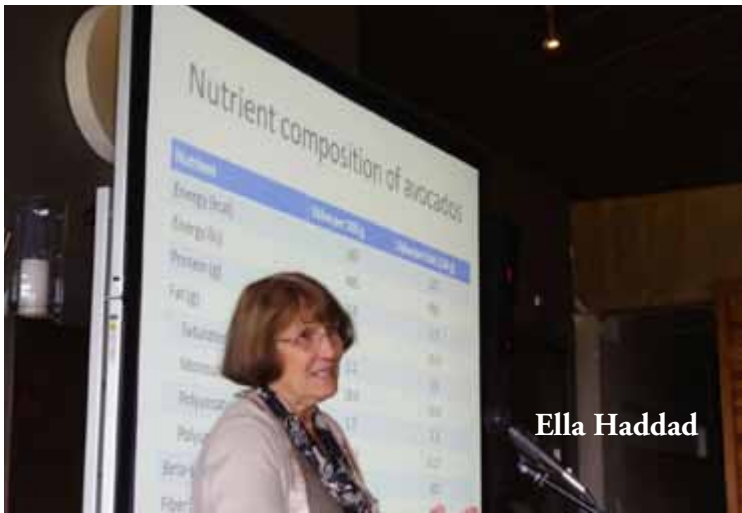
Dr. Hallett started the session with an overview of fruit skins of various horticultural commodities and a discussion on how they differ, but also how they were similar. He presented work from New Zealand on avocado peel morphology and how the fruit responds to moisture and physical damage during development and postharvest. Dr. Hofman summarized the state of our knowledge on how tree nutrition can impact how fruit respond to the postharvest environment, and hypothesized on how nutrition may be playing a role in these responses. The session concluded with a presentation by Dr. Everett on her work regarding avocado fruit damage due to hydration and physical damage. She also discussed the work of Dr. Prusky (Volcani Institute, Israel) on the presence of antifungal dienes in the fruit peel and how these change with fruit age and postharvest environment. The group then discussed further the role of tree nutrition on peel disorders found in the postharvest environment. The link between preharvest management of the tree and postharvest fruit quality was also discussed at length.

Session 7 - Health and nutrition

Speakers: **Don Ingram**, Pennington Biomedical Research Center, Baton Rouge, LA, USA; **Ella Haddad**, Loma Linda University, Loma Linda, CA, USA

Session Highlights:

This final session started with Dr. Haddad summarizing some of the preliminary data collected by the Loma Linda University group on the possible health advantages of including avocado in the human diet. Preliminary results suggest that eating avocados may reduce subsequent



food intake through loss of appetite via the process of “satiation”. Dr. Ingram followed with a discussion of work on life extension studies using mice and dogs, and the influence of this by avocado. He discussed at some length the impact of D-mannoheptulose in life extension. There was a very lively discussion following these two presentations regarding both these research projects. Since most of the meeting participants were not familiar with these lines of research there were many questions asked of the two presenters.

In summary, the 2011 Avocado Brainstorming meeting was successful. The goal of bringing young scientists to work on avocado research was very evident. There was a free-flow of information between all participants. One of the most gratifying aspects of the meeting was to see contacts being made or reinforced between attendees. This was especially so in observing the interaction of the “young” scientists with those with years of avocado experience. It left the organizing committee with a good feeling that avocado research will carry forward for the future while building on the past and present efforts. Avocado Brainstorming 2015 will be held somewhere in South America and we hope to report to you our observations from that meeting in a few years’ time.

Finally we thank the various sponsors for covering the costs of running Avocado Brainstorming and the Plant & Food Research support staff who ensured the smooth operation of the meeting.