Comprehensive Automation for Specialty Crops
Publications, progress reports, presentations, workshops, tours, and field days

**Research Papers/Written Reports**


Sanjiv, Sanjiv, Marcel Bergerman, Jillian Cannons, Benjamin Grocholsky, Bradley Hamner, German Holguin, Larry Hull, Vincent Jones, George Kantor, Harvey Koselka, Guiqin Li,


INVITED PRESENTATIONS


Mid-Atlantic Young Grower Alliance. 2009. Investigating New Technologies at Interpoma (panel discussion). Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.


L. Hull. 2009. Advanced Approaches to IPM (included explanation of automated scouting research). President’s Day Fruit Growers Educational Meeting, Biglerville, PA.

J. Travis, H. Ngugi, N. Halbrendt. 2009. Disease Management—A 5-Year Strategic Plan (included explanation of sensor network research). President’s Day Fruit Growers Educational Meeting, Biglerville, PA.


K. Ellis and J. Remcheck. 2009. Impact of Specialty Crops Innovations Initiative on the Adams County Fruit Belt. Gettysburg and Adams County Chamber of Commerce Agriculture Committee Meeting, Gettysburg, PA.


P. Heinemann and J. Schupp. Innovative Technologies for Peach Thinning. Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.

T. Baugher. 2010. Results from 2009 Thinning Trials. Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.


J. Schupp. 2010. Preparing for Orchard Mechanization. International Fruit Tree Association Conference, Grand Rapids, MI.

L. Hull. 2010. Taking IPM to the Next Level (included explanation of information-driven systems and new tools for monitoring). President’s Day Fruit Growers Educational Meeting, Biglerville, PA.
Ellis, K. and N. Halbrendt. 2010. PSU Pest and Weather Alert Systems (included preliminary information that relates to sensor networks). President’s Day Fruit Growers Educational Meeting, Biglerville, PA.


M. Bergerman. 2010. Innovations in Crop Intelligence and Agricultural Automation for Tree Fruit Production (Round Table). Ontario Fruit and Vegetable Convention, Brock University, St. Catharines, Ontario.


J. Schupp, T. Baugher, E. Winzeler, J. Remcheck. 2010. Training Systems for Early Peach Production and Increased Opportunities for Automation. Penn State Fruit Research and Extension Center Technology Showcase, Biglerville, PA.

K. Ellis. 2010. Surveys to Increase Adoption of New Technologies. Penn State Fruit Research and Extension Center Technology Showcase, Biglerville, PA.


Baugher, T., J. Schupp, K. Lewis, G. Hoheisel, K. Ellis, D. Ames, J. Remcheck. 2011. Pilot orchards provide laboratories in the field to increase industry adoption of labor assist and precision technologies (Poster). Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.


P. Brown and J. Schupp. 2011. Encouraging Results from CASC Harvest Assist Trials with a Commercial Partner. Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.


J. Schupp. Peach Training Systems for the Mid-Atlantic. Mid-Atlantic Fruit and Vegetable Convention, Hershey, PA.


C. Seavert. 2011. Are You Playing to Win or Playing Not to Lose. International Fruit Tree Association Convention, Pasco, WA.

C. Seavert. 2011. Agricultural Economics: Sustaining Profits, Controlling Expenses (interactive Turning Point discussion). International Fruit Tree Association Convention, Pasco, WA.


C. Seavert. 2011. Knowing When Technology is the Right Choice for Your Nursery Farwest Horticulture Convention, Portland, OR.

M. Bergerman. 2011. Developing and Managing a Large SCRI grant. Invited seminar at Michigan State University, Lansing, MI.

M. Bergerman. 2011. Developing and Managing a Large SCRI grant. Joint SAAESD & ASRED Spring Meeting, Greenville, SC.

S. Singh. 2011. Working on Collaborative Projects. 16th Biennial Research Symposium of the Association of 1890 Research Directors, Atlanta, GA.


T. Baugher. 2012. Mechanization Research in the USA. International Fruit Tree Association Annual Conference. Santiago, Chile.


**TRADE MAGAZINE AND NEWSPAPER FEATURE STORIES**


Tender Fruit Grape Vine, September/October 2008. “Reducing Labour in the Orchard” by Ken Slingerland

Pennsylvania Ag Connection, October 2008. “USDA Awards Over $28 Million in Specialty Crop Research” by USDA.


Peach Fuzz, October 2008 USDA Awards More than $28 Million in Specialty Crops Research by California Canning Peach Association.


Good Fruit Grower, December 2008. “Versatile Robotic Scout should be able to Detect Pests and Diseases and Estimate the Crop, as well as Guide Robotic Pruners and Harvesters” by Geraldine Warner.


Cling Peach Review, Fall 08/Winter 08. “A Time for Innovative Thinking—All Segments of Peach Industry Excited by Innovative Mechanization Research” by Ann Schmidt-Fogarty.


American/Western Fruit Grower, February 2009. “Tree Fruit: Precision Ag Coming Into Focus” by Jim McFerson. (alsoon growingproduce.com)

Lancaster Farmer, February 2009. “New Orchard Technologies Emerging – Apple Tour in Italy, Orchard Robotics are Topics at Convention.”


Penn State College of Agricultural Sciences Dean’s Blog, July 2009. “Our Land Grant Bears Fruit” by Bruce McPheron.


Good Fruit Grower, October 2009. “Ready for Robots? New Technologies will Improve Orchard Efficiency, but will your Orchard be able to Accommodate them?” by Geraldine Warner.

Peach Times, Fall 2009. “What’s Next? Thinning Technology Shows Promise for U.S. Peach Production” by Katie Ellis and Jim Remcheck.


PrecisionAg Works, November 2009. “Tree Fruit: Precision Ag Coming into Focus,” by Jim McFerson.

Penn State College of Agriculture Magazine, Fall 2009. “Fruitful Endeavor – Biological Engineering Students Take Talents to Orchards.”


American/Western Fruit Grower, June 2010. “Welcome to the Machine – Apple Growers are Closer than Ever to Having an Automated Harvesting System suitable for their Needs,” by Brian Sparks.


Good Fruit Grower, August 2010. “Electric Farm Vehicles,” by Geraldine Warner. (Circulation – 11,000)


Good Fruit Grower, September 2011. “The Future is Here – Technology Designed to Automate Various Aspects of Fruit Production will be on View at a WSU Field Day,” by G. Hoheisel.

Good Fruit Grower, October 2011. “New Orchard Technologies are Coming,” by M. Hanson.


American/Western Fruit Grower, March 2012. “Applying Precision Ag to Tree Fruit,” by J. McFerson.


American/Western Fruit Grower, April 2012. “From the Ground Up,” by B. Sparks.


KEPR-TV, September 2012. “Robots replacing fruit pickers? Not quite, but a new machine is changing the industry” by Melanie Tubbs


**Bulletin, Fact Sheets, Computer Software and videos**


November 6, 2008 – Engineering Solutions Tour – T. Baugher, H. Ngugi, and grower representatives Joy Cline, Sergio Aguilar (CASC advisory panel member), Chris Baugher, Neil Starner, Corey McCleaf, Phil Baugher, John Rice, Daniel Rice, Lee Showalter, and Bruce Hollabaugh hosted the Carnegie Mellon SCRI-CASC team of engineers for tours/discussions of vertical axis orchard systems, work platforms, mechanical thinning, GPS guided planting, fruit handling systems, and automated nursery tree caliper measurements.

November 6 – 12, 2008 – Engineering Solutions Tour – K. Lesser, J. Schupp and 9 growers traveled to Bolzano, Italy to attend Interpoma – an international tradeshow on the production, storage, and marketing of apples. Vendors included: nursery companies; tree training, support system, and hail net providers; manufacturers of orchard platforms, mowers, sprayers, tractors, and mechanical thinners; chemical companies; packing line and cold storage facilities; businesses for marketing and packaging solutions. After the tradeshow, the group visited two apple orchards in the South Tyrol region of Italy, and then traveled to the Bodensee region of Germany. The European growers were innovative – having high density tall slender spindle trees and using new technologies such as orchard/harvest assist platforms, tunnel and tower sprayers, and advanced IPM practices. They also visited a packing facility which packs and sells Kiku apples, and the Bodensee tree fruit research station.
November 13, 2008 – Report for Funding Agency – T. Baugher, R. Crassweller, and J. Travis met with the State Horticultural Association of Pennsylvania Board of Directors and provided an update on the three SCRI grants received by Penn State.

November 17, 2008 – PA Pilot Orchard Session at Penn State Fruit Research and Extension Center – J. Schupp, R. Crassweller, J. Halbrendt, T. Baugher, and K. Lesser provided training on advanced IPM strategies for orchard floor management and wildlife control, minimal pruning strategies to reduce labor requirements, and tree architectures for automation observed during a Mid-Atlantic Young Grower Alliance Tour of Italian and German orchards.

November 18, 2008 – Mid-Atlantic Young Grower Alliance Tour of Intensive Fruit Production Systems – T. Baugher, A. Michael, L. Kime, and growers Aimee Rohrbaugh, Dave Musselman, Sidney Kuhn, Dave Kuhn, Mary Margaret Kuhn, Tom Child, and Michael King provided training on risk management, precision agriculture technologies, and tree architectures for automation.

November 30, 2008 – Engineering Solutions Tour – T. Baugher and Interpoma tour representatives K. Lesser, Eddie Rankin, and Megan Rankin hosted a dinner discussion/slide presentation on innovations observed at Interpoma for a delegation from Western New York growers/educators.

December 1, 2008 – Engineering Solutions Tour – T. Baugher, K. Lesser, L. Hull, H. Ngugi and grower representatives Maggie Reid, John Baugher, and Bruce Hollabaugh hosted a comprehensive automation/innovative thinning tour for two Cornell extension educators and four New York growers.


December 17, 2008 – Report for Funding Agency – J. Schupp, J. Travis, and T. Baugher met with the State Horticultural Association of Pennsylvania Extension Committee and provided an update on the three SCRI grants received by Penn State.

December 18, 2008 – Report for Stakeholder Group – P. Heinemann, J. Schupp, T. Baugher, L. Hull, R. Marini, R. Crassweller, and K. Lesser met with the Ag Innovations Advisory Committee and provided an update on the three SCRI grants received by Penn State.

January 28, 2009 – In-Depth Workshop on Tree Architectures for Automation – T. Baugher, J. Schupp, R. Crassweller, R. Marini, and CIG growers Neil Starner, Corey McCleaf, Justin Weaver, and Bill Gardenhour conducted an in-depth workshop on tree architectures adaptable to orchard automation. Ninety growers attended the workshop, and 140 workshop notebooks were distributed. Workshop participants were surveyed via Survey Monkey and 78% indicated they learned a great deal about new strategies of pruning for efficiency in intensive fruit plantings. Also 78% are making the following plans as an outcome of what they learned at the
workshop: 1) planting new competitive orchard systems at higher tree densities, 2) establishing new competitive orchard support systems, and 3) adopting peach pruning and training strategies for targeting fruit size and yield. As a result of attending the workshop, 88% rated their level of comfort with transitioning to high value cultivars planted in competitive orchard systems as “very comfortable.”

February 3, 2009 – Advisory Panel Meeting in Conjunction with Mid-Atlantic Fruit and Vegetable Convention – CASC project leaders shared progress with Advisory Panel members and Pilot Orchard cooperators.

April 22, 2009 – Field Demonstration – J. Schupp, T. Baugher, K. Ellis, S. Miller, J. Remcheck, and Grower Cooperators J. Cline, E. Haller, and K. Lesser conducted a mechanical thinning open house –“Spotlight on Mechanical Thinning.” Thirty growers and extension professionals attended from PA, NJ, Ontario, Nova Scotia, and MD. Participants observed the new PT 250 dual string thinner thinning an open center peach orchard, the Darwin 300 vertical string thinner in a perpendicular V orchard, and the new USDA peach drum shaker thinning a perpendicular V orchard.

April 22, 2009 – Field Demonstration – K. Lewis conducted a mechanical thinning open house at Valicoff orchards, Sunnyside, WA for 67 participants.


June 2, 2009 – Classroom in the Field at Hollabaugh Orchards Conservation Innovation Grant (CIG) planting for 50 growers – J. Schupp, R. Crassweller, T. Baugher, L. Hull, and H. Ngugi discussed advanced integrated orchard management strategies and two tree architecture systems for adaptability with automation.

June 25, 2009 – Engineering Solutions Field Day at C&G Orchards and Penn State FREC for 20 growers – Carnegie Mellon, USDA-ARS Appalachian Fruit Research Station, Purdue University and Penn State engineers and plant scientists demonstrated SCRI Comprehensive Automation strategies including autonomous row following, stress sensing, localization, autonomous spraying and mowing.

June 25, 2009 – Cherry Day at Washington State University Prosser Research and Extension Center. G. Hoheisel and K. Lewis organized a field day for 90 growers and allied industry members that included a discussion on mechanical harvest for stem free cherries, worker augmentation, mechanical thinning and over the row platforms.


August 2-4, 2009 – One Year into It: Engineering Solutions for PNW Specialty Crops – C. Seavert, K. Lewis, S. Singh, and P. Heinemann led strategic planning sessions on utilizing engineering technologies to address challenges faced by Pacific Northwest Specialty Crop industries.

August 3, 2009 - One Year Into It: Engineering Solutions for PNW Specialty Crops, Current activities in Building Engineering Capacity in the PNW nurseries presented by J.S. Owen in Wilsonville, OR to 65 growers, allied suppliers, and colleagues.


September 21-22, 2009 – Two-Day Meeting with USDA-SCRI Administrators – P. Heinemann presented first year results from the Innovative Thinning project.

September 24, 2009 – Dean of Agriculture Tour for PA Legislators and Agricultural Leaders – P. Heinemann, T. Baugher, J. Schupp, J. Liu, R. Dice, and A. Leslie presented impacts from Specialty Crop research initiative projects to 80 legislators and agricultural leaders.

October 21, 2009 – Tour for University of Maryland Advanced Technologies in Horticulture Class – T. Baugher, K. Ellis, J. Schupp, and Young Grower Alliance provided orchard demonstrations on innovations for specialty crops.

December 15, 2009 – Report for Funding Agency – T. Baugher and J. Remcheck met with the State Horticultural Association of Pennsylvania Extension Committee and provided an update on the SCRI grants received by Penn State.

December 16, 2009 – PA Pilot Orchard Lunch and Learn Session – J. Schupp, L. Hull, T. Baugher, and K. Ellis provided training on advanced IPM strategies for insect control, minimal pruning strategies to reduce labor requirements, and updates on comprehensive automation for specialty crops.

November 5, 2010 – Specialty Crop Tour for Young Growers – T. Baugher, J. Schupp, K. Ellis, and J. Remcheck facilitated a tour for 20 young growers to an innovative orchard in MD and a Delaware nursery utilizing new rootstocks for modern tree architectures.


November 10, 2010 – Spotlight on Assisted Harvest – T. Baugher, K. Ellis, G. Hoheisel, and E. Winzeler conducted a harvest platform demonstration for 20 members of the PA Ag Innovations Advisory Committee and the State Horticultural Association of PA.


February 2, 2010 – Advisory Panel Meeting in Conjunction with Mid-Atlantic Fruit and Vegetable Convention – CASC project leaders shared progress with Advisory Panel members and Pilot Orchard cooperators.

February 3, 2010 – Special Orchard Automation Session during Mid-Atlantic Fruit and Vegetable Convention – T. Baugher, K. Ellis, J. Schupp, P. Heinemann, and 4 growers who cooperated on field trials led a half-day session on orchard automation. There were 250 participants, and 156 participated in a survey to measure potential impacts – 58% indicated that as a result of educational programming they would likely plant new competitive orchard systems at higher tree densities, and 22% said they were already making changes; 53% responded that they would likely adopt new labor saving technologies, and 18% are already making changes; 55% said they were likely to adopt new IPM strategies/technologies for increasing precision and reducing environmental impacts, and 29% are already making changes.

presented an interactive session for 25 producers on considerations for successful orchard renewal and adoption of new technologies.


March 19, 2010 - Classroom in the Field at Mike Flinchbaugh’s and Justin Weaver’s Conservation Innovation Grant (CIG) planting for 16 Young Grower Alliance Members – J. Schupp and T. Baugher discussed apple and peach tree architecture systems for adaptability with automation.

May 13, 2010 – Classroom in the Field at Neil Starner’s Conservation Innovation Grant (CIG) planting for Pilot Orchard Cooperators – T. Baugher discussed two tree architecture systems for adaptability with automation.

June 21, 2010 - The ASABE annual meeting tour included a stop at Soergel Orchards in Pittsburgh, where the CASC team demonstrated the APM. There were about 60 visitors in the group, including 45 ASABE attendees, 4 CMU Summer Scholar interns, Soergel’s farm employees, and local middle-school students. In the first part of the demonstration Brad Hamner showed the vehicle following a few tree rows and turning from one row into another. He explained in detail each of the components of the autonomy system (sensors, computing, and actuation) and entertained a variety of technical questions from the audience. In the second part Matt Aasted showed the audience how to control the APM using the newly-developed grower-friendly APM user interface running on a field-ready handheld Panasonic tablet computer. He then let several attendees control the robot using the interface, including all the children present. People were able to use the interface with literally no training (especially the children!).

June 17, 2010 – Tour of Specialty Crop Innovation Projects at USDA-ARS Appalachian Fruit Research Station for 14 Young Grower Alliance members – S. Wolford demonstrated harvest assist technologies.

August 2, 2010 – USDA SCRI Director’s Workshop at the American Society for Horticultural Science Convention – S. Singh presented a progress report on the SCRI CASC Project.

August 26, 2010 – Fruit Technology Showcase at Penn State Fruit Research and Extension Center – B. Grocholsky, M. Aastad, J. Schupp, T. Baugher, K. Ellis, J. Remcheck, L. Hull, H. Ngugi, B. Lehman, G. Krawczyk, four graduate students, and six summer interns presented 2010 research results on Comprehensive Automation for Specialty Crops.

September 9, 2010 – Current and future strategies in nursery automation. J.S Owen presented update of caliper/counter to 11 industry leaders at J Frank Schmidt Nursery and Son, Co. and led to collaborative research for nursery inventory management with University of Arkansas and University of Florida.


September 20, 2010 – Specialty Crop Innovations Tour for University of California Extension Educators – J. Schupp and T. Baugher provided “train the trainer” programs for two tree fruit extension educators.


October 20, 2010 – Specialty Crop Innovations Open House and Harvest-Assist Demonstration at Penn State FREC. CASC project leaders had exhibits for 25 producers and legislators on each thematic area. Over 75 producers, agricultural leaders, and legislators (including aides to Senator Casey and Representative Platts) attended at demonstration on the CASC vacuum assisted harvest project.

December 19, 2010 – Penn State Extension In-depth workshop on “Plant Water Relations and Cropping Efficiency,” which featured CASC research on stress detection. Sixty producers attended the workshop, and in an exit survey, 82% of respondents indicated they learned something that has potential to make their businesses more profitable in the future, with new technologies on monitoring irrigation needs ranking highest. Respondents grew a combined total of 2326 acres of fruit.


February 22, 2011 - Ag Innovations – Progress and Future Directions Summit held in South Central Pennsylvania. Seventy producers and community leaders participated in a summit to develop strategies for preserving the Mid-Atlantic Fruit Belt through innovation.

March 10, 2011 - PA Pilot Orchard Lunch and Learn Session – J. Schupp, L. Hull, and T. Baugher provided training on advanced IPM strategies for insect control, minimal pruning strategies to reduce labor requirements, and updates on comprehensive automation for specialty crops (2011 trials planned with Allegheny APM and WeedSeeker).
March, 2011 – Tours of innovative PNW orchard systems and technologies for 300 International Fruit Tree Association Conference participants.

March 15, 2011 – Ag Tools Apple Grower Workshop held at Penn State FREC. Twelve producers and financial consultants attended an in-depth workshop on Ag Profit led by Clark Seavert and Jim Julian.


March 16, 2011 – Ag Finance Round Table held at Penn State FREC. Four ag lenders participated in a round table discussion to provide feedback on Ag Finance and Ag Lease.

March 17, 2011 – Specialty Crop Tour for Young Growers – T. Baugher, K. Ellis, and J. Remcheck facilitated a tour for 20 young growers to innovative orchard operations in Lancaster County, PA.

March 23, 2011 – Report for Stakeholder Group – J. Schupp and T. Baugher met with the State Horticultural Association of Pennsylvania Strategic Planning Committee and the Pennsylvania Apple Marketing Board director to update the group on progress with SCRI projects.

July 13, 2011 – Penn State Fruit Research and Extension Center Field Day – J. Schupp, L. Hull, H. Ngugi, T. Baugher, B. Hamner, and M. Bergerman presented field demonstrations relevant to the Mid-Atlantic fruit industry on Comprehensive Automation for Specialty Crops for 200 participants.

August 16, 2011 – Washington State University Sunrise Orchard Field Day – CASC team members presented field demonstrations on mechanical thinning, autonomous platform and automated trap.


March 23, 2011 – Report for Stakeholder Group – J. Schupp and T. Baugher met with the State Horticultural Association of Pennsylvania Strategic Planning Committee and the Pennsylvania Apple Marketing Board director to update the group on progress with SCRI projects.

December 6, 2011 – Tour of Specialty Crop Innovations in Two Pennsylvania Orchards for 20 Young Grower Alliance members.
December 15, 2011 - Report for Stakeholder Group – J. Schupp and T. Baugher met with the State Horticultural Association of Pennsylvania Extension Committee to update the group on progress with SCRI projects.

December 20, 2011 – Penn State Extension In-Depth Workshop on “Apple Cropload Management,” which featured new technologies for optimizing chemical thinning programs. Ninety-five producers attended the workshop.

February 11, 2012 – T. Baugher conducted Specialty Crop Innovations Tour for 25 Nebraska LEAD young agricultural leaders.

February 13-17, 2012 – K. Lewis led a producer tour to World AG Expo in Tulare, CA. Expo exhibits, field tours and facilitated round table discussions have resulted in a Technology roadmap for WSU CPAAS.

April 5, 2012 - Report on CASC activities at W1009 annual meeting by K. Lewis.

May 23, 2012–K. Lewis trained C & O nursery staff on the use of automated tree counter.

July 11, 2012 – T. Baugher conducted a Specialty Crop Innovations Tour for 85 Mid-Atlantic specialty crop producers.

September 28, 2012 – J. Schupp, T. Baugher and DBR Conveyor Concepts demonstrated the latest DBR harvester for Eastern orchard terrain and orchard systems for 35 Mid-Atlantic fruit producers.

October 2, 2012 – Washington State University Center for Precision Automated and Agricultural Systems conducted a technology expo and field day showcasing the CASC autonomous orchard vehicle “Cascade,” CASC harvest assist system, and mechanical thinners. The event was attended by 95 people.