Larry E. Schrader

How did you spend your career?

After completing a BS in agronomy at Kansas State University (1963), I was awarded a university fellowship at the University of Illinois at Urbana–Champaign and earned a PhD in the plant physiology program with a sole minor in biochemistry (1967). My major professor was Richard Hageman, and my dissertation was about induction and regulation of nitrate reductase in maize. Hageman and John B. Hanson were leaders of a dynamic graduate program in plant physiology that provided training for many graduate students and research associates who became leaders in ASPP/ASPB.

I had been commissioned as a second lieutenant in ROTC at Kansas State and deferred active duty to complete graduate training. Upon completion of my doctorate, I served two years as a captain and research biochemist at the U.S. Army Medical Research and Nutrition Laboratory in Denver. My research focused on human nutrition and exercise physiology, resulting in three peer-reviewed articles.

In 1969, the University of Wisconsin–Madison (UW) employed me as an assistant professor of plant physiology in the Department of Agronomy. My responsibilities included teaching an advanced graduate plant physiology course, teaching part of a BioCore organismal biology course for honor students, and conducting research on nitrogen and carbon assimilation. I was promoted to associate professor in 1972 and to professor in 1976. Eleven students obtained a MS under my direction at UW, and 13 earned a PhD. Eighteen scientists worked as research associates or postdoctorates in my lab at Madison.

In 1980, Joe Key and David Krogmann persuaded me to serve for a year as chief of the USDA Competitive Research Grants Program in Washington, DC. It was an interesting experience to oversee the review of 798 research proposals and learn about exciting science in other disciplines, and I encountered several unexpected challenges.

The first occurred after five outstanding practicing scientists had been recruited during October 1980 as program managers. They were to be short-term federal employees, but the paperwork had not yet been completed before President Reagan was inaugurated in January 1981. The day after his inauguration, the new president imposed a freeze on hiring of all federal employees. I was furious and was tempted to resign and return home to Madison. After a few phone calls, I decided that I must at least try to save the Competitive Grants Program. Over the next few days, I became well acquainted with the deputy secretary of agriculture and the head of personnel at USDA, and we worked together to find a way to bring the five scientists to Washington. We succeeded; the rest is history, and the program survived.

The second challenge was deciding which of the 798 proposals would be funded, with only $16 million available. Far more projects were worthy of financial support than could be funded, but the program managers worked very hard to be fair and objective. Nevertheless, it was difficult to explain to some applicants why they were not funded.

The third challenge was the nature of my appointment. My appointment specified that I would work three weeks a month in Washington and then travel back to Madison to spend a week with my family, students, and research associates. I did not want my students and research associates to be affected by my absence. In retrospect, it probably made them more independent and better prepared for their next jobs.

In 1984, I accepted an offer from the University of Illinois to serve as professor and head of the Agronomy Department. This was an unusual opportunity in that several faculty members had reached or were near retirement

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age. During my five-year term, 13 new tenure track faculty were hired. I also served as director of the newly created Center of Excellence for Crop Molecular Genetics and Genetic Engineering within the department.

In 1989, I was appointed dean of the College of Agriculture and Home Economics, the largest college at Washington State University (WSU). With legislative approval, the Center for Sustaining Agriculture and Natural Resources was created during my first year. But because of a shrinking economy caused by hard times for Boeing Co., new state funding for higher education was limited, and the center did not expand as envisioned. I decided not to seek a second five-year term, but wisely decided to return to the faculty as a full-time research professor.

After 10 years in full-time administration, I was faced with starting a new career. I elected to work with the tree fruit industry (apples and sweet cherries) and moved to Wenatchee, Washington, to join the WSU Tree Fruit Research & Extension Center as a plant physiologist. Washington State produces two-thirds of the U.S. apple crop. Conversion of mature orchards to new varieties on dwarfing rootstocks had created new problems for growers. About 10% of the apples were sunburned on these smaller trees, and my first project was to mitigate this problem. With the capable assistance of several postdocs, we soon identified and characterized three types of sunburn and their causes. This led to a major push in my laboratory to invent a "suntan lotion" for apples. After extensive field-testing, a carnauba wax–based formulation was widely accepted by growers, patented by the university, and licensed for commercial production beginning in 2003. RAYNOX® is still widely used in many countries and has saved growers millions of dollars.

Because after 1994 my laboratory was off campus, graduate student training opportunities were limited. I served as major professor for only one MS and one PhD candidate during my time in Wenatchee. However, eight postdoctoral research associates joined my program and made substantial contributions. The almost daily interaction with leading apple and cherry growers was enjoyable and gratifying. The last 15 years of my career were particularly rewarding.

During my career, I was afforded many opportunities for international service. It started in 1980–1981 with an NSF-funded Japan–U.S. exchange program on carbon–nitrogen interactions. Five U.S. and five Japanese scientists participated. I hosted five Japanese visitors in Madison, and then visited several universities and research institutes in Japan during 1981. Seminars were presented in Sapporo, Nagoya, Tokyo, and Tsukuba Science City, and a chapter was written for a book published by Japan Society for the Promotion of Science.

Later, opportunities arose to advance plant physiology by teaching abroad. In 1982, the Ministry of Agriculture in the People's Republic of China asked me to teach plant physiology to teachers who had fallen behind during the 10-year Cultural Revolution. During an intensive 13-day period in Nanjing, I taught about 60% of a graduate plant physiology course to more than 100 scientists and teachers from 27 of the 29 provinces and presented plant physiology seminars at several institutions (Beijing, Guangzhou, Hangchow, Nanjing, and Shanghai).

In 1983, I spent a month at Institut Pertanian Bogor in Bogor, Indonesia, teaching a graduate-level minicourse on carbon and nitrogen metabolism, evaluating all graduate programs in plant sciences, and presenting seminars at several institutions in Indonesia. Between 1989 and 1993, I reviewed programs and help establish student exchange programs with the Kharkov Agricultural Institute in Ukraine in the final days of the USSR. In 1990, I conducted a site visit to an international agriculture development project in Amman, Jordan. WSU was lead university on a project funded by the U.S. Agency for International Development to establish a new university in Jordan.

In 1993, I visited Japan and Taiwan as part of a three-member WSU delegation to establish exchange agreements for faculty and students. In Japan, we visited Kobe University and Kyoto University. In Taiwan, we signed exchange agreements at National Chung Hsing University and visited Pingtung Polytechnic Institute in Ping Tung and National Taipei University of Technology and National Taiwan Normal University in Taipei.

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Invitations to speak at international meetings took me to the World Soybean Conference IV in Buenos Aires, Argentina (1989); the XIII International Botanical Congress in Sydney, Australia (1981); the Sixth International Congress on Photosynthesis in Brussels, Belgium (1983); the International Horticulture Congress in Seoul, Korea (2006); and the Second International Apple Symposium, Yantai, China (2006). In 2010, I presented invited lectures on apples and cherries at two national conferences in Adelaide, Australia.

I officially retired at the end of December 2010 but worked two additional years writing and closing my laboratory. A capstone of my career was coauthoring, with Josef Racsko, a comprehensive 50-page review about sunburn of apple, which was published in 2012 in *Critical Reviews in Plant Sciences*.

What do you consider to be your most important contributions to plant science?

The early part of my career focused on nitrogen uptake and assimilation. My PhD dissertation was on the induction and regulation of nitrate reductase in maize. This enzyme is essential for most agronomic crops, as nitrate is the principal form of soil N available to field-grown crops. Nitrate must be assimilated before amino acids and protein can be synthesized. We developed a rapid colorimetric assay of nitrate in plant tissue, and according to ResearchGate in March 2020, this paper had been cited more than 2,100 times and read by nearly 12,000.

Although nitrate-N is the major form of N available to plants in soil, work in my lab was the first to demonstrate that corn prefers a 1:1 mixture of nitrate and ammonium-N. Plant growth and grain yield are increased when both forms of N are available. A graduate student in horticulture asked me to examine his cranberry plants growing in nutrient culture with nitrate as the N source. The plants were N-deficient and barely growing. By adding ammonium-N, the plants flourished. We discovered that these plants were not absorbing nitrate-N, nor did they have any nitrate reductase activity. We established that cranberries require ammonium-N. This finding had great economic and environmental consequences, as growers had been using ammonium nitrate in the cranberry bogs. The nitrate was not used and was released later into streams when the bogs were drained.

Because most of my colleagues at Wisconsin were plant breeders and geneticists, many plants with unique genetics were available. Isogenic populations of alfalfa at four ploidy levels (diploid, tetraploid, hexaploid, and octoploid) developed by Edwin T. Bingham were used to study effects of gene dosage on carbon assimilation, gene products such as RuBP carboxylase and glutamine synthase, and agronomic traits. Maize mutants with starch-deficient endosperms (*Shrunken-2 and Brittle-1*) were provided by Oliver Nelson and used to study source–sink relationships. The close relationship of carbon and nitrogen assimilation became apparent to me, so carbon–nitrogen interactions were examined by studying amino acid transport, partitioning of photosynthate, and ureide metabolism in soybeans.

In my second career, my major focus was to improve apple and sweet cherry quality. In apples sunburn frequently is the number-one source of culls, costing apple growers millions of dollars annually. I consider RAYNOX®, invented in my lab, to be an important contribution to the apple industry. Similarly, as sweet cherries near maturity, they are susceptible to cracking and splitting when it rains. As we better understood the cracking phenomenon in cherries, we invented another protective formulation, RainGard®, that was invented, patented, and commercialized.

When did you become a member of ASPP/ASPB?

I joined ASPP in 1963.

How did the Society impact your career, and what motivated you to become a Founding Member of the Legacy Society?

I was heavily involved with ASPP early in my career. My first refereed publication was published in *Plant Physiology* in 1965, and my first oral presentation at an ASPP annual meeting was made in 1966. I served for two years (1983–1985) as secretary of ASPP at a time when the secretary was also general program chair for national annual meetings; this involved service on the site selection and symposium committees. Soon thereafter I served as

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president-elect and vice president (1986–1987) and as president (1987–1988). I was a member of the ASPP Executive Committee for five years. I realized during my tenure as secretary and general program chair that ASPP was outgrowing the facilities available on most campuses for the annual meetings. During my presidency, we held the first annual ASPP meeting off campus in Reno, Nevada, in 1988. There was some opposition to moving from campuses to the big cities (especially those with casinos), but we had a successful and well-attended meeting.

I served on the editorial board for *Plant Physiology* (1979–1980, 1983–1987). In 1987, under the leadership of ASPP President Eric Conn (I was president-elect), the Executive Committee approved a new journal, *The Plant Cell*. As incoming president, my responsibilities included recruiting the first editor, Bob Goldberg, and persuading the editor-in-chief and editorial board of *Plant Physiology* that the new journal would be beneficial to ASPP and not decrease the importance or stature of *Plant Physiology*. As a consequence, commitments were made to upgrade paper quality, add color reproductions, and make other improvements to *Plant Physiology*. In 2009, I was elected a Fellow of ASPB.

Serving in numerous roles in the Society provided me the opportunity to observe the impact of our organization on promoting excellent research and educational programs and on influencing public policy. Our Society publishes two of the top plant science journals in the world and therefore helps our members disseminate their scientific discoveries to a broad audience. These activities of ASPB have strengthened our Society and influenced many careers, including mine. These positive experiences and impressions provided my motivation to become a Founding Member of the Legacy Society.

What important advice would you give individuals at the start of their career in plant science?

Attend annual ASPB meetings and present your research. For some, it is less threatening to participate initially in regional ASPB meetings. Get involved in your professional societies. Volunteer to serve on committees; it is a great way to expand your network.

Establish collaborative relationships with colleagues, at your institution or even elsewhere, who have different skill sets and interests. Often these multidisciplinary approaches are needed to solve complex problems. Some collaborators may have unique mutants or germplasm that will help answer a question, or they may have instrumentation and procedures that can help you achieve your objectives.

Academic Family Tree
https://academictree.org/plantbio/tree.php?pid=807987