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JOHN DAVID AXTELL
1934 – 2000

A Biographical Memoir by
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JOHN DAVID AXTELL

February 5, 1934–December 2, 2000

BY ARNEL R. HALLAUER

JOHN AXTELL WAS RECOGNIZED nationally and internationally for his research on sorghum (*Sorghum bicolor* L.). He had broad interests in the breeding and genetics of sorghum, but his research emphasized grain and forage quality and genetic improvement of sorghum germplasm. One of Axtell's major scientific findings was the discovery and identification of genetic factors responsible for reduced protein availability in grain sorghum. He led an interdisciplinary research team of biochemists, nutritionists, and geneticists who demonstrated that tannins had a negative effect on protein availability and hence on nutritional quality of grain sorghum.

Axtell also recognized the importance of increasing the content of the essential amino acid, lysine, in grain sorghum and the impact that increased lysine levels would have on improving the diets of humans who depend on grain sorghum as a staple food component. He pioneered a successful research program that identified natural and induced high lysine mutants in grain sorghums. Agronomic deficiencies associated with high lysine mutants of cereal crops have limited widespread cultivation of corn (*Zea mays* L.) and barley (*Hordeum vulgare* L.). But the high lysine sorghum

cultivar from Ethiopia that was discovered by Axtell in a systematic survey of the world sorghum collection remains the only high lysine cereal crop under extensive cultivation. The high lysine cultivar is known locally as *Wotet Begunchie* (translated as *milk in my mouth*) and continues to be widely grown in the Wollo region of northwest Ethiopia.

Axtell most recently focused his research on the digestibility of sorghum proteins. He and his colleagues conducted extensive studies that clearly established that methods of food preparation had dramatic effects on the digestibility of sorghum proteins. Axtell and his colleagues developed a laboratory assay to determine the digestibility of sorghum-based foods without having to feed the sorghum to animals. Further, they demonstrated with use of the laboratory assay that the proteins of various cereal crops behave differently when cooked and that the cooking process was responsible for the decreased protein digestibility in sorghum. Further studies by Axtell and his colleagues clearly demonstrated that a traditional African fermented food product, *nasha*, significantly improved the digestibility and utilization of protein and energy from sorghum. These findings suggested that the traditional African societies that depend on sorghum as a staple have evolved food preparation methods that reduce some of the nutritional deficiencies associated with sorghum. These findings were corroborated from other studies conducted in Axtell's laboratory using other traditional African sorghum products, such as *kisra*, *asida*, *ugali*, and *marisa*. The research on digestibility ultimately led to the discovery and development of new, novel, highly digestible strains of sorghum. Germplasm developed from Axtell's research on digestibility has been widely distributed to the seed industry, national research programs, and international research centers.

Axtell also made significant contributions in the education and training of graduate students. He was a very effective

teacher in the classroom and took great pride and joy in working with graduate students. Students studying and working with Axtell not only learned the essential technical research skills but they also were stimulated by his enthusiasm and dedication to research; they were inspired by his example. He served as major advisor of 39 graduate students who fulfilled the requirements for M.S. and Ph.D. degrees and served on advisory committees for more than 100 graduate students. His former graduate students currently occupy leadership positions in research and development in universities, in the seed industry, in international agricultural research centers, and in national research programs in developing countries. Axtell also had an international reputation as a counselor and teacher. Through his students he has made significant contributions to the quantity and quality of food available in the world.

John Axtell made valuable contributions to the agricultural sciences during his 34 years of tenure at Purdue University. The trademark of Axtell's university career was interdisciplinary research. He consistently and increasingly worked towards developing a team effort in addressing research problems in protein quality, tannin biochemistry, and forage quality of sorghum. Internationally his contributions in basic research findings, germplasm enhancement, graduate student education, and leadership in plant breeding and genetics are widely recognized. His greatest passion was for long-term institution building and for human capital development, tools that he believed were essential for improving the lives of the poor in developing countries.

PERSONAL HISTORY

John David Axtell was born in Minneapolis, Minnesota, on February 5, 1934. He became interested in science and enrolled at the University of Minnesota for his undergraduate

studies. He earned his B.S. degree in agronomy and plant genetics in 1957. He continued his education at the University of Minnesota and earned his M.S. degree in plant genetics in 1965. Because of his interest in genetics, he enrolled for further graduate studies in plant genetics at the University of Wisconsin, Madison, where he completed the requirements for a Ph.D. degree in plant genetics in 1967. Later in 1967 he accepted a faculty position in the Department of Agronomy at Purdue University. Axtell's contributions in teaching, research, and mentoring of graduate students were recognized by his peers and colleagues. He progressed rapidly in the academic ranks from assistant professor (1967-72), to associate professor (1972-75), to professor (1975-82), and to Lynn Distinguished Professor of Agronomy (1982-2000). His professional career of 34 years was at Purdue University, and he became one of the most recognized faculty members for his contributions to the Department of Agronomy, College of Agriculture, and Purdue University. Axtell was always available and willing to assist and counsel faculty members and graduate students. His genuine warmth and friendliness contributed to his status as a valued colleague and a caring mentor, both for colleagues and students.

John Axtell is survived by his wife of 43 years, Susan D. Kent, in West Lafayette, Indiana; son John, Jr., of Ridgewood, New Jersey; daughter Catherine of Albuquerque, New Mexico; and daughter Laura of Minneapolis. His genuine warmth, caring, generosity, and enthusiasm for life were also extended to his family. Axtell's family has pleasant memories of the many recreational activities and journeys that he planned for them. The children recall that he made routine activities special and special occasions magical; he made every day a celebration of life.

Axtell's warmth for others was reflected when he would greet people with special gifts and a smile, because he took

so much pleasure in giving. His children recall that his greatest gift, however, was to teach them the many important lessons by example. Throughout his life he demonstrated compassion and thoughtfulness in his actions toward others; he always remembered the importance of small acts of kindness and was grateful for the things others did for him. Through his actions he taught his children to work hard and to do their best, to strive to make a difference in the lives of others, to respect all people, and to celebrate the diversity in humankind.

It was an unexpected and severe loss to his family, colleagues, and peers when John Axtell suddenly died on December 2, 2000, at St. Elizabeth Medical Center, Lafayette, Indiana. He was very active in teaching, research, and participation in professional activities until the time of his death.

PROFESSIONAL HISTORY

John Axtell's professional career of 34 years was at Purdue University. During his tenure there he made a broad range of contributions to the agricultural sciences. Although his primary responsibilities were teaching and research, he also made significant international contributions in basic research, germplasm development, and scientific leadership in plant breeding and genetics. During his professional career John Axtell's research emphasized the genetics and improvement of sorghum, both as a staple in human diets and as feed for animals.

A major scientific finding of Axtell's was the discovery and identification of factors responsible for the reduced protein availability or digestibility in grain sorghum. The presence of tannins, located primarily in the testa layer, conferred to the sorghum grain resistance to both bird damage and weathering. For this reason sorghum varieties high in tannin content are commonly grown and utilized in

some areas of the world. Axtell and his students demonstrated for the first time that tannins had a negative effect on protein availability and hence on nutritional quality of sorghum. The significance of this discovery was two-fold. First, it resulted in a shift in emphasis of sorghum breeding programs around the world towards lower tannin sorghums. As a result, almost all sorghum varieties and hybrids developed and released for human consumption in the last 10 to 15 years have been of lower tannin types. Second, it attracted scientists in biochemistry, genetics, and food science to undertake research on the various aspects of tannin and phenolics in sorghum and other food products.

Recognizing the importance of increasing the lysine content of sorghum and the impact this would have on improving the diets of people who depend on sorghum as a staple diet, Axtell pioneered a successful research program that led to the identification of natural and induced high lysine mutants in sorghum. While agronomic problems associated with the high lysine cereal mutants have limited the widespread cultivation of high lysine corn and barley, the high lysine sorghum cultivar from Ethiopia, discovered by Axtell in a systematic survey of the world sorghum collection, remains as the only high lysine cereal under widespread utilization. This cultivar, known locally as *Wotet Begunchie* continues to be widely grown in the Wollo region of north-west Ethiopia. The high lysine sorghums are readily recognized by farmers in the region as special purpose varieties, and they maintain them by saving seed from their own fields.

In recent years Axtell focused his research on the digestibility of sorghum proteins. A study by scientists at Johns Hopkins University in the early 1980s, which involved feeding malnourished Peruvian children, suggested that the protein digestibility of sorghum gruel was significantly lower than that of wheat (*Triticum* sp.), rice (*Oryza sativa*), or

corn. This study attracted the attention of various individuals, including leaders of donor agencies, who questioned the merit and ethics of supporting sorghum research for utilization by humans. In response Axtell and his colleagues conducted studies that clearly established that methods of food preparation could have dramatic effects on the digestibility of sorghum proteins. Axtell and his colleagues developed a technique for determining the digestibility value of sorghum-based foods *in vitro*. Using their *in vitro* assay, they demonstrated that the proteins of various cereals behave differently when cooked and that the cooking process was responsible for the decreased protein digestibility in sorghum. Furthermore, Axtell and his colleagues, using *in vitro* assay, rat balance tests, and human feeding of malnourished infants, clearly demonstrated that a traditional African fermented food product, *nasha*, significantly improved the digestibility and utilization of protein and energy from sorghum. This suggested that traditional African societies that depend on sorghum as a staple have evolved food preparation methods that alleviate some nutritional problems associated with sorghum. This has been corroborated from additional studies conducted in Axtell's laboratory using such traditional African sorghum products such as *kisra*, *asida*, *ugali*, and *marisa*. Thus, Axtell planned and executed scientific studies that helped clarify an issue that could have had serious ramifications for sorghum research, both in the United States and the less developed countries.

Axtell also made worldwide contributions in germplasm development. Varieties and populations of sorghum developed by him and his colleagues at Purdue University have been widely distributed to national research programs and to international research centers. These varieties have either been selected directly or utilized as parents in intercrossing programs by various breeders. A number of these varieties

have been released for wide cultivation in India, Ethiopia, Colombia, and Kenya. An outstanding example is a Purdue sorghum variety P-954063 introduced to ICRISAT, which remains as the most widely used parental line in their program. P-954063 also has been the base population of a variety selected and released in Ethiopia under the name *kobomash*.

PUBLIC SERVICE

Research and teaching were Axtell's primary responsibilities, but he was an active participant and leader in local and international affairs. Locally he chaired numerous departmental committees; School of Agriculture committees, including three dean search committees; and several university committees. He provided counsel to department heads, deans, and leaders of national and international research programs and made valuable contributions to crop science and agricultural sciences in general during the past 30 years. He was a member of the Board on Agriculture and Renewable Resources of the National Academy of Sciences (1978-81); member of scientific review of Future Strategy of International Rice Research Institute at Los Banos, Philippines (1988); chairman of the Symposium on Strategies for Improving Crop Quality: The Next Challenge; International Crop Science Congress, Ames, Iowa (1992); member of the Committee on Plant Sciences, Commission on Life Sciences, National Research Council, Washington, D.C. (1993); member of the Scientific Council to the Gene Expression Center with the Board on Agriculture, National Research Council, Washington, D.C. (1991-93); member of the McKnight Foundation Oversight Committee of the Collaborative Crop Research Committee, Minneapolis, Minnesota (1993-97); and member of the National Research Council's Committee on Science, Technology, and Health Aspects of the Foreign Policy Agenda of the United States (1998).

John Axtell was elected to membership in the National Academy of Sciences in 1982. He was a member who became a strong advocate and an effective spokesman for the Agricultural Sciences Section (62) and was elected chairman of that section for 1987-90. Because of his leadership of Section 62, he was elected chairman of Class VI (Applied Biology and Agricultural Sciences) of the National Academy of Sciences for 1994-97. John Axtell always attended the annual meetings of the National Academy of Sciences, and he was recognized as a leader in his section and class. He was a strong supporter of the importance of the agricultural sciences and their impact on providing adequate quantities of good nutritional food for the United States.

FOREIGN SERVICE

John Axtell's opinions were widely sought by peers and students in international agriculture development because of his excellent knowledge and understanding of the challenges and opportunities of international development. Most of Axtell's sorghum research was directed toward improving the nutritional value of sorghum, particularly where sorghum is a staple in the human diet. Consequently, Axtell, colleagues, and students worked closely with the peoples of Africa to improve sorghum quality and production. His willingness to participate and assist with international research programs will be a great loss. Axtell was an active participant and a strong supporter of the activities of the International Sorghum and Millet Consortium (INTSORMIL): he was a member of the Title XII Technical Committee (1979-82); chairman of the Title XII Technical Committee (1981); coordinator of activities in Niger (1983-95); chairman of the Ecogeographic Zone Council (1983-85 and 1993-94); principal investigator (1979-2000); and was instrumental in conceptual development of INTSORMIL. Axtell's advice and

counsel also were provided to other international research programs: AID representative at CIAT/AID board meeting at Cali, Colombia (1982); preparation of a draft project paper on "Bases of Plant Resistance to Insect Attacks," a U.S. AID research project for the International Center for Insect Physiology and Ecology (ICIPE), Kenya (1982); AID representative to the Asia Ag Officers Conference on Rainfed Agriculture (ICRISAT) (1983); advisor on the Joint Committee on Agricultural Research and Development and the Board for International Food and Agricultural Development (BIFAD) (1984-85); director for the Purdue/AID Sorghum Project (1972-94); U.S. scientific liaison officer to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) at Hyderabad, India (1984-87); technical advisory panel member for the Southern Africa (SADCC) Sorghum/Millet Improvement Program (1985-93); and member of the AID Academy for Educational Development, Communication for Technology Transfer in Agriculture (CTTA) to discuss the potential of Swaziland serving as a CTTA diffusion site (1985-87). John Axtell's presence and contributions to INTSORMIL and other international organizations were very important to the international community. One individual stated that John Axtell's death was "a global disaster for sorghum and millet's global family."

HONORS AND AWARDS

- 1974 Special fellowship, National Institute of General Medical Sciences
- 1975 Sigma Xi Research Award, Sigma Xi
Certificate of Appreciation, U. S. Agency for International Development
- 1975 Alexander von Humboldt Award
- 1976 Crop Science Research Award, Crop Science Society of America
- 1977 Fellow, American Society of Agronomy
- 1982 Lynn Distinguished Professor, Purdue University
- 1984 International Award for Distinguished Service to Agriculture, Gamma Sigma Delta
- 1985 Fellow, Crop Science Society of America
- 1998 Purdue's Pride in International Programs. Purdue Profiles: John Axtell
INTSORMIL Team Award, Purdue University

SOURCES OF INFORMATION used to summarize the distinguished career of John D. Axtell included John D. Axtell, *Crop Science Society of America News*, February 2001, p. 33; "Memorial Resolution for John D. Axtell" by Gebisa Ejeta, March 9, 2001; and John D. Axtell's resume in the Department of Agronomy, Purdue University.

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