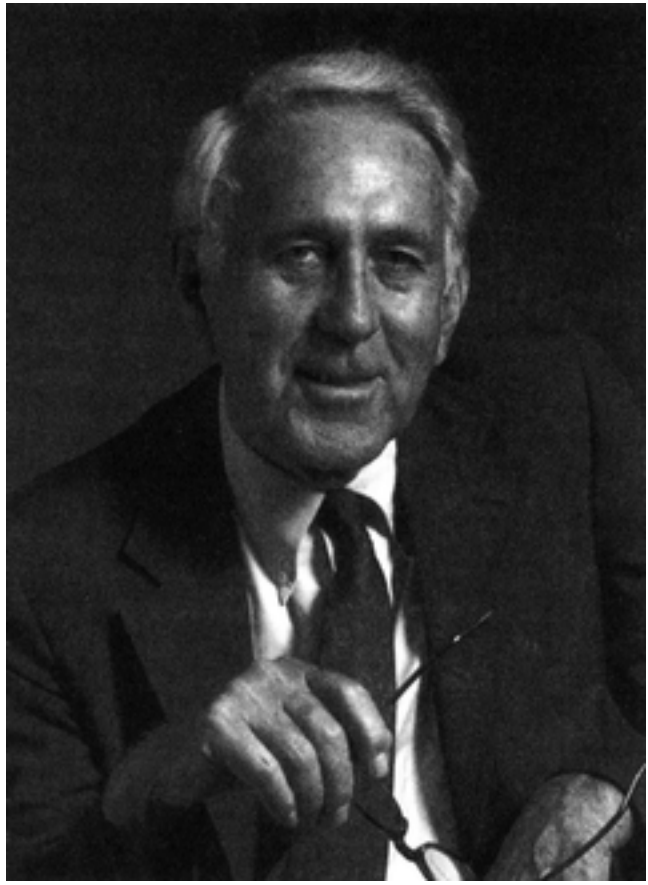
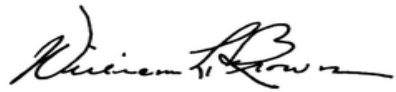


Courtesy of Pioneer Hi-Bred International, Inc.



WILLIAM L. BROWN

July 16, 1913–March 8, 1991

BY DONALD N. DUVICK

DURING A FIFTY-YEAR CAREER as geneticist, businessman, and public servant, William L. Brown made significant and lasting contributions to increasing and stabilizing food production worldwide. He did so through his personal research, his administration of a major international seed firm, and his service on key national and international agricultural boards. Throughout his career Brown was especially concerned with preserving, describing, and utilizing the wealth of germplasm represented by the hundreds of races of maize, collected or still available from indigenous farmers in the Americas and worldwide. He was a leader in efforts to conserve, classify, and utilize this diverse genetic resource.

Brown preached the cause of genetic diversity in all crops as a bulwark against pest epidemics and changing weather patterns. He prodded and then helped the U.S. Department of Agriculture to increase its effort and effectiveness in conservation of plant genetic resources. He reinvigorated the National Research Council's Board on Agriculture, leading it into path-breaking studies and reports on sustainable agriculture as well as genetic resource conservation. He was a leading figure in the movement to internationalize plant

breeding in the service of the rural poor of developing countries.

Brown and his colleague Edgar Anderson published landmark monographs on the two ancestral maize types (Southern Dents and Northern Flints) that, when hybridized, gave rise to the modern North American race (Corn Belt Dent). Corn Belt Dent is the genetic foundation for all hybrid maize of the temperate zones.

Known and revered as a leader, but also as a scientist and a humanitarian, William L. Brown made lasting contributions to science and to humanity.

PERSONAL HISTORY

William Lacy Brown was born in Arbovale, West Virginia, on July 16, 1913, into a family of West Virginia hill farmers and grew up on a Greenbrier Valley livestock farm. According to Brown's friend and mentor, Edgar Anderson, William Brown's father was "a genuine gentleman, courteous and kind in manner, but with no interest in books or their contents."

Brown attended the local rural grammar school and then went on to high school in the nearby community of Green Bank. He developed an interest in the science of biology while still in high school, where he also was a star athlete active in football, basketball and track. Following graduation from high school, he enrolled at Bridgewater College, a small liberal arts school in the hills of western Virginia. He majored in biology, was captain of both the football and basketball teams and served as class president in all four years of college. He graduated with a degree in biology. After a year of graduate work at Texas A&M University he transferred to Washington University (St. Louis), where he studied under Edgar Anderson in the Henry Shaw School

of Botany, majoring in cytogenetics and taxonomy. He received an M.A. (1939) and Ph.D. (1941) from that institution. His doctoral thesis was entitled "Cytogenetics of *Poa pratensis*." According to Brown the thesis demonstrated a strong likelihood that the apomictic species *P. pratensis* (bluegrass) is a polyploid of hybrid origin.

In August 1941 William Brown married Alice Hannah, a high school classmate. From that union came two children, Alicia Anne (Matthes)Brown and William Tilden Brown.

Also in 1941 Brown left Washington University for a position as cytogeneticist with the U. S. Department of Agriculture, Forage Crops Division. His doctorate was granted in absentia. In 1942 he left the USDA for a position in industry, as director of sweet corn breeding for Rogers Brothers Company in Olivia, Minnesota. In 1945 he again changed jobs, accepting a position as geneticist in the Corn Breeding Department of the Pioneer Hi-Bred Corn Company (which would later change its name to Pioneer Hi-Bred International, Inc.). Brown stayed with Pioneer Hi-Bred until his retirement in 1984.

Although genetics applied to plant breeding was Brown's profession, botany in its broadest sense was his avocation. He was a keen gardener and horticulturist, growing an eclectic and purposely diverse mixture of useful fruits and vegetables and exotic trees and shrubs. He was particularly proud of his success in growing a handsome bald cypress tree, certainly not indigenous to Iowa. Brown introduced me to the mysteries and complexities of Iowa's native prairie flora, taking me and another friend to a nearby tall-grass prairie remnant on a hot, sunny August afternoon when the composites and grasses were in full flower. The prairie was floristically rich; the air was redolent with the resinous fumes of numerous, diverse sunflower species. Brown pronounced

the outing a near success; it lacked only the sighting of a rattlesnake.

William and Alice Brown joined the Society of Friends soon after their move to Des Moines. As they said to me when they were contemplating the move, the Quaker emphasis on simplicity, integrity, service, and worth of the individual was a natural fit to their own tastes (and as I can also testify, to their own lifestyle). They were active in their local Meeting and also in the national American Friends Service Committee.

Brown was elected to the National Academy of Sciences in 1980. Active in his retirement years, he chaired the National Research Council's Board on Agriculture and Renewable Resources from 1982 to 1988. He also conducted a research program on the cytology and evolutionary history of a Native American maize variety with the goal of restoring it to its ancestral form, for use by the tribe (the Eastern Cherokee) that had developed it. Results of the study were published in his name after his death, due to the efforts of a fellow scientist and close friend, Major Goodman.

On March 8, 1991, William L. Brown died of emphysema at the age of seventy-seven.

PROFESSIONAL HISTORY

COLLEGE AND UNIVERSITY

After graduation from Bridgewater College Brown followed his biology professor, Walter S. Flory, to Texas A&M University, starting a graduate program under Flory's direction. Brown's funds were limited, and he supplemented his income by playing professional basketball with a Houston team at $50 per game.

He also met the maize geneticist Paul Mangelsdorf. This acquaintance resulted in a lifelong friendship and profes-

sional relationship between the two scientists. Mangelsdorf is internationally famous for his studies of maize landraces and their relationships and for his theories about the origin of maize.

Mangelsdorf and another renowned geneticist, Edgar Anderson, had been fellow graduate students at Harvard University. Anderson was now a geneticist in St. Louis with appointments at Washington University and the Missouri Botanical Garden. According to Brown, "Edgar had written telling Paul that they had support for a fellowship, and asked if there was a student down there that he would recommend." Mangelsdorf gave this information to Brown, who applied and was accepted for study with Anderson, thus solving or at least alleviating his problems with finances for graduate school. The fellowship paid $50 per month, and Anderson boarded Brown in his home rent-free.

Brown knew that Anderson was already recognized as a brilliant geneticist and taxonomist with interest in ethnobotany and evolution. He did not know that Anderson also was eccentric, even for a botanist. Anderson's first task for Brown was to study the grasses in the back yard of his home on Flora Place in St. Louis. Anderson gave no instructions other than to "work on them," and left Brown standing alone in the back yard. As Brown told me in later years (more than once), "I went out there and decided how many different kinds of grass there were. Most of it was crab grass but not all of it. After an hour or two I went and told him a few things about what I had learned. He said there must be more than that, why don't you go back and work at it a little more. We did that for a good part of a couple of days. I was just about ready to call it quits. Then I finally decided there really is something to this after all. I finally learned what a number of them were. But he wasn't going to tell

me." From Anderson, Brown learned the value of keen—and independent—observation.

From Anderson, Brown also gained an appreciation of the role of hybridization in evolution. Anderson developed the concept of introgressive hybridization—usually termed "introgression"—and gave it its name. As the name implies, introgression refers to the gradual infiltration of germplasm of one species into another through repeated backcrossing. Throughout his entire career Brown's ideas about evolution and breeding were influenced by this aspect of Anderson's research and theory. He and Anderson were to work as a team for several years after Brown's graduation from Washington University, stimulated to do so by their mutual interest in the origins and categorization of maize varieties and races. They complemented each other in scientific capabilities and in temperament. Brown was skilled in the modern cytogenetic techniques. Anderson was skilled in recognizing and quantifying key morphological traits. Anderson was expansively literate with unbounded imagination in devising new theories about the evolution of races of maize and maize itself. Brown was concisely literate and, although not without imagination, tended to be much more cautious in pronouncements of new theory or in extrapolating from data.

I once spent an evening listening to the two men revise the manuscript for their 1953 paper, "Origin of Corn Belt Maize and Its Genetic Significance." Anderson would read aloud the sections he had written. Brown would listen without expression but from time to time would interrupt to say that it might be well to take out a superlative or to reduce the scope of a particularly sweeping conclusion. When Brown read his sections aloud Anderson would take the opposite tack. In the end they always agreed and their resulting papers speak for the success of their combined efforts.

CORPORATE CAREER

Brown's brief experience in the USDA left him with a lifelong distrust of the organization's bureaucratic rules. He told of needing to use a microscope on the table next to his, but being unable to use it officially until several weeks of form-filling and official approval were completed. The microscope was the property of a different division, and proper permission had to be obtained before it could be used by an outsider, even if the outsider was also in the USDA. Experiences like this made him ready to move out of the USDA at the first opportunity. He left the USDA in 1942 for a position with Rogers Brothers seed company in Minnesota.

His work as a sweet corn breeder in a small company was not very satisfying and, when Anderson told him in 1945 of an opening in a larger company, Pioneer Hi-Bred, he applied for the job and got it. Anderson had been doing some consulting work for Pioneer; they had tried to hire him, but he suggested they instead have a look at his former graduate student.

Brown's initial duties with Pioneer were not spelled out very clearly. He was supposed to do "fundamental studies," not corn breeding as such. He was the first doctoral level employee of the company. His employment represented a significant enlargement of the scope and concept of research and development activities at Pioneer Hi-Bred, which at that time employed only seven other professional researchers, all of them engaged in highly practical activities such as breeding and testing of maize inbreds and hybrids.

Brown soon developed a research program building on his training as a cytogeneticist. Within a few years he had published a paper showing the existence of a relationship between hybrid vigor and diversity of knob number of pa-

rental inbred lines. The diversity in knob number seemed to derive from the two postulated parents of corn belt dent varieties: Northern Flints and Southern Dents.

After a few years of work on fundamental studies Brown decided that corn breeding looked so interesting that he wanted to take an active part in it, even though he had no training in plant breeding, or even in agriculture, except for experience on the farm as a boy. But he found that lack of formal training in corn breeding was not a handicap. His training in genetics and botany gave him the grounding he needed. As he told me in later years, "Breeding is largely the application of recognized techniques, and one can pick that up pretty quickly."

Brown also gave large credit to his supervisor and mentor at Pioneer, Raymond Baker. Baker had established the corn breeding program for the company and was a mine of practical information about corn breeding. Brown has said, "Most of what I have learned about breeding I learned from Raymond. He is an amazing person as you know. He has an awful lot of knowledge that you have to pull out of him a little at a time." Interestingly, Baker did not have formal training as a corn breeder either. His highest degree was a B.S. in agriculture from Iowa State College. He had spent a lifetime of association with professionally trained corn breeders, however, and learned theory from them, which was then tested by him and his breeders in the practical world of plant breeding for profit.

Brown began to travel with Baker on his annual round of inspection trips to Pioneer corn breeding stations across the corn belt. Baker soon gave Brown responsibility for guidance of several of the breeding stations, particularly those in the eastern and southern part of the United States. From that beginning Brown's responsibilities in research continued to enlarge. In 1958 he was given the title of assistant

director of research; in 1965 he was made vice-president and director of corporate research for the company.

Brown's abilities in administration eventually took him out of research management. In 1975 he became president of the company and in 1979 chairman and chief executive officer. Brown retired from day-to-day management in 1981, when he assumed the position of chairman of the board. In 1984 he retired from the company.

As research director Brown supervised and was largely responsible for a rapid rise in the company's research capacity primarily through addition of new plant breeders and support staff and new breeding locations. Under his direction the company undertook breeding and sales of several crops in addition to corn, including sorghum, soybeans, wheat, and alfalfa. Research was initiated to develop maize hybrids for the tropics and for northern Europe, two very different markets with very different breeding needs. Brown's vision of potentials for commercial plant breeding activity spread well beyond the company's original target of hybrid corn for the U.S. Corn Belt. He envisioned, and helped to develop, a company with international responsibilities in breeding and selling seed of many crops.

Brown's interest in and support for the company's research programs continued during his years as president, chief executive officer, and chairman of Pioneer Hi-Bred. He initiated a reorganization of the company's research programs soon after assuming the office of president. The previously independent research programs were united under one administrative head, giving them greater access to common facilities and knowledge across the company. Additional crop species were added to the company's research and development program. With his encouragement biotechnology research and development was initiated in 1979, early in his tenure as chief executive officer. Most impor-

tantly, product performance, sales, and profitability increased continually during his administrations as research director, president, and chief executive officer. For example, yielding ability of the U.S. maize hybrids sold by the company increased by approximately 25% from 1968 to 1984. Net income for the company in 1984 was approximately three times as great as in 1975.

Researchers at Pioneer remember Brown with great affection and respect. He understood the details and possibilities of research as it applied to needs of the company and, perhaps more importantly, he understood and empathized with the researchers as scientists and as people. It was clear to researchers that he was happiest when out in the research plots inspecting the latest varieties and discussing details of breeding and genetics with the scientists.

RESEARCH CAREER

Just as his high school and college careers had not been one-sided, Brown's career as a scientist-administrator had more than one dimension. Throughout most of his career he maintained a personal program of basic research in maize with emphasis on classification and relationships of the races of maize and on genetic diversity and its consequences for plant breeding.

Within a year after joining Pioneer he toured the southeastern United States, collecting local open pollinated varieties of maize. He did so because he knew that hybrid corn was soon going to replace all of the local varieties; if they were not collected and preserved, their germplasm would be lost and future breeders would have no chance to sample it for needed genes such as for special kinds of disease resistance.

In the next year, 1947, he grew out the collection for increase and study at the Arboretum of the Missouri Bo-

tanical Garden located west of St. Louis in the outskirts of the Missouri Ozarks. To do this he moved his young family onto the grounds of the Arboretum, where they lived in semi-isolation in a slightly refurbished barn, cooking over an open fire and depending on a spring for drinking water and the nearby Meramec River for bathing facilities. Alice Brown was then, as in later years, an essential party to Brown's research endeavors. When studies were completed Brown donated the collections, on behalf of Pioneer, to the North Central Plant Introduction Station at Ames, Iowa. They still reside there, available to anyone who asks for them.

The collections of southern open pollinated varieties of maize were an important foundation for one of two seminal publications co-authored with Edgar Anderson. "The Northern Flint Corns" and "The Southern Dent Corns" appeared in 1947 and 1948. The two monographs were followed by the publication of "Origin of Corn Belt Maize and Its Genetic Significance," also co-authored with Anderson. These landmark papers described the two North American racial complexes in great morphological and cytogenetic detail and discussed their role as parents of the Corn Belt Dent complex and as contributors to heterosis presently utilized in modern hybrid maize. The Corn Belt Dent complex ("the common yellow dents") is the progenitor of today's U.S. maize hybrids, as well as of hybrid maize for the temperate zones worldwide.

In 1952 Brown obtained a leave of absence from his work at Pioneer to accept a twelve-month position as Fulbright advanced scholar at the Imperial College of Agriculture in Trinidad. He collected maize varieties from Caribbean islands and grew them out at the Imperial College as a basis for their classification into races and discussion of their possible relationships. The study was published under the title, "Maize of the West Indies." This research evolved natu-

rally from his earlier work with U.S. open pollinated varieties. It was the beginning of a lifetime career of study and classification of the races of maize, sometimes independently but more often in association with other geneticists and botanists.

Brown made the acquaintance of Henry A. Wallace in the first year of his employment with Pioneer Hi-Bred. Wallace, a native Iowan, was secretary of agriculture for President Franklin Roosevelt in the 1930s, and then gave further service to the Roosevelt administration as vice-president of the United States, and secretary of commerce. Wallace had founded the Hi-Bred Corn Company (the forerunner of Pioneer Hi-Bred) in 1926. He turned the management of the company over to others when he went into government service but nevertheless maintained a deep interest in the company's research work in corn breeding and genetics. He routinely came out to Iowa to visit the company breeding nurseries in late summer when the corn plants were well developed and suitable for inspection and close observation.

Wallace soon developed an easy and close relationship with Brown, not only in regard to scientific subjects, but also in consideration of other philosophical topics. One result of the friendship was the book, *Corn and its Early Fathers*, first published in 1956. I remember well the day when Wallace proposed to Brown that they collaborate in writing the book. The two men had spent the previous day, a Sunday, in looking at a series of old open pollinated maize varieties that Brown was growing in order to study and compare their special characteristics, particularly as sources of inbred lines. Wallace and Brown had not only studied the varieties, they also had spent much of the day in speculating on the origins of the varieties, the purposes for which they might have been developed, and what this might mean

for hybrid corn of the present. They now were seated in Brown's office laboratory discussing the previous day's activity. Early on in the conversation Wallace suggested that he and Brown should also look at the lives of the originators of the varieties: "They might be as interesting as the corn." From such an investigation they might be able to write a book, one that would educate the interested public in the societal and personal aspects of corn breeding and selection. Brown was silent for a time, then replied that although he had never written a book, he might be able to help.

This incident illustrates an important contribution that Wallace made to Brown's career. He encouraged Brown in his natural inclination to pursue studies on maize for their own sake, as well as for the possibility that they might make money for the company. The two men also agreed that plant breeding must be done with strong concern for its social consequences and with recognition of the personalities and social forces that shaped the nature of research and development programs.

Nobelist Barbara McClintock and Brown were friends and professional collaborators. Their acquaintance started in 1945 when Brown and Edgar Anderson went to Cold Spring Harbor to learn cytogenetic technique from her. Brown understood and agreed with McClintock's ideas about transposition of genetic material ("jumping genes") long before the majority of the genetic establishment was aware of her work; however, the main bond between the two scientists was their common interest in use of cytological markers, especially chromosome knobs, to classify races of maize.

PUBLIC SERVICE CAREER

Brown's rapid rise as an authority on genetic diversity and racial affinities of maize soon brought requests that he

serve on boards and committees concerned with preservation and classification of indigenous maize varieties from all parts of the world. He was a member of the National Research Council's original Committee on Preservation of Indigenous Strains of Maize from 1952 through 1956. On this committee he classified NRC maize collections from Bolivia and Chile and gained great satisfaction from doing so.

A succession of similar committee and board assignments and chairmanships, most of them relating to genetic diversity and genetic resources, continued throughout his entire career. Most notably, he chaired the Rockefeller Foundation's Maize Germplasm Committee from 1969 to 1972, served on the National Academy of Sciences's Committee on Genetic Vulnerability of Major Crops in 1972, chaired the Maize Advisory Committee for the International Board for Plant Genetic Resources in 1975, and served as vice-chairman (and usually as acting chairman) of the USDA's National Plant Genetic Resources Board from 1976 to 1982.

Service on these committees gave opportunity for Brown to voice his deep concern for the genetic vulnerability of crop plants and to advocate policies of germplasm conservation intended to preserve farmer varieties that otherwise might have been lost as farmers abandoned them for new, professionally bred varieties. He repeatedly pointed out the relatively narrow genetic base of Corn Belt Dent maize hybrids and advocated development of breeding methods for introgression of diverse germplasm from the hundreds of races of maize that as yet have no representation in Corn Belt Dent maize. He also published on these topics in professional journals and other media.

While serving on the National Plant Genetic Resources Board, formed to make policy recommendations to USDA, Brown was a major force behind the board's successful rec-

ommendations that USDA increase and update its activity in conservation of plant genetic resources, through its National Plant Germplasm System.

Brown's warnings about genetic vulnerability were buttressed with realistic assessments of the situation. He pointed out that "total genetic diversity" does not in itself provide insurance against genetic vulnerability. Useful sources of genetic diversity must include needed new kinds of resistance to pests and other stresses that adversely affect productivity and quality. He noted that, contrary to statements from some critics, modern cultivars can be more stable in performance than older ones they have replaced. He also opined, in opposition to some critics, that a commercial seed industry could make significant contributions to the overall effort to increase genetic diversity in crop plants.

AFTER ELECTION TO THE ACADEMY

Brown chaired and revitalized the National Research Council's Board on Agriculture and Renewable Resources from 1982 to 1988, taking on this responsibility soon after retiring from active management duties at Pioneer Hi-Bred. As chair he brought about major NRC publications in the fields of sustainable agriculture and plant genetic resources and thereby moved agricultural concerns into a prominent place in the National Academy of Sciences.

Brown was directly responsible for founding in 1982 the quarterly news journal *Diversity*. He garnered funding for its establishment and operation from industry, government, and private foundations, convincing donors of the need for a journal that would foster international dialogue and cooperation in the conservation and use of humanity's plant genetic heritage. In 1985 he organized the nonprofit Genetic Resources Communications System, Inc., to publish

the journal. He served as president of the board of directors for its first three years.

Brown put some of his company's funds behind his pronouncements on conservation of plant genetic resources. In 1987 Pioneer Hi-Bred granted $1.5 million to the USDA to initiate and direct the Latin American Maize Program (LAMP), a five-year project. LAMP was a path-breaking cooperative effort of twelve Latin American countries, which rejuvenated, grew out, and evaluated collections of maize varieties that had been languishing in their germplasm banks for decades due to lack of funds for operation. Unprecedented cooperation among the twelve participating countries resulted in evaluation of more that 14,000 landrace varieties, many of which had immediate utility in their country of origin or in nearby countries. This project, perhaps more than any other, epitomized Brown's hopes and aspirations for the cause of plant genetic diversity in support of humanity worldwide. Although he did not live to see its completion or the follow-up programs that it stimulated, he would have heartily approved the final form of the project and its results.

BROWN'S LEGACY

William L. Brown was a biological scientist. He personally produced consequential scientific research in maize genetics and cytogenetics, maize evolution, and germplasm conservation and utilization. His research in general was descriptive and analytical in nature, rather than experimental. Brown's personal accomplishments in science are not, however, the primary reasons for his high regard in the scientific community; rather, he was known and will be remembered as a visionary leader, a stimulator, an organizer. The captain of industry was also an initiator and executor of worthy new public service projects in science. Brown in-

spired affection and emulation among his peers; he also had an unbending will when he was convinced that the path he had chosen was the right one. Brown brought projects to completion; he left no dangling threads. These manifold and diverse qualities, applied to science that mattered to him, gave results. Brown classified and described landraces of maize, but he aided and inspired far more work than he turned out personally. He was a practical maize breeder and developed valuable germplasm, but under his direction scores of plant breeders in all parts of the globe annually boosted yielding ability of many of the world's staple crops. He personally investigated and experimented to increase genetic diversity in crop plants, but in leadership of such bodies as the USDA's National Plant Genetics Resources Board, in formation of the journal *Diversity* and in instigation of the Latin American Maize Program, he multiplied his personal efforts by orders of magnitude.

Perhaps most consequential was the fact that Brown put his talents to work in the right causes at the right time. He raised the banner for conservation of genetic resources and for increased genetic diversity just as professionally bred, new varieties were displacing countless numbers of farmer varieties worldwide. He reorganized his company's research activities at the point when they had grown too voluminous to operate well under an earlier policy of nearly total decentralization. He instigated the Latin American Maize Program at the point when it was becoming clear to all that germplasm collections in many developing countries were going to die on the shelf, unknown and unused for lack of funds to rejuvenate the seed or to categorize and characterize the materials.

Brown's legacy is the message that science in service of humanity can be accomplished when scientists persistently

seek out and constructively work with appropriate bases of power and funds.

IMPORTANT HONORS AND MEDALS

Fellow, American Society of Agronomy, 1970
Fellow, Iowa Academy of Science, 1970
Fellow, Drake University, 1970
Agronomic Service Award, American Society of Agronomy, 1979
Distinguished Fellow, Iowa Academy of Science, 1980
Distinguished Alumni Award, Bridgewater College, 1980
Member, National Academy of Sciences, 1980
Honorary Phi Beta Kappa, Drake University, 1981
President, Crop Science Society of America, 1982
Distinguished Economic Botanist, Society for Economic Botany, 1982
Distinguished Alumni Award, Washington University, 1983
Genetics and Plant Breeding Award for Industry, Crop Science Society of America, 1986
Henry Shaw Medal, Missouri Botanical Garden, 1986
Honorary D.Sc., Drake University, 1987
Fellow, American Association for the Advancement of Science, 1989
Honorary Ph.D., West Virginia University, 1989

WILLIAM L. BROWN'S FRIENDS and family and his personal files as well as those maintained by Pioneer Hi-Bred International have been valuable sources of information for this short memoir. Two additional excellent aids have been a brief but fact-filled biography from the National Academy of Sciences issued at the time of his death, and a superb biographical article by Isabel Shipley Cunningham published in 1992 in the journal *Diversity*. Finally, I have drawn on my forty-plus years of companionship with Brown, my mentor and fellow scientist at Pioneer Hi-Bred, and family friend and fellow botanist in other walks of life.

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