MAJOR GOODMAN:
AN IOWA FARM YOUTH DEVOTED HIS CAREER TO BROADENING THE MAIZE GENETIC BASE

This volume is dedicated to Major Goodman. Little did this editor (*PAP*) visualize that the mathematics student sitting in the back row in a beginning genetics class in 1958 would be the subject of a MAYDICA commemorative issue 47 years later.– In the course of development of genetic concepts, there have been near important laboratories to advance an understanding of the emerging field of genetics. Early in the 20th century, the "*Fly Room*" at Columbia University under Professor T. H. Morgan led to an early understanding of genes and chromosomes by 1915[1]. Though Drosophila genetics led the way early in the century, the plant genome was advanced by Professor R. A. Emerson and his students at the "*hole*" at Cornell University[2] were finding and collecting maize mutants, making crosses and thereby establishing maize as a plant genetic organism. By this time both plant and animal genetics and breeding were well underway. Later in the century in North Carolina, Major Goodman began his effort with colleagues to better understand the corn breeding diversity. With these efforts, he attracted a number of corn breeders and geneticists to the North Carolina laboratory and fields to research the diversity and origin of maize. This effort is evident among the contributors to this volume. This volume is a testimony to the North Carolina effort under Major Goodman and his colleagues to propel the maize genome with a new understanding. This[3] editor is indebted to Dr. James Holland for his effort to assemble the authors contributing to this volume as a tribute to Major Goodman.

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Maydica 51 (2006): 3-13

MAJOR M. GOODMAN

A LAUDATION

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Received February 10, 2005

MAJOR GOODMAN

INTRODUCTION

This volume of *Maydica* is dedicated to Major M. Goodman, who is considered by many maize scientists to be the world authority on maize germplasm resources and their utilization in breeding. By serendipity, this issue will be published to coincide with the 40th anniversary of his Ph.D. The scale of his breeding nursery, yield trials, and rate of inbred line release are greater now than ever before in his career. We have heard him joke on numerous occasions about his retirement plans but, fortunately for us, that day has not arrived. With

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this commemorative issue of *Maydica*, we wish him our best and demonstrate our profound respect for Dr. Goodman and his many accomplishments. We thank Arnel Hallauer, Charles Stuber, Brooks Coetzee, and Sheila Goodman for background information. We also thank Peter A. Peterson, for organizational and editorial support for this commemorative issue.

Iowa: the early ears

Major Mereland Goodman was born in Des Moines, IA on Sept. 13, 1938. First, an explanation of his name. Major is his name, not a military rank, but how did he get such a name? He was the seventh-born child in his family; his father was blind and 54 years old and his mother was 47, so his birth came as something of a surprise. His father was a great fan of a radio show called "Major Bowes' Amateur Hour," which featured the jokes of the host, Major Bowes. His father, therefore, upon hearing about his surprise new son said, "Well his name has to be Major, since he is the biggest joke around".

Major attended both elementary and high school at Johnston Consolidated School, Johnston, IA. Growing up in Johnston probably had a critical influence on his decision to become a maize breeder, because Johnston is the headquarters of the Pioneer Hi-Bred, International seed company and Johnston was also at the time a relatively small town, such that by chance, Major was to come in contact with key figures in the history of maize breeding. Major's first job outside of the family farm and poultry operation was re-shingling the roof of Raymond Baker's house. Raymond Baker was Pioneer's first maize breeder and its leading plant breeder for 43 years; his experiences with creating the first generation of inbred lines from open-pollinated varieties were to be an important scientific influence on Major. Major's brother, Robert, was a foreman for a Pioneer Hi-Bred field crew, and Major started working during summers of his high school years for his brother. Eventually, he met Dr. William L. Brown, who was one of the leading maize breeding researchers for Pioneer Hi-Bred, Intl. Bill Brown encouraged him to attend college and afterward to attend graduate school, and Brown remained a positive influence throughout his life. Dr. Brown went on to have a very productive career with Pioneer, and ultimately became Pioneer's President/CEO, serving in this role from 1975 to 1981.

In Goodman's words, he "lacked adequate financial resources for even the first quarter of the freshman year of college". His high school teachers insisted that he plan for college, even though "that was not one of his most cherished goals". They also worked on his behalf to help him obtain a scholarship to attend college. He received a National Merit Scholarship and entered Iowa State University in September, 1956. He graduated with a B.S. in mathematics in May, 1960. As an elective class in his undergraduate coursework, he took Genetics 301 taught by Peter A. Peterson (current editor of *Maydica*!) in 1958.

North Carolina: graduate school

Major obtained a National Science Foundation Cooperative Graduate Fellowship to support his graduate education, and began his M.S. studies in genetics at North Carolina State College (now University) in Raleigh in September, 1960. For a few years during graduate school, he rented a house with Arnel Hallauer (who worked with Dr. Bob Moll and the maize quantitative genetics group in the Department of Genetics as a USDA-ARS postdoctoral researcher, and who became a widely respected maize breeder and member of the National Academy of Sciences), Bill Crum (later a productive maize breeder for DeKalb), and Robert Kuehl (now an emeritus professor at the University of Arizona and author of a textbook on experimental design and statistical analysis).

Major's M.S. degree advisor was H.F. Robinson (of North Carolina mating design studies), but Dr. Robinson at the time was busy as Department Head, so Dr. Bob Moll was a surrogate advisor for Major during his M.S. studies. Major's thesis was "A study of the genetic variability in divergent and closely interbred populations of maize", in which he compared two maize populations developed by W.L. Brown, Goodman's mentor at Pioneer Hi-Bred. One population was a composite developed from Corn Belt Dent hybrids and the second population was a West Indian composite, composed of germplasm from the same hybrids that made up the Corn Belt Composite, but also included germplasm from varieties adapted to the West Indies. Field evaluations of the two populations in North Carolina and in Iowa (with the assistance of Dr. Brown) demonstrated that, although the Corn Belt Composite had the higher mean yield, the West Indian Composite population had greater additive genetic diversity, responsiveness to selection, and upper range for yield (GOODMAN, 1965a). The results of his

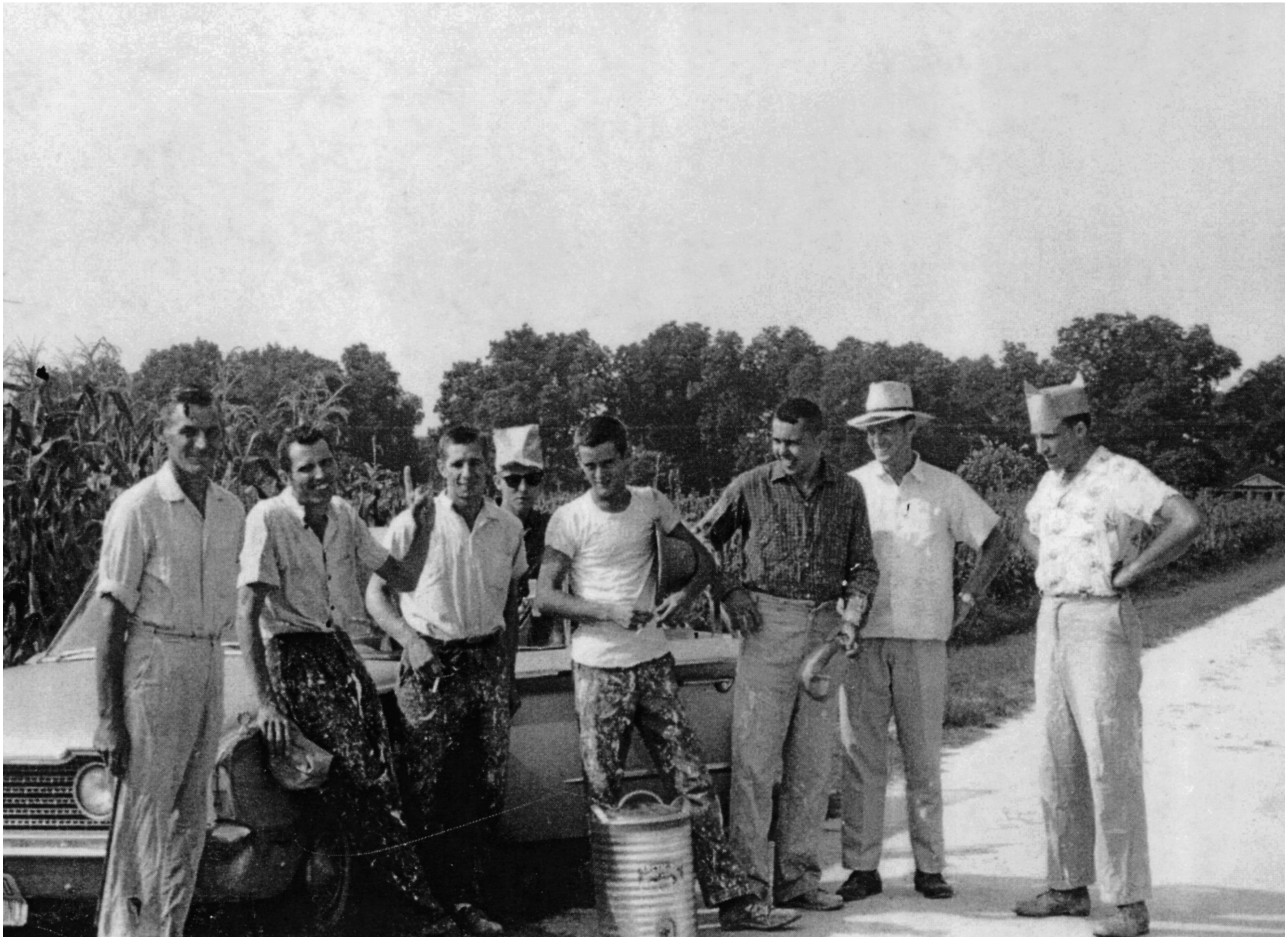

FIGURE 2 - Maize breeding students and workers, Raleigh, NC, circa 1960. (Left to right): Slim Tunstall, Bob Forsberg, Bill Crum, Charles Faison, Wayne Dillard, Carl "Bert" Huether, Major Goodman, and Charles Stuber.

first published paper and the influence of William Brown were obviously crucial to Major's lifelong dedication to enhancing the genetic base of the U.S. maize crop with tropical maize germplasm.

After completing his M.S. degree in January, 1963, he began his Ph.D. studies in genetics at North Carolina State College with Dr. Stanley G. Stephens. Goodman used trait correlations to determine the parentage of hybrid populations, using cotton (*Gossypium barbadense* and *G. hirsutum*) as the experimental organism (GOODMAN, 1966, 1967a). His thesis, "Classification, Correlation, and the Structure of Populations", which garnered the Phi Sigma and Phi Kappa Phi awards for outstanding Ph.D. dissertations at North Carolina State University in 1965, reflects many of the themes that would later characterize his career in maize genetics and breeding. These include crop evolution, classification, statistical genetics, multivariate statistics, and their application to applied plant breeding. The breadth of his knowledge of maize was apparent even early on, reflected in his review of "The history and origin of maize: current theories on the relationships between maize and some of its relatives" (GOODMAN, 1965b) published as a North Carolina Agricultural Experiment Station Technical Bulletin, the same year he received his Ph.D. working in cotton.

To Brazil and back: the beginnings of maize racial classification work

An NSF-funded post-doctoral appointment allowed Goodman to work from 1965 to 1967 with Dr. Ernesto Paterniani of the Escola Superior de Agricultura at Piracicaba, Brazil. His work in Brazil addressed several important questions about the classification of maize accessions into racial groups. For example, what characters are most appropriate for classification? What measures of morphological distance best represent underlying genetic distances? What multivariate statistical techniques are best for displaying relationships among accessions, and how can these be used to elucidate evolutionary relationships among races? An important outcome of this research was the publication of the 1977 book, "Races of maize in Brazil and adjacent areas", (PATERNIANI and GOODMAN, 1977) which updated the previous monograph of Brazilian races (BRIEGER *et al.*, 1958). The Paterniani and Goodman monograph contains a wealth of information, historical, geographic, morphological, photographic, and genealogical, about the diversity of maize in Brazil. Included in it are agronomic data to guide breeders in their selection of superior material to use in maize improvement programs and discussions of the maintenance of germplasm collections and the identification of typical racial collections. Goodman would come back to these themes time and again later in his career, stressing that the best way to ensure the conservation of germplasm collections is to evaluate them and use them in breeding programs.

In 1967, Goodman was appointed as a Visiting Assistant Professor in the Department of Statistics at North Carolina State University, funded as part of an NIH training grant in statistical genetics managed by Dr. C. Clark Cockerham. In 1968 he became an Assistant Professor, and then was promoted to Associate Professor in 1970 and Professor in 1976. He was married in 1970 to Sheila Balfour Dail. Along with Sheila came her two sons, whom he raised as his own.

He continued applying multivariate statistics to the classification of maize throughout this time, resulting in numerous publications on the races of maize (GOODMAN, 1967b, 1968; GOODMAN and PATERNIANI, 1969; BIRD and GOODMAN, 1977; GOODMAN and BIRD, 1977) and on theoretical aspects of the classification problem (GOODMAN, 1969, 1972, 1973, 1974; CASTILLO-MORALES and GOODMAN, 1978; CERVANTES *et al.*, 1978). The importance of these studies is reflected in the fact that two of these papers were republished as part of the first volume in the series "Benchmark Papers in Systematic and Evolutionary Biology". Major's work on racial classification continued throughout his career and today he is considered the foremost authority on the races of maize. The book chapters he coauthored with W.L. Brown on "Races of Corn" (BROWN and GOODMAN, 1977; GOODMAN and BROWN, 1988) represent the most comprehensive reviews of the classification of maize races available.

Isozymes: genetics and classification revisited

In the 1970s, Goodman began a long-running cooperative project with Dr. Charles Stuber of the USDA-ARS and Department of Genetics at North Carolina State University on allozyme variation in maize. Since environmental and genotype-by-environment interaction effects complicate classification based on morphological characters, the development of molecular markers that more directly measured genetic differences was an important objective. Interpretation of isozyme protein gels can be difficult, however, because multiple copies of enzyme loci are often found in the maize genome, and heterodimers representing subunits of the functional enzymes can form from the products of different alleles at the same loci or from alleles at different loci. Therefore, Drs. Goodman and Stuber performed detailed studies of the inheritance of isozymes (STUBER *et al.*, 1977; GOODMAN *et al.*, 1980b; STUBER and GOODMAN, 1983, 1984). The sometimes complicated genetics of isozymes are well represented by the malate dehydrogenase isozymes, which are coded by three mitochondrial and two nuclear loci, each with multiple alleles, and an additional modifier locus linked to one of the nuclear loci that can alter the electrophoretic mobility of the isozymes (GOODMAN *et al.*, 1980a, 1981).

Having worked out a reliable set of isozyme locus assays, GOODMAN and STUBER (1980) demonstrated their utility in identifying lines and hybrids in breeding programs (a precursor to today's DNA fingerprinting techniques). This led to a series of studies on the genetic diversity in inbred lines representing the public maize breeding gene pool of the U.S. (SMITH *et al.*, 1985a,b). Goodman and Stuber then collaborated on a series of landmark studies in the 1980s using isozymes to study a broad range of topics on racial classification and variability within maize and teosinte (with Goodman taking the lead, DOEBLEY *et al.*, 1983, 1984, 1985, 1987, 1988; GOODMAN and STUBER, 1983; SMITH *et al.*, 1984, 1985c; BRETTING *et al.*, 1990) and on marker-assisted selection (with Stuber taking the lead, STUBER *et al.*, 1980, 1982). Thanks to Drs. Goodman and Stuber, students of maize races in the 1980s not only had one of the largest arrays of genetic markers available for a crop, but each marker was assignable to a specific locus and allele. This enabled use of statistical genetic analyses that relied on interpreting the markers according to locus/allele models. This made maize systematists and evolutionists the envy of other students of plant evolution in that period. Whereas DNA-based markers soon replaced the isozymes as the preferred tools for QTL studies, Goodman, Stuber, and Dr. Jesus Sánchez Gonzalez (currently at the University of Guadalajara in Mexico) continued to use isozymes and morphological measurement studies through the 1990s for classification purposes, because they remain relatively inexpensive and highly informative (SANCHEZ and GOODMAN, 1992a,b; SANCHEZ *et al.*, 2000a,b; SANCHEZ *et al.*, this issue). Furthermore, the practical utility of isozyme analyses extends to the present; they are still widely used commercially for quality assurance assays during hybrid and inbred maize production. In addition to using isozymes to study the genetic diversity of maize, Goodman also collaborated with Drs. Sam Levings and David Timothy at North Carolina State University on investigating the variability in mitochondrial DNA of maize and teosinte (WEISSINGER *et al.*, 1982a,b; TIMOTHY *et al.*, 1983).

Forays into the evolution question

The results of Goodman's research on the patterns of genetic variability in maize and teosinte had important implications for understanding their evolution- surely the longest-running debate in the history of maize genetics. The development of isozyme markers permitted unprecedented understanding of the relationships between teosinte (particularly *Z. mays* ssp. *mexicana* and var. *parviglumis*) and maize populations. As WILKES noted recently (2004), Goodman's lab at North Carolina State University was a "center of graduate training" in maize domestication studies in the 1980s, citing P. Bretting, R. Bird, J. Doebley, J. Sánchez, and J.S.C. Smith as important researchers to come out of Major's lab (although, perhaps "the center of postgraduate training" is more accurate, as only Jesus Sánchez did his graduate work there). Major published a comprehensive review of the topic in *Critical Reviews in Science* (GOODMAN, 1988) and contributed a chapter on the topic to an important crop evolution textbook (GOODMAN, 1995). Wilkes further noted that Major Goodman is one of the few researchers "declining to join" the dominant group of scientists supporting the "single domestication from teosinte" theory of maize evolution (WILKES, 2004). Goodman's position might be interpreted as leaving open the question of the origin of maize until the genetic differences between, and the variability within, maize and teosinte can be fully reconciled with the archeological, ethnological, and historical records. This is particularly interesting since his former post-doc, John Doebley, is the leading authority on maize evolution and a strong supporter of the dominant theory, and Major has collaborated on some recent studies on the subject (MATSUOKA *et al.*, 2002).

Preserving the heritage of humankind: germplasm preservation, evaluation, and use

Beyond categorizing the genetic diversity available in Latin American maize collections into racial groups, Goodman spent a substantial part of his career working to preserve, evaluate, and incorporate tropical maize germplasm into useful breeding lines. Starting in 1979, he began speaking and writing publicly about the dire condition of the U.S. and world maize germplasm collections (TIMOTHY and GOODMAN, 1979; GOODMAN, 1984, 1990; GOODMAN *et al.*, 1988; GOODMAN and CASTILLO GONZALEZ, 1991; GOODMAN and HERNANDEZ, 1991). These reports detailed the state of the maize collections in the USA and in Latin American, and noted a troubling host of problems, including sets of collections intended for backup that were instead discarded, and the extinction of several type collections and whole races due to poor management of the collections. The tenor of these assessments can perhaps be judged from a few quotes:

"The majority of our germplasm banks function more as seed morgues than as seed banks" (GOODMAN *et al.*, 1988).

"Another decade or two of discussion will 'solve' the problem: much of the germplasm will be extinct" (GOODMAN and CASTILLO GONZALEZ, 1991).

"It is likely that more funds have been spent on germplasm conferences over the last 30 years than have been spent on actual seed replenishment in Latin American maize germplasm banks" (GOODMAN and HERNANDEZ, 1991).

Goodman was blunt in his assessment of the problems of the germplasm system, but he did more than just criticize; he took on important responsibility for ameliorating the problems. He was appointed chair of the USDA Maize Crop Advisory Committee from 1981 to 1986, with responsibility for planning the acquisition of approximately 20,000 maize accessions into the US germplasm system. He also spearheaded an effort funded by USDA to rescue several thousand critical Latin American accessions by funding and managing seed increases of them in their home countries (Colombia, Mexico, and Peru) beginning in the mid 1980s. This was succeeded by a joint USDA-CIMMYT program to regenerate accessions in the CIMMYT collection and back them up at the USDA-ARS National Seed Storage Lab (now the National Center for Genetic Resources Preservation) in Fort Collins, CO, which started in 1991 and is still ongoing. Finally, he helped to organize the Latin American Maize Project (LAMP), a 5-year program supported by both USDA and private industry (Pioneer Hi-Bred) and involving researchers from the USA and many Latin American nations (SALHUANA *et al.*, 1998). The objective of this program was to evaluate the agronomic utility of the Latin American maize racial collections in the countries in which they were collected. The information collected and distributed by LAMP will help to focus breeding efforts on the most promising landrace collections.

Many people in many countries were involved in these efforts, but much of the credit for forcefully demonstrating the urgency of the problem to administrators who were in positions to fund these efforts belongs to Goodman. The success of his work on behalf of maize germplasm resources can be seen by comparing the state of the US maize germplasm collections in 1983 and today. In 1983, the USDA-ARS North Central Regional Plant Introduction Station in Ames had about 3,000 accessions, most of which were temperate in origin (GOODMAN, 1983). In 2004, the same genebank station has about 18,000 accessions, which can be easily searched and ordered through the internet (TABA *et al.*, 2004).

The shift to applied plant breeding

In 1983, Dr. Goodman joined the Department of Crop Science at North Carolina State University, his "home" department ever since, with the title of Professor of Crop Science, Statistics, Genetics, and Botany, attesting to his wide expertise. This change in departments also brought about a shift in focus in Major's research. From this point on, with the invaluable help of a full-time field technician, Mr. Bill Hill, for the first time in his career, Goodman began to focus on applied maize inbred line development, because he felt that the best way to ensure the conservation of maize germplasm was to actually use it in applied breeding.

Goodman has released more than 90 public inbred lines to date, starting with NC252. These lines include Southern USA germplasm, some Midwestern USA germplasm, pure tropical germplasm, and lines with mixed tropical-temperate parentage. His most important contribution to practical plant breeding has been the development of inbred lines representing a new heterotic group for temperate maize breeding programs. Despite the many problems inherent in working with tropical maize in the temperate USA, and despite many failed attempts by previous workers to obtain useful tropical germplasm derivates (HALLAUER, 1978), he now has created numerous lines with partial or complete tropical parentage that can produce higher-yielding hybrids in combination with Corn Belt Dent lines (HOLLEY and GOODMAN, 1988; GOODMAN, 1992, 1999; UHR and GOODMAN, 1995; HAWBAKER *et al.*, 1997; TALLURY and GOODMAN, 1999). Furthermore, he has demonstrated with molecular markers that tropical germplasm is maintained in inbreds with partial tropical parentage, and that these alleles contribute to improved yield (LEWIS and GOODMAN, 2003; TARTER *et al.*, 2004).

Starting in 1990 with the release of NC296, a first-cycle inbred derived purely from tropical double-cross hybrids, he has released a steady stream of 2nd and 3rd-cycle pure-tropical lines. His inbred line development program continues today as one of the larger-scale and more important public maize breeding programs in the nation, with promising advanced lines continually moving through the program pipeline. Although documenting the use of public lines in commercial hybrids is difficult, we know that by the late 1990s, one line was being used in commercial hybrids in the U.S., Mexico, and India; a second was in use in the U.S. and Argentina; and a third one was being promoted by CIMMYT for worldwide use in subtropical areas.

The most important sources of tropical germplasm for Goodman's program have been elite tropical hybrids (GOODMAN, 1992). However, he also began a large-scale germplasm evaluation and incorporation program based on his set of 1,300 typical Latin American maize accessions. Beginning in the late 1960s, he was screening the accessions for general agronomic fitness in his winter nursery in Homestead, FL (GOODMAN, 1983). From these nursery evaluations, multiple stages of testing, starting first with accessions *per se* in short-daylength nurseries, and ending with yield trials of topcrosses of semiexotic inbreds resulting from a photoperiod conversion program (CASTILLO-GONZALEZ and GOODMAN, 1989; HOLLAND and GOODMAN, 1995; HOLLAND *et* *al*., 1996; TARTER *et al*., 2003; TARTER and HOLLAND, this issue). This program was conducted with minimal resources relative to commercial breeding programs, but demonstrated that with a long-term investment, the racial accessions can be tapped as valuable sources of germplasm. This program also served as a model for the Latin American Maize Project, described previously, and its successor program, the Germplasm Enhancement of Maize (GEM) Project.

The GEM project is another joint public-private program aimed at creating unique germplasm lines from crosses between superior tropical maize germplasm and elite proprietary lines that have been contributed by private company collaborators through F_1 crosses. Currently, Goodman leads the southern USA portion of the GEM program, developing and testing 50%-exotic lines that will hopefully contribute to a broadening of the genetic base of commercial maize in the USA. He has developed scores of high-yielding GEM lines to date, with a steady stream of improved germplasm in the pipeline of his program.

Dr. Goodman's impact extends to the commercial sector. International germplasm exchange within multinational breeding companies has expanded in part because of his many years of interaction with commercial plant breeders and his continuing reminders of the great potential of exotic germplasm to the private sector. Major's presentations at events such as the American Seed Trade Association and The Illinois Corn Breeders School have provided a commercial forum for his ideas and encouraged their adoption within private breeding programs. Every multinational breeding company now has an active program to encourage exchange of germplasm across international borders and many of these efforts have resulted in commercial products. Much of the initial commercial success resulted from the incorporation of U.S. Corn Belt Dent germplasm in places where it is an exotic. In recent years some of this germplasm has returned to the U.S., now improved with exotic germplasm, and has resulted in commercial products. This ping-pong approach to germplasm exchange shows great merit for the future of maize breeding and genetic diversity. Major's leadership has been critical to this effort by encouraging the use of exotics on principle, by training graduate students who now work at seed companies, and by demonstrating that performance does not have to be crucified on the altar of genetic diversity.

Service and awards

In addition to his intense research efforts, Goodman has also provided important service contributions to science and society. As mentioned previously, he served on several important germplasm committees, and specifically, these included the Rockefeller Foundation Maize Germplasm Committee (1972-75), USDA Maize Crop Advisory Committee (chair from 1981-86), Advisory Panel for USDA Maize Genetics Stock Center (chair, 1985-86), the U.S. Congress Office of Technology Assessment Panel on Biological Diversity (1985-86), and the National Academy of Sciences, National Research Council Panel on Global Genetic Resources (vice-chairman, 1986-1993). In addition, he served on USDA competitive grants panels, the Genetic Mechanisms Panel (1983-85) and as panel director for the Plant Genetics and Molecular Biology Panel (1987-88).

His list of awards is extensive, although the most prestigious was his election to the National Academy of Sciences in 1986. Other notable awards include election as a Fellow of the Crop Science Society of America (1986), the O. Max Gardner award (in 1987 as the member of the University of North Carolina system who has "made the greatest contribution to the welfare of the human race"), his appointment as William Neal Reynolds Professor and Distinguished University Professor (both in 1987) at North Carolina State University, the Frank N. Meyer Medal for work with plant genetic resources from the Crop Science Society of America (1999), and most recently, the Holladay Medal for Excellence for an outstanding career at North Carolina State University (2003).

Graduate and postdoctoral student training

To date, Major has mentored 4 M.S. students, 13 Ph.D. students, 8 post-docs, and 7 visiting scientists, and he currently has two graduate students. He rarely had more than two students at any one time, permitting each student great opportunity for one-on-one interactions with Major. These students have moved on and are active in both public and private research endeavors. All of them have a commitment to the need for increasing genetic diversity for the long-term sustainability of plant species and stable crop performance to feed an ever-increasing world population. In addition, he has mentored many graduate students working for other professors and has freely given time and resources to help them solve research problems.

Major never spent much time in the classroom teaching (he had formal responsibility for one class on multivariate statistics that he taught only once, and later claimed, in typical sardonic Goodman fashion, that the students knew more than he did about the subject). However, the students and post-docs who were lucky to be around him in the field or in the lab learned by questioning, listening, observing, and working alongside Major. Major is very open to discussing plant breeding, statistical, and genetics issues with his student and colleagues. He is very generous with his time, spending hours, if necessary, to explain matters, without ever making the "receiver" of the information feel inferior or ignorant. One often wonders how he can accomplish anything, given the steady stream of interruptions by his colleagues seeking him out for advice and counsel.

Goodman's students learn first-hand about his unwavering commitment to the hard work of running a maize research and breeding program - he is often the last to leave the maize nursery in the evening. After a long day of fieldwork, when we students and post-docs would be asleep, Major would work late into the night or the early morning analyzing data, developing planting lists for his next nursery, and reviewing dissertation drafts for students and manuscripts for colleagues.

Graduate students are never told in words that they need to work long hours, but they quickly learn from watching him that they need to be prepared to do whatever it takes to get the job done. Student workloads on Goodman's project tend to be heavy, and his students will likely always remember the twin discomforts of pollinating maize in the extreme heat and humidity of the North Carolina summer, on the one hand, and approaching hypothermia while searching for obscure seed stocks hidden in dark corners of his cold room, on the other. However, generations of students and post-docs have been motivated by witnessing Major's work ethic and commitment to maize germplasm. No one works harder than he in the nursery, preparing for planting, or analyzing data. Students and post-docs preparing nursery seed packets have also been surprised to receive chocolates or ice cream bars, flung at them by Major to keep their spirits up.

Students have learned from Major the importance of determination, patience, and careful observation of phenotypes. His patience in working with individual plants probably started in his isozyme days, when he carefully nursed sickly, pitifully weak transplants, many of which lacking functional enzymes at multiple loci; some lacking any tassels, or ear shoots - or both. Many others would have given up in futility at the prospect of dealing with isozyme stocks or adapting exotic germplasm, but Major's patience (and perhaps stubborness) kept pushing the work forward. His determination has also been displayed during his heroic attempts to recover useful data from hurricane-blasted yield trials (with a surprising rate of success). Students have also been struck by his ability to assimilate diverse sources of information and his incredible memory for pedigrees and phenotypes of maize lines. He often has detected mislabeled or contaminated seed lots with one look, without needing to compare them to known samples. He also has an uncanny ability to analyze data, and in general, his mathematical abilities are astounding. Numbers seem to talk to Major. He has been observed to pore over tables of raw or partially "massaged" data and, without resorting to a computer or even a hand calculator, unerringly extract latent critical patterns and results that later proved to be the most important findings. These characteristics together seem to have given him an edge in the art of plant breeding, and they are skills that cannot be taught from books, but may be learned by close experience with people like Major. Although students may have been puzzled by the ability of Major and Bill Hill to communicate almost exclusively with half-finished mumbled sentences, they often learned most by being given responsibility for managing nurseries and making selections, even when they had little prior experience.

Goodman's continuous dedication to speak out about the need to better manage and utilize maize germplasm at every opportunity also impressed his students. Like all research topics, the popularity of exotic maize germplasm work has gone up and down over the years. However, Major has never wavered and has kept the importance of exotic germplasm fresh in the minds of maize researchers. Again, this taught his students that with unwavering dedication, long-term goals are attainable and are more important than short-term achievements.

Major is also famous among his students and virtually anyone else he has interacted with for his sense of humor. He has a keen sense of irony and little patience for pretentiousness, and these traits may have gotten him in trouble at times. The people who have worked with and know Major, however, know that the more he likes someone, the more likely he is to give them a hard time. Moreover, we have all heard Major making sarcastic comments about his own research. His mantra of "good stuff" or "now, this one will save the world!" which he regularly repeats while harvesting his worst-looking inbred ears, has now been picked up by many former employees to apply to their own germplasm when it looks particularly poor. Many other examples could be given, but what students learned from this man of simple tastes (who, for example, will only wear a tie when forced) is to take their research seriously, but not to take themselves or others too seriously.

Despite his penchant for irony and his reputation for sometimes blunt criticism, Major ultimately demonstrates loyalty to, and a caring and giving relationship with, the people who work with him, patiently taking time, that he often does not have, for anything they need. Major and Sheila have both been very generous to his students in times of need; they go out of their way to help people. Moreover, they work hard to make foreign students and scholars feel welcome. They have picked up foreign students and visiting scientists at the airport in the middle of the night, collected household items for them, and helped them get their lives in Raleigh established as quickly as possible. After these students returned to their home countries, Major has often carried extra bags on his trips abroad to deliver belongings they have left behind. His experience in Brazil has made him aware of the challenges one faces when living in a foreign country.

His commitment to training international students has made an important impact on plant breeding research in many countries. He also has served on Ph.D. committees for students studying at the Colegio de Postgraduados in Mexico, and he regularly gives presentations in Latin America. His passion to transfer his knowledge of maize to others and to work for global cooperation in germplasm preservation and use is a key reason why his reputation is so strong internationally.

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