Coordinated Access to the Research and Extension System
Mississippi Agricultural and Forestry Experiment Station

Southern Cooperative Series Bulletin

September 1997 SCSB#386

Preservation and Utilization of Germplasm in Cotton 1981-1992

By Personnel Participating in Regional Research Project S-77

Southern Cooperative Series Bulletin #386
ISBN 1-58161-386-5

September 1997

Contact: Jack C. McCarty, Jr., Ph.D.
USDA - ARS, Mississippi State, MS
Phone: (662)323-2230
E-mail: jcm@ra.msstate.edu

Agencies and Personnel Participating in S-77

State	Personnel	Agency
Alabama	W.C. Johnson R.L. Shepherd A.J. Kappelman, Jr.	Agricultural Experiment Station (AES) U.S. Dept. of Agriculture/ Agricultural Research Service (USDA/ARS) USDA/ARS
Arizona	J.E. Endrizzi F.R.H. Katterman E.L. Turcotte C.V. Feaster R.G. Percy	AES AES USDA/ARS USDA/ARS USDA/ARS
Arkansas	B.A. Waddle N.P. Tugwell Wayne Smith J.M. Stewart	AES AES AES AES

Louisiana	J.E. Jones D.S. Calhoun	AES AES
Mississippi	R.R. Bridge F.M. Bourland V.G. Meyer J.N. Jenkins J.C. McCarty W.R. Meredith W.L. Parrott	AES AES AES USDA/ARS USDA/ARS USDA/ARS USDA/ARS
New Mexico	D.D. Davis N.M. Malm C. Hawkins J.R. Barrow	AES AES AES USDA/ARS
North Carolina	L.L. Phillips D.T. Bowman J.A. Lee	AES AES USDA/ARS
Oklahoma	L.M. Verhalen	AES
South Carolina	T.W. Culp C.C. Green O.L. May	USDA/ARS USDA/ARS USDA/ARS
Texas	D.W. Stelly G.A. Niles K.M. El-Zik D.W. Altman P.A. Fryxell A.E. Percival R.J. Kohel N.L. Trolinder J.E. Quisenberry	USDA/ARS USDA/ARS USDA/ARS USDA/ARS USDA/ARS USDA/ARS USDA/ARS USDA/ARS USDA/ARS

Project Coordinator:	R.J. Kohel D.W. Stelly	USDA/ARS Texas AES
Administrative Adviser:	Ken Tipton	Louisiana AES
CSRS Representative:	Preston Jones	

Table of Contents

Introduction

Cotton is important to the economy of the southern and southwestern states, and the problems with which it is faced are well known. Regional Project S-77 and its predecessor S-1 were instruments through which Federal and State workers maintained *Gossypium* germplasm and coordinated research on the genetics, cytogenetics, and taxonomy of cotton. The research was designed to provide basic knowledge about the cotton plant and about specific traits of importance in cotton production. A better understanding of the diversity existing in *Gossypium*, of the heritable systems of the plant, and the systematics of the genus were researched.

Progress under Regional Project S-77 and S-1 was summarized in Southern Cooperative Series Bulletin 47 which covered the period 1948-1955, Southern Cooperative Series Bulletin 139 which covered the period 1956-1967, and Southern Cooperative Series Bulletin 256 which covered the period 1968-1980. Each of these bulletins includes a comprehensive, annotated bibliography of the papers published by the members of the project for those respective periods. The present bulletin provides coverage from 1981-1992. Project S-77 was terminated in 1992 because its scope and objectives were considered too broad to meet the requirement for a Regional Project. Southern Regional Information Exchange Group - 61 (SRIEG - 61) was organized in 1993 and replaced many of the functions of S-77

Taxonomy

Knowledge of the taxonomy of *Gossypium* and its closely related genera (the tribe *Gossypieae*) has advanced in several ways since 1980 in the work done under S-77. Seven new species of *Gossypium* have been discovered and described and others have been reinstated or recognized anew from among the previously known diversity of the genus. The new species include one species from Mexico (*Gossypium schwendimanii*) and six species from the Kimberley region of northwestern Australia (*G. enthyle, G. exiguum, G. londonderriensis, G. marchantii, G. nobile, and G. rotundifolium*), where a center of evolutionary diversity exists, with 11 species currently known from this relatively limited area.

Allozyme analysis of a representative subset (153 accessions) of *G. barbadense* revealed geographic structure to the diversity within the species, a probable center of origin of the species in South America west of the Andes, probable patterns of diffusion, and evidence of introgression from *G. hirsutum*. Allozyme analysis did not support the recognition of infraspecific taxa such as var. braziliense. Greatest variability was noted in accessions collected in South America west of the Andes. Affinity among accessions of northeastern South America, the Caribbean, and Central America, and decreasing diversity in this series suggests a dispersal pathway from South America to Central America via the Caribbean. High variability in improved cultivars relative to regional variation was due in part to introgression from *G. hirsutum*. Little evidence of introgression was observed in regions of sympatry with *G. hirsutum*, leading to the speculation that introgression, where it persists, is largely due to human manipulation.

An allozyme study of the Galapagos Islands endemic *G. darwinii* revealed surprising diversity. Although morphological evidence supports the hypothesis of interbreeding of some native Galapagos cottons with *G. barbadense*, and although it emphatically does not support the hypothesis of *G. hirsutum* introgression, nevertheless allozyme analysis has detected introgression of putative *G. hirsutum* alleles into *G. darwinii*. Accessions possessing introgressant alleles cluster on islands or areas that have seen the highest levels of human activity. The retention of *G. darwinii* in specific rank is supported. This new information about the diversity of *Gossypium*, including new information about relationships among the species derived in part from molecular studies in other laboratories, has been brought together into a new taxonomic monograph of *Gossypium*. This treatment includes a key for the identification of specimens, complete descriptions of the species, references to illustrations and distribution maps, and a classificatory breakdown into subgenera, sections, and subsections. One new section and one new species (from Africa) are described. The total number of species in the genus is thus enlarged to 50. Work being done with related genera primarily concerns interactions of these plants (especially in the genus *Hampea*) with the boll weevil. This work is ongoing, and it is premature to draw any conclusions. However, it can be said that some species of *Hampea* serve as natural hosts to anthonomid weevils in southern Mexico, and some do not. What factors mediate this difference are not yet clear, nor is it yet known if these weevils are forms of *Anthonomus grandisor* distinct (but undescribed) species of *Anthonomus*. It is hoped that a fuller knowledge of evolutionary and ecological relations of the boll weevil (or its nearest relatives) to its host plants will lead to a better understanding of the life cycle of the insect and thus to improved means of controlling it in an agricultural context.

Cotton Germplasm

The 50+ presently recognized *Gossypium* species are listed in Table 1. J. O. Beasley established a cytological classification of genomes that is closely related to taxonomic affinities, and geographic distribution. However, in recent years opinions have been expressed for a reassessment of the present classifications within the genus. K. Vollesen has attempted to address this problem for the species native to Africa and the area of the Arabian Peninsula. However, it may be necessary to do this for the entire genus as recent explorations have uncovered new species and additional existing variability and relationships within species groupings. The present distribution of the species is as follows:

- A genome -two cultivated species from the Far East, Middle East, and Africa.
- B genome -eight wild species from Africa, and the Cape Verde Islands.
- C genome -16 wild species from Australia.
- D genome -13 wild species from Mexico, Peru, and the Galapagos Islands.
- E genome -four wild species from the Arabian peninsula and Northeast Africa.
- F genome -one wild species from East Central Africa
- G genome -one wild species from Australia.
- AD genome -five (two cultivated and three wild) species from Mexico, South America, the Hawaiian Islands, the Galapagos Islands, and Brazil (the cultivated two having recently attained worldwide distribution through cultivation).

Collection

The US National Cotton Germplasm Collection resides in the Crop Germplasm Research Unit, Southern Crops Research Laboratory, Southern Plains Area, Agricultural Research Service (ARS), United States Department of Agriculture (USDA), in cooperation with the Soil and Crop Sciences Department, Texas A&M University, College Station, Texas; and regional coordination of its activities has been under the auspices of the Technical Committee of Regional Research Project S-77. It is maintained as a working collection with permanent storage at the National Seed Storage Laboratory, Fort Collins, Colorado. The collection is part of the National Plant Germplasm System (NPGS) and, as part of this system, all aspects for the preservation and use of the data information and physical germplasm are coordinated through the Cotton Crop Germplasm Committee (CCGC). The CCGC functions as an advisory group to provide expert advice to individuals and organizations such as the National Plant Genetics Resources Board (NPGRB), the National Plant Germplasm Committee (NPGC), ARS, State Agricultural Experiment Stations (SAES), and others, on technical matters related to cotton germplasm, its breeding, and effective utilization. Information on accessions maintained, and the evaluation information of these, is accessible through the Germplasm Resources Information Network (GRIN) computer system which is part of the Data Base Management System (DBMS), a part of the Plant Genetics and Germplasm Institute, Beltsville, Maryland. The collection maintains seed accessions of varieties, primitive race stocks, wild species, of the allotetraploids, and accessions of the cultivated and wild diploid species.

TABLE 1. THE SPECIES OF GOSSYPIUM L.

Date described	Species	Genome group	Distribution
1763	*G. hirsutum* L.	AD	New World cultigen
1753	*G. barbadense* L.	AD	New World cultigen
1865	*G. tomentosum* Seem.	AD	US (Hawaii)
1907	*G. darwinii* Watt	AD	Galapagos Islands
1907	*G. mustelinum* Watt	AD	Brazil
1753	*G. herbaceum* L.	A	Old World cultigen
1753	*G. arboreum* L.	A	Old World cultigen
1860	*G. anomalum anomalum* Wawr. & Pevr.	B	Africa
1987	*G. anomalum senarense* Vollesen	B	Africa
1862	G. *triphyllum* (Harv. & Sond.) Hochr.	B	Africa
1950	*G. capitis-viridis* Mauer	B	Cape Verde Islands
1916	*G. benadirense* Mattei*	-	Africa
1987	*G. bricchettii* (Ulbri.) Vollesen*	-	Africa
1988	*G. trifurcatum* Vollesen*	-	Africa
1993	*G. vollesenii* Fryx.*	-	Africa
1958	*G. longicalyx* Hutch. & Lee	F	Africa
1863	*G. sturtianum* J. H. Willis	C	Australia
1875	*G. robinsonii* F. Muell.	C	Australia
1964	*G. nandewarense* (Derera) Fryx.	C	Australia
1858	*G. australe* F. Muell.	-	Australia
1863	*G. costulatum* Tod.*	-	Australia
1863	*G. populifolium* (Benth.) Tod.	-	Australia

1863	*G. cunninghamii* Tod.*	-	Australia
1923	*G. pulchellum* (C. A. Gard.) Fryx.*	-	Australia
1974	*G. pilosum* Fryx.*	-	Australia
1974	*G. nelsonii* Fryx.*	-	Australia
1992	*G. enthyle* Fryx.*	-	Australia
1992	*G. exiguum* Fryx.*	-	Australia
1992	*G. londonderriense* Fryx.*	-	Australia
1992	*G. marchantii* Fryx.*	-	Australia
1992	*G. nobile* Fryx.*	-	Australia
1992	*G. rotundifolium* Fryx.*	-	Australia
1910	*G. bickii* Prokh.	G	Australia
1824	*G. trilobum* (DC.) Skov.	D	Mexico
1853	*G. klotzschianum* Anderss.	D	Galapagos Islands
1854	*G. thurberi* Tod.	D	Mexico, US (Arizona)
1863	*G. sturtianum* J. H. Willis	C	Australia
1873	*G. davidsonii* Kell.	D	Mexico
1899	*G. harknessii* Brandg.	D	Mexico
1911	*G. aridum* (Rose & Standl.) Skov.	D	Mexico
1913	*G. gossypioides* (Ulbr.) Standl.	D	Mexico
1932	*G. raimondii* Ulbr.	D	Peru
1933	*G. armourianum* Kearn.	D	Mexico
1956	*G. lobatum* Gentry	D	Mexico
1972	*G. laxum* Phillips	D	Mexico
1978	*G. turneri* Fryx.	-	Mexico
1988	*G. schwendimanii* Fryx.	-	Mexico
1874	*G. stocksii* Mast. in Hook	E	Arabia
1895	*G. areysianum* (Defl.) Hutch.	E	Arabia
1904	*G. somalense* (Gurke) Hutch.	E	Arabia
1935	*G. incanum* (Schwartz) Hillc.	E	Arabia

*Not available in cultivation.

Source of the Collection

The collection presently maintains 5,500 seed accessions of the *Gossypium* spp. This material has been accumulated through the years and represents a significant accumulation of scientific capital from 76 countries and political jurisdictions. The material was obtained from planned explorations to various parts of the world, by donations from individual collectors, and by exchanges with other similar international collections, such as the Institut de Recherche du Coton et des Textiles Exotique, France; Central Institute for Cotton Research, India; Instituto Nacional de Investigaciones Agricolas, Mexico; Cotton Research Institute, Pakistan; Institute of Plant

Industry, former Soviet Union; Germplasm Resources Research Division, Peoples Republic of China; and others.

The collection makes available and preserves the broadest possible genetic base for cotton. It provides source material for basic studies in genetics, cytogenetics, taxonomy, and other disciplines, as well as applied studies in screening for resistance to pests and diseases, environmental stress, and in plant productivity. Seeds from the collection are available to cooperators for research studies of various kinds, within and outside of Regional Research Project S-77. However, activities that focus on maintenance and acquisition continue to be the primary objectives in order to preserve the natural variability of cotton as a resource for continued efforts to modify and improve cotton cultivars.

Plant Explorations

Cotton collecting expeditions have been taking place since the turn of the century. The early collections were for the most part to the purported center of variability of *G. hirsutum*, that is southern Mexico and Guatemala. These early expeditions were time consuming and difficult to arrange, because at that time there were only limited travel facilities in the areas explored. As interest in cotton germplasm collecting and preservation has increased, funding for this type of activity has become available, and today these collections are more easily arranged and carried out. Added interest in obtaining and preserving *Gossypium* germplasm has also increased the scope, not only of the geographic areas explored, but also of the material collected.

Several of the plant explorations that have taken place during the previous decade are reviewed to give the reader an idea of the scope of these operations, and to establish a more readily available record of where some of these species may be found. Funds for these expeditions were provided by USDA, ARS and the United Nations, FAO, IBPGR. The information cited was gleaned from the exploration reports of the participating individuals.

1. Simpson and Vreeland to Northern Peru, 1983

Beryl Simpson and James Vreeland, the University of Texas, Austin, had planned a botanical collection to Peru in the summer of 1983. Because they would be in the area where *G. raimondii* is endemic, and because this species was rumored to have become extinct since last being collected, these scientists were contracted to either verify the rumor or collect seeds of the species. Since herbarium collections of the species had been made in 1979 and 1980, it did not seem plausible that the species was extinct.

Collecting during the summer of 1983 was difficult because of the excessive and unseasonable rainfall and flooding of 1982-1983 caused by the climatic phenomenon known as "El Nino." The roads in this part of the world were severely damaged, and many roads following rivers into the Andes were impassable. Nevertheless, they were able to visit known localities of *G. raimondii*, plus most localities illustrated in Boza and Madoo (1941) but from which specimens had never been collected, and several apparently previously unexplored neighboring areas.

The first sightings of *G. raimondii* were from the Pan American Highway where it crosses the Chicama River.

These plants, growing on the south bank of the river, were presumably in the same locale as reported by Phillips and Stephens in their technical report of 1966. From this highway westward along the old road to Cartavio, they found several patches of plants. The plant population exhibited variable age distribution. After working the lower Chicama, where they also found several populations of *G. barbadense*, they traveled from Casca NNW toward Santa Ana. Passing the crest separating the drainage of the Cascas and Santa Ana Rivers, they encountered extensive populations of *G. raimondii* in a region called Pampa Larga (ca. 950 m elevation). Hundreds of plants were seen growing along the valley and continued along the rocky rubble of the Santa Ana River. Descending to 800 m they also found a large population in the Santa Ana Valley. Plants became sparse as the elevation decreased. Short excursions were made up the Cupinsque River. Because elevations were never reached above 300 m, no evidence of *G. raimondii* was seen. Traveling to the Huertas River Valley, they found *G. raimondii*, with populations observed on both sides of the road, starting about 1 km south of Chilete and ending before the town of Huerta. A trip up the Zana River Valley proved fruitless. In the Department of Cajamarca in the Province of Hualgayoc, *G. raimondii* had been previously collected. Nanchoc, a small village that lies along the Zana River, was reached with the aid of a helicopter provided by the Peruvian Military. No *G. raimondii* was found, and their report indicates that the habitat is such that it is unlikely to grow in the immediate vicinity.

2. Stewart, Craven, and Fryxell to Australia, 1983

This expedition to western Australia, conducted by James McD. Stewart, Lyn A. Craven, and Paul A. Fryxell, was a collaborative project supported by USDA through ARS and the National Plant Germplasm Unit, and by the Commonwealth Scientific and Industrial Research Organization (CSIRO) through the Australian National Herbarium. The timing of the trip was set to correspond to the usual period when the *Gossypium* species of the area have matured some capsules but the plants have not desiccated. The primary purpose of this trip was to document, as far as possible, the extent of variation within and among *Gossypium* species of the region and to obtain seeds representative of that diversity for the US Germplasm Collection.

Seed of *G. hirsutum, G. australe, G. cunninghamii, G. pilosum, G. populifolium,* and *G. pulchellum* were collected during this expedition. It was apparent to the participants that there is extensive diversity in the wet-dry tropics of Australia. The diversity has only begun to be measured because the remoteness of the area makes the logistics of collecting difficult. A previous trip to the area by Stewart suggested that the diversity of the cotton genus was greater in the Kimberley Region of Australia than was previously realized. Collections made on this trip confirmed that the taxonomic understanding of the *Gossypium* of the area is not complete. Specimens taken at 10 km intervals along the length of the Mitchell Plateau will be useful in deciphering an apparent cline that occurs there. The *Gossypium* collections north of the Carson River are distinctive and may represent undescribed species. However, the specimens do have similarities to known taxa and will require detailed study to determine their taxonomic position. At the very least, they represent previously unknown variation that will require accommodation in current species descriptions. The location of *G. cunninghamii* in the Northern Territory of Australia appears disjunct from the species of the Kimberley to which it is related. Quite likely, additional *Gossypium* diversity will be discovered in these areas once they are penetrated by botanists, as was the case for the Kimberley where each new area visited yielded something different.

3. Schwendiman, Ano, and Percival to Ecuador, 1983

Jacques Schwendiman and George Ano of the Institut de Recherches du Coton et des Textiles Exotiques (IRCT), France; and A. Edward Percival (USDA, ARS), USA, participated in a collecting expedition to Ecuador, including the Galapagos Islands, which was supported by the UN, FAO, IBPGR. They were joined by Andres Brando of the Instituto Nacional de Investigaciones Agropecuarias (INIAP), Ecuador, for part of the collecting.

The first phase was collecting in continental Ecuador, and began with the intent to travel from Quito south to Puyo in Pastaza Province. This travel was not possible as the road leading there was temporarily blocked by landslides, due to the unseasonable weather mentioned above. The participants then headed straight south to Azuay and Loja Provinces, where the first cotton was collected in Loja. From southern Loja, travel was northwest to El Oro, then north to Guayas, Los Rios, and Manabi Provinces. In Loja, El Oro and Manabi, with few exceptions, only dooryard *G. barbadense* was collected. However, in Guayas, and Los Rios, large populations of endemic wild *G. barbadense* were found. One of the main problems encountered in all of the areas explored was that much of the cotton was not open. It was apparent that the unseasonable rains had greatly delayed boll maturity.

On the Galapagos Islands, *G. barbadense* was found on San Cristobal. *G. darwinii* was found on Santa Cruz, Eden off of Santa Cruz, Floreana, Espanola, Gardner off of Hood, San Cristobal and Rabida. *G. klotzschianum* was found on Santa Cruz and San Cristobal, and as previously reported, it was found growing intermingled with *G. darwinii* in extensive populations of both species.

The accessions collected have added to the germplasm diversity of the collections represented, and the large number of accessions collected from the Galapagos Islands should aid in clarifying questions that have been raised concerning the elevation of *G. darwinii* to a species level.

4. Fryxell and Burandt to Venezuela, 1984

Paul A. Fryxell (USDA, ARS) and Charles L. Burandt (Texas A&M Univ.) undertook this collection from January to February. A rough itinerary of the route followed was Maracaibo, Coro, Maracay, Barquisimeto, Guanare, Merida, Caracas, and back to Barquisimeto and Maracaibo.

Collections of cotton seeds were made in natural vegetation, on roadsides, and in dooryards, from sea level to as high as 1,800 m elevation. Most of the samples collected were of *G. hirsutum*, but two dooryard *G. barbadenses* were also found. Considerable variability was found among the collections of *G. hirsutum*. Many samples were collected opportunistically as they were encountered; others were specifically sought out on the basis of prior information, especially the wild cottons occurring in natural vegetation, sometimes in remote places along the northern coast.

The cottons collected were found to be in all stages of development. A few were in full foliage and in early stages of flowering with no mature fruits. Others were still flowering but with both green and open bolls, while still others were past flowering. Some plants were merely dry sticks lacking any foliage but with a mature crop of open bolls. The wild cottons observed in natural vegetation formed large but locally restricted populations. There was often one or a few parent plants of apparent great age in each population. Some of the cottons exhibited characteristics (e.g. short brown fiber, small flowers, and fruit) that set them apart from the dooryard and roadside cottons. In the opinion of the collectors, these wild cottons are an indigenous part of the vegetation and not escapes from cultivation.

5. Percival and Stewart to Southern Mexico, 1984

This cotton collection by A. E. Percival and J. McD. Stewart (USDA, ARS), during the month of September, was a collaborative project with the Secretaria de Agricultura y Recursos Hidraulicos, Instituto Nacional de Investigaciones Agricolas (SARH, INIA), Mexico, represented by Arturo Hernandez and Fernando de Leon. The rough itinerary followed was: Brownsville, Texas, south through the States of Tamaulipas and Veracruz, east to Tabasco, northeast and around the Yucatan Peninsula to Chetumal, Quintana Roo, south through Chiapas, west to the Isthmus of Tehuantepec, and back north to Texas.

Seeds were collected of dooryard (one atypical) and wild strains of *G. hirsutum*, one *G. barbadense*, and one *G*. cf. *aridum*. The only truly wild *G. hirsutum* cottons collected were *G. hirsutum* var. *yucatanense*, from the northern coast of Yucatan. The distribution, growth habit, and morphology clearly indicated that these are wild and well adapted to the ecological niche where they were found. Interestingly, no dooryard cottons could be classified *yucatanense*. Likewise, the majority of feral cottons were associated with human settlement and were of types similar to the dooryard cottons.

As important as the sites where cottons were found, were the observations in areas where cotton was not found. It is the classic story of germplasm loss. The town of Acala, Chiapas and the valley where it is located was specifically visited because it was the site of collections of the original germplasm that gave rise to the outstanding Acala cultivars. They found no cotton there, or at any locations near the road that runs along the length of the valley. One individual in Acala related that promoters from Tapachula, Chiapas tried to establish commercial cotton production in the area. When insects became a problem, the promoters recommended that all native cotton plants be destroyed to better control the insects. The commercial venture subsequently failed, and the collectors found no cotton being grown there today.

6. Stewart, Craven, and Fryxell to Australia, 1985

As with the 1983 expedition to Australia, the participants were James McD. Stewart, Paul A. Fryxell (USDA, ARS) from the USA, and Lyn Craven from Australia (Australian National Herbarium, CSIRO). This exploration was based on funding from IBPGR, USDA, and CSIRO.

This plant exploration to central, northern, and northwestern Australia collected samples of most of the 12 currently recognized taxa from Australia and eight additional *Gossypium* variants. These findings have provided new germplasm for study and exploitation, and also made plain the need for taxonomic re-interpretation of the Kimberley cottons. This exploration significantly extended our knowledge of the geographic range of the Australian wild cottons and their range of variation, as was the case with the 1983 collection.

The collectors found that in the arid zone of Central Australia, *G. nelsonii* occurs sympatrically with three other species of *Gossypium*, including *G. australe*, with which some workers confuse it. It was established that the species are indeed distinct in the field and that *G. nelsonii* occurs over a much wider geographical area than the one site previously reported. The wild Kimberley cottons had previously been allocated to five species: *G. costulatum, G. populifolium, G. pilosum, G. pulchellum, and G. cunninghamii*. Moreover, they previously were thought to have relatively isolated distributions within the region. It is clear from the results of this collection that this is not an adequate representation of the actual situation, and the descriptions of six new species resulting from this exploration are currently in preparation by the individuals named. In the Kimberley region, *Gossypium* was found to be far more widespread, abundant, and more variable than previously recognized. An exception is *G. cunninghamii*, which occurs on the Cobourg Peninsula, outside the Kimberley, and thus is isolated from the others. However, even this species was found to be more widespread and abundant than previously known.

The climate where these species are found is tropical with alternating wet-dry seasons, and the plants are long-lived perennials that have adapted to a fire-mediated ecology by regrowing annual stems from woody rootstocks. In the absence of fire for one or more years, the stems occasionally survive the dry season and persist, especially in the erect-growing type of plants. The sample of variability among the many populations sampled appeared to be complex, with the morphological characters recombining in various ways. It seems clear that this group of wild cottons is in an early and active stage of speciation. Thus, this exploration provided materials to begin an analysis that will lead to a more satisfactory interpretation of the variability and the recognition of newly discovered species.

7. Schwendiman, Percival, and Belot to the Caribbean, 1985

This exploration, financed by IBPGR, included the same IRCT and USDA, ARS personnel of the 1983 exploration to Ecuador mentioned previously. It was conducted from the last of February to the first of April and included the following localities listed in the order collected. Trinidad and Tobago; Curacao, Bonaire and Aruba (Netherlands Antilles); Jamaica; Grand Cayman (British West Indies); South Florida (USA); The Dominican Republic; and Puerto Rico. The period for collecting seeds was optimal, as with few exceptions the cotton found was in the late flowering, open mature boll stage.

Accessions of dooryard, feral, and wild *G. hirsutum* and dooryard *G. barbadense* were collected. The distribution, growth habit, and morphology of the wild cottons indicated that they are truly wild and adapted to the ecological niches where they were found. Wild types were found on Curacao, Bonaire, Jamaica, South Florida, the Dominican Republic, and Puerto Rico. The feral and dooryard types were found on all the islands and in Florida, and they were associated with human settlements or disturbances.

With the exception of those populations that appeared to be of a truly wild nature on the islands of Curacao and Bonaire, the cottons found appeared to be plentiful and in no danger of being eliminated. However, the one wild population on Curacao and the one on Bonaire could be lost due to developments in the areas where they are established.

8. Percival and Wilson to the Galapagos Islands, 1985

This exploration by A. E. Percival and F. D. Wilson (USDA, ARS) was conducted to collect the western and northern islands of the Archipelago that had not been collected during the 1983 expedition to the these islands. This collection was a collaborative project with Instituto Nacional de Investigaciones Agropecuarias (INIAP), Ecuador, which was represented on the exploration by Gelasio Basante.

The following islands were collected and explored during September: Santa Cruz (Indefatigable) -- Puerto Ayora, road from Las Gemelas to Baltra crossing and Turtle Beach; Marchena (Bindloe) -- Black Beach and Point Mejia; Pinta (Abingdon) -- Cape Chalmers, and north of Cape Chalmers; Isabela (Albemarle) -- Point Vincente Roca, Banks Bay, Black Cove, Tagus Cove, Urvina Bay, Elizabeth Bay, Iguana Cove, San Pedro Cove, and the road Villamil to Santo Thomas; and Fernandina (Narborough) -- two locations between Point Espinosa and Cape Douglas. *Gossypium darwinii* was collected from Santa Cruz, Marchena, and Isabela, and *G. klotzschianum* was collected from Santa Cruz and Isabela. The *G. klotzschianum* collected from Isabela was unique, as it had not been found on this island during previous expeditions. It was found at two locations, and in each case only a few small plants were seen growing and only a few seeds were gathered. It was not possible to determine if there might be other larger populations of the species on this island or whether the few plants growing resulted from being recently introduced.

9. Percival and Stewart to Brazil, 1988

This USDA, ARS funded exploration by A. E. Percival and J. McD. Stewart to northeast Brazil during the month of September was a collaborative project with the Centro Nacional de Recursos Geneticos, Empresa Brasileira de Pesquisa Agropecuaria (CENARGEN, EMBRAPA), Brazil. Antonio Miranda, Jose de Alencar, and Elusio Freire represented EMBRAPA. The area collected involved portions of the states of Bahia, Ceara, Pernambuco, Piaui, and Rio Grande do Norte. With the exception of a small area on the northern coast around Touros, Rio Grande do Norte, all of the area collected is a tropical semiarid region with a wet-dry season.

Seeds of *G. hirsutum, G. mustelinum*, and *G. barbadense* were collected. The endemic allotetraploid wild species *G. mustelinum* was collected at four sites from where it had previously been reported (Pickersgill et al., 1975), and from two new sites. Except for variation in the ages of some of the plants at each site, little morphological variation was noted, and all of the sites were next to or near water drainage areas, indicating that the species has adapted to take maximum advantage of the limited rainfall of the area.

It may have been indeed fortunate that this collection was made possible at this time. The area collected is an area almost exclusively devoted to the production of "Moco" type cotton, with limited corporate production. Moco cotton (*G. hirsutum* var. *marie-galante*) is morphologically variable, and has characteristics suggesting introgression from *G. barbadense* and *G. mustelinum*. Moco is grown as a perennial and plants are ratooned each season. Once fields are established, planting involves only replacement of plants that may have died. Moco growers are largely small farmers that grow the crop with limited, or no, technical agricultural input. Many of the fields are established on rocky hillsides, almost exclusively adaptable to a crop such as Moco cotton, which can survive the dry season, and where the plants can become established among the rocks and boulders.

There are native insect pests, such as boll worms, that damage the crop, but not to the extent that it was not economical to grow. However, with the invasion to the area in 1985 by the boll weevil (*Anthonomous grandis* Boheman), production in parts of the area has been so reduced that it is no longer economical to harvest what little crop is produced. Breeding schemes were underway by EMBRAPA personnel to reduce the impact of this insect. Some of these involve developing early and/or resistant Moco type cultivars. Given the environmental conditions and sedentary nature of agricultural practices of cotton production in the area, it remains to be seen whether or not this will succeed. Regardless of the outcome of the breeding efforts to produce boll weevil-resistant and adapted varieties, the germplasm base of the material presently grown will change in the not-too-distant future. Moco cotton will either be eradicated in part or all of the area, or adaptable varieties will be successfully produced with introduced germplasm from other *G. hirsutum* types. In either case, this will permanently alter the present Moco germplasm base of the area. It is satisfying to note that this collection secured representative cotton germplasm from this area of the world. Some of this material may in future prove valuable as it appears to be variable for many lint quality and agronomic characters.

10. Percival and Stewart to Northwest Mexico, 1990

This collection was a collaborative project between USDA, ARS; The University of Arkansas; and Secretaria de Agricultura y Recursos Hidraulicos (SARH), Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP), Mexico. Lorenzo Perez Solis and Enrique A. Garcia Castaneda represented INIFAP.

This collecting expedition to northwest Mexico was from mid-November to mid-December and covered parts of the states of Baja California Norte, Baja California Sur, Sonora, and Sinaloa. With the exception of portions of the state of Sinaloa, the areas explored were semiarid regions. Most of the areas visited have a wet-dry season, with precipitation of about 400 mm per year, and the coastal area of Sinaloa ranging to about 1,000 mm. The distribution of this rainfall can be variable within areas and from year to year.

Seeds of *Gossypium turneri* were collected in Sonora, in the area of San Carlos above the city of Guaymas. *G. thurberi* was also collected in this state southeast of the town of Magdalena. *G. armourianum* was collected only on San Marcos Island in the Gulf of California. *G. davidsonii* and *G. harknessii* were collected in Baja California Sur. No seeds of *G. aridum* were collected as the period of mid December was early. Plants of this species were found in abundance, but they were only beginning to bloom.

Maintenance

All of the accessions maintained in the collection are increased by self pollination at several locations.

The U.S. Department of Agriculture and the National Cotton Council, in cooperation with the Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP), Mexico, maintains a Cotton Winter Nursery at Tecoman, Colima, Mexico. This nursery was moved to its present location from Iguala Guerrero, Mexico, where it had been in operation since 1950. This operation is located at a sufficiently southern latitude to make it satisfactory to grow accessions in the collection that are photoperiodic. This off season facility allows geneticist and breeders to grow an average of three generations every two years more efficiently, and at less coast, than if they did this in a greenhouse during the winter months.

The non-photoperiodic varieties and stocks are increased at Weslaco, Texas. This location is maintained as it is proximal to the Mexican border, and from where other users of the Cotton Winter Nursery are able to send materials for seed increase during the off-season.

The wild species, most of which are also photoperiodic, are increased in greenhouses at College Station, and Weslaco, Texas. Most of these accessions have unique growing requirements that can only be duplicated in a greenhouse.

Distribution

Previous to 1985 seed stocks of cotton accessions maintained were distributed, for the most part, from in house available seed at various locations, or from the stocks kept at the National Seed Storage Laboratory. The permanent funding for the maintenance of The National Gossypium (Cotton) Collection at College Station, Texas, was secured in 1985. Since July of 1987 the collection has distributed seed of 9,691 of the accessions maintained. Request for seed has spanned the spectrum of uses from ornamental to biotechnology, with most coming from geneticist and breeders for crop improvement.

Evaluations

A primary purpose of maintaining a germplasm collection is to evaluate the accessions. Evaluations for agronomic characteristics are routinely conducted as this material is increased. However, specific evaluations can only be accomplished with the cooperation of the researchers in the various disciplines that screen this material seeking specific traits. Specific traits can and have been transferred.

Wild and Diploid Germplasm. Nonfiber-producing cottons include most of the wild diploid species of *Gossypium*. Seeds of some of these species have hairs, but none bear usable or spinabe fiber. The seed hairs that may be present are too short and too firmly attached to the seed to be of any potential utility. Being diploids, these species are also too distantly related to cultivated allotetraploid cotton to be directly useful in conventional breeding programs. The fiber-producing cultivated Asiatic diploids also fall into this category. Nevertheless, they are potential sources of useful genes that have been, and can be, transferred to cultivated tetraploid cottons using special techniques.

Wild and Allotetraploid Germplasm. The fiber-producing cottons include the two cultivated allotetraploid species *G. hirsutum* and *G. barbadense*. The other three allotetraploid species that are a potential source of germplasm are the wild *G. tomentosum*, *G. darwinii*, and *G. mustelinum*. The cultivated species have a wide range of variability in terms of cultivars, strains, feral types, and genetic mutants, followed by *G. darwinii*, which has less variability, limited to its geographic distribution on each of the Galapagos Islands. The other two species, *G. tomentosum* and *G. mustelinum*, have little observed variability, probably because few accessions of these have been collected, and because they have only been found in limited geographic locations. The transference of desirable characters between the allotetraploids is more straightforward, but it is also difficult. Hybrids between the allotetraploids break down in the F_2 generation. The viable offspring tend to assimilate back to each of the two parent types, and the true recombinants are weak or unable to survive; thus, large populations are required in order to transfer the desired character.

Germplasm Utilization. The introduction of desirable germplasm into agronomically acceptable cotton cultivars is an ongoing and dynamic enterprise in most cotton breeding programs. However, the transfer of desirable characters from exotic intraspecific and interspecific sources, though continuous, has primarily been done in state and federal breeding programs. Some examples of this are as follows:

Cotton varieties that are hairy impart resistance to insects such as the jassids (*Empoasca* spp.), which are important pests in Africa and parts of Asia. The presence in the plant of the single major gene T_1 is responsible for this desired phenotype. Conversely, the single major gene T_1^{sm} controls the smoothleaf character and would be beneficial to have in varieties where dense pubescence is not desirable. Varieties with smooth leaf characteristics help control insects that require plant hairs for egg laying.

Okra leaf shape is conditioned by the gene L_2^o and is desirable in areas that have relatively high humid conditions as harvesting is approached. This leaf type has been found to reduce losses from boll rot organisms, and effects earlier maturity due to a more open plant canopy in varieties that have this leaf characteristic.

Varying degrees of pest resistance and/or plant modification have been obtained using other monogenic inherited characters such as red plant color, bract genes, nectariless genes, leaf-shape genes, dwarf genes etc., and polygenic characters which control plant allelochemistry, fiber properties, water-use efficiency, nematode resistance, boll types, etc. A few examples of these are as follows:

Bollworm/Tobacco Budworm Resistance. Numerous morphological traits have been determined to confer significant levels of resistance to the bollworm (*Helicoverpa zea*, Boddie)/tobacco budworm (*Heliothis virescens*, F.) complex (BW/TBW). Breeding work at the Louisiana Agricultural Experiment Station has been aimed at combining several of these resistance traits with high lint yield and acceptable fiber quality. Experimental strains, LA 850074 and LA 850075, are frego bract, smooth leaf, and their flower buds (including calyx lobes) have a high frequency of gossypol glands (HG). LA 850082 is frego bract and smooth leaf. LA 870210 and LA 870222 are HG. All five strains have suffered significantly less BW/TBW damage than commercial check varieties in the field, and have produced lint yields that are competitive with commercial varieties in numerous tests. All except LA 850082 also have acceptable fiber quality.

Boll Weevil Resistance in Converted Races Stocks. Nine race-stock-derived, day-neutral strains were compared with the boll-weevil-susceptible cultivars, Stoneville 213 and Deltapine 41, and the resistant frego-nectariless breeding line, La.81-560FN, for relative field resistance to boll weevil and for anther number and mass per flower. Field resistance was confirmed in four strains (MT 109, MT 330, MT 763, and MT 1180) and identified for the first time in MT 323 and T 1219. The race-stock-derived strains had as many or more anthers per flower, but less than or equally as much anther mass per flower as the checks. All race-stock-derived strains were late and unproductive, but they provide sources of boll weevil resistance that should be used in cultivar development.

Race Stock Conversion

The utilization of the primitive race stocks has been limited because most require short days to initiate flowering and produce fruit. A program has been in progress for a number of years to incorporate day-neutral genes in the primitive race stocks.

The program involves crossing short-day race stocks with a day-neutral donor line (commercial Delta-type cotton) at the Cotton Winter Nursery located at Tecoman, Colima, Mexico. The F_1 generation is self-pollinated at the Winter Nursery and the F_2 generation is grown at Mississippi State University where segregation for flowering response occurs. Large populations (about 1,000 plants) are grown because the number of factors controlling the short-day flowering habit is not known and varies among the race stocks. Equal numbers of open-pollinated bolls are harvested from each plant that sets fruit, and the seed are bulked for each population. These F_3 seeds are increased for release and for research purposes.

One plant that sets fruit at a low node and continues to fruit is selected from the F_2 population. The F_3 progeny from this plant are backcrossed to the race stock.

The same procedure is followed for each backcross and is repeated for about four backcross cycles. The day-neutral donor parent is used as the female in all subsequent crosses. This permits the backcrossed material to be in an Upland cytoplasm during the conversion.

In the ongoing conversion program, day-neutral selections have been made in more than 1,000 F_2 populations. These represent more than 600 different race stock accessions. More than 300 of these accessions have been classified to race. Of the remaining accessions, about one-third have been classified as race *latifolium*. From 1-40 accessions from the other 6 races are in the conversion program.

Germplasm releases involving more than 500 day-neutral lines have been made from this program. Seventy-nine of these have been backcrossed four times to the race stock accessions. Seed of the day-neutral lines have been supplied to commercial breeders and public research scientists in the United States.

The converted race stocks should be useful for the diverse germplasm they contain. The day-neutral lines can be exploited by researchers in search of new traits and they can be used to expand the genetic base of cotton.

Germplasm Releases

A major aspect of germplasm development and utilization concerns the formal release of breeding and commercial varieties at advanced stages of development. These stocks or varieties have particular characteristics and/or traits that are genetically stable, and of which larger amounts of seed are made available. The following releases have been made by individuals or programs that actively participated in S-77:

Culp, T. W. 1981. Registration of Pee Dee 4548 germplasm line of cotton. Crop Sci. 21:992

Culp, T. W. 1984. 'PD-1,' a new cultivar with improved fiber strength, was released as a replacement for 'SC-1,' the first cultivar with extra-fiber strength genes from triple-hybrid origin that produced yield equal to commercial cultivars. The major advantages of PD-1 over SC-1 are higher yield, stronger fiber, and greater resistance to the fusarium wilt-rootknot nematode complex. PD-1 has higher lint percentage, smaller bolls, smaller seed, stronger and coarser fiber, lower elongation, and higher yarn strength.

Culp, T. W. 1984. Seven germplasm with high-yield potential and improved fiber quality were released. Preliminary data suggest that a higher level of fiber strength has been reached through intermating and selecting but without a decrease in yield. The seven lines possess fiber properties that are beneficial to the textile industry.

Culp, T. W., R. F. Moore, and J. B. Pitner. 1984. Simultaneous improvement of lint yield and fiber strength in cotton. South Carolina Agr. Exp. Stn. Tech. Bull. 1090.

Culp, T. W., R. F. Moore, and J. B. Pitner. 1985. Registration of PD-1 cotton. Crop Sci. 25:198.

Culp, T. W., R. F. Moore, and J. B. Pitner. 1985. Registration of seven germplasm lines of cotton. Crop Sci. 25:201-202.

Culp, T. W. 1986. PD 6208, a germplasm line with high yield potential and fiber strength approaching the level of 'Acala SJC-1,' has been accepted for release as a commercial cultivar ('PD-3') for production in the Southeast.

Culp, T. W., R. F. Moore, L. H. Harvey, and J. B. Pitner. 1988. Registration of 'PD-3' cotton. Crop Sci. 28:190

Feaster, Carl V. and E. L. Turcotte. 1983. Notice to growers relative to release of a commercial variety of American Pima cotton, 'Pima S-6.' USDA, and Ariz., New Mex., and Tex. Agric. Exp. Stn. Memo. 3 p. and Registration of Pima S-6 cotton. (Reg. No. 81). Crop Sci. 24:382. 1984
Pima S-6 was released as a replacement for 'Pima S-5' in a major portion of the Pima cotton belt. The advantages of Pima S-6 are earlier maturity and higher yield.

Jenkins, J. N., J. C. McCarty, Jr., J. Fallieri, and J. F. Mahill. 1983. Release of 15 doubled haploid germplasm lines of Upland cotton with *Gossypium hirsutum* L. nuclear genes in *G. barbadense* L. cytoplasm. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp. and 1984 Crop Sci. 24:624-625.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., and W. H. White. 1983. Notice of release of MHR-1, a germplasm line of cotton with resistance to *Heliothis virescens* (F.). USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 5 pp. and 1984 Crop Sci. 24:625-626.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., and R. L. Shepherd. 1987. Notice of release of three noncommercial germplasms of Upland cotton tolerant to tobacco budworm. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and 1988 Crop Sci. 28:869.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., and R. L. Shepherd. 1987. Notice of release of two noncommercial germplasms of Upland cotton tolerant to tobacco budworm. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and 1988 Crop Sci. 28:870.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., and R. L. Shepherd. 1987. Notice of release of three noncommercial germplasms of Upland cotton tolerant to tobacco budworm and the tarnished plant bug. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and 1988 Crop Sci. 28:869-870.

Jones, J. E., J. I. Dickson, W. Aguillard, W. D. Caldwell, S. H. Moore, R. L. Hutchinson, and R. L. Rogers. 1991. Registration of 'LA 887' Cotton. Crop Sci. 31:1701.
'LA 887,' tested experimentally as LA 830887, was developed from a cross of LA 434-RKR x DES 11-9. LA

434-RKR is an experimental strain with superior fiber quality and resistance to root-knot nematode (RKN). DES 11-9 is an experimental strain obtained from R.R. Bridge, Delta Branch Experiment Station, Stoneville, MS. A selection (DES 11913) from DES 11-9 was subsequently released as 'DES 119.' LA 887 is characterized by premium fiber quality, resistance to the RKN/fusarium wilt complex, and high yield potential.

Jones, J. E., J. P. Beasley, J. I. Dickson, and W. D. Caldwell. 1988. Registration of four cotton germplasm lines with resistance to reniform and root-knot nematodes. Crop Sci. 28:199-200.
Lines included La. RN 4-4, La. RN 909, La. RN 910, and La. RN 1032. All were selections from LA 434-RKR. LA 434-RKR originated from a cross of Bayou 7769 x 'Deltapine 16'. Bayou 7769 is resistant to root-knot nematode (RKN) and was developed from a crossof 'Deltapine 15' x 'Clevewilt-6'. The germplasm lines were evaluated for nematode resistance in the greenhouse in RKN and reniform nematode (RN) infested soil, and in the field on natural RN-infested soil at Baton Rouge, LA.

Jones, J. E., J. I. Dickson, E. Burris, D. F. Clower, W. D. Caldwell, J. G. Marshall, and S. J. Stringer. 1988. Registration of three insect resistant cotton germplasm lines. Crop Sci. 28:200.
Lines included La. HG-063, La. HG-065, and La. HG-660 which combine resistance to bollworm/tobacco budworm (BW/TBW) with early maturity, good yielding ability, acceptable fiber quality, and reduced pubescence. BW/TBW resistance is attributed to a high frequency of normal-size gossypol glands (HG) located over the calyx (including lobes), ovary wall, and other plant parts. The lines were developed from a cross between two HG lines, La. HG 83-1-1546 x La. HG 1838-1497. The two parents were selected from an intercross population involving Louisiana advanced breeding lines, 'Stoneville 213,' and GT5A-10-15-2XG15. The strain, GT5A-10-15-2XG15, obtained from M. J. Lukefahr, was the original source of the HG trait.

Mahill, J. F., J. N. Jenkins, and J. C. McCarty, Jr. 1982. Notice of release of a semigametic breeding line of cotton (*Gossypium* spp.) involving the *G. harknessii* Brandag. species cytoplasm with male sterility. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp. and 1983 Crop Sci. 23:403-404.

Mahill, J. F., J. N. Jenkins, and J. C. McCarty, Jr. 1982. Notice of release of a semigametic breeding line of cotton (*Gossypium* spp.) involving cytoplasm of tetraploid species *G. hirsutum* L., *G. tomentosum* Seems, and *G. barbadense* L. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp. and 1983 Crop Sci. 23:403-404.

Mahill, J. F., J. N. Jenkins, and J. C. McCarty, Jr. 1982. Notice of release of four semigametic germplasm breeding lines of cotton (*Gossypium* spp.) involving cytoplasm of diploid species *G. herbaceum* L., *G. arboreum* L., *G. anomalum* Wawr. and Peyr., and *G. longicalyx* Hutch. and Lee. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp. and 1983 Crop Sci. 23:403-404.

Mahill, J. F., J. N. Jenkins, J. C. McCarty, Jr., and W. L. Parrott. 1983. Notice of release of four doubled haploid lines of cotton, *Gossypium hirsutum* L., with resistance to the tobacco budworm, *Heliothis virescens* (F.). USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 8 pp. and 1984 Crop Sci. 24:625.

McCarty, J. C. Jr., J. N. Jenkins, and W. L. Parrott. 1981. Germplasm release of 23 BC_2F_4 and 33 BC_1F_4 noncommercial flowering lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. Miss. Agric. and Forestry Exp. Stn. Res. Report 6(17). 4 pp.

McCarty, J. C. Jr., J. N. Jenkins, and W. L. Parrott. 1982. Germplasm release of 6 BfC_2F_4 and 66 BC_1F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. Miss. Agric. and Forestry Exp. Stn. Res. Report 7(16). 2 pp.

McCarty, J. C. Jr., J. N. Jenkins, and W. L. Parrott. 1983. Germplasm release of 54 BC_2F_4 and 5 BC_1F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo.5 pp. and 1984 MAFES Res. Report 8(15). 3 pp.

McCarty, J. C. Jr., J. N. Jenkins, and W. L. Parrott. 1985. Notice of release of two germplasm lines of cotton with resistance to the boll weevil, Anthonomus Grandis Boh. USDA and USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and Crop Sci. 26:1088.

McCarty, J. C. Jr., J. N. Jenkins, and W. L. Parrott. 1985. Notice of release of 4 BC_1F_4 , 46 BC_2F_4 and 21 BC_3F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn Memo. 4 pp.

McCarty, J. C. Jr., J. N. Jenkins, R. L. Shepherd, and W. L. Parrott. 1986. Notice of release of 38 BC_2F_4 and 29 BC_3F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp.

McCarty, J. C. Jr., J. N. Jenkins, R. L. Shepherd, and W. L. Parrott. 1988. Notice of release of 39 BC_3F_4 and 16 BC_4F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp.

McCarty, J. C. Jr., J. N. Jenkins, R. L. Shepherd, and W. L. Parrott. 1990. Notice of release of 22 BC_2F_4 and 10 BC_4F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp.

McCarty, J. C. Jr., and J. N. Jenkins. 1992. Notice of release of 53 BC_4F_4 noncommercial flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp.

Shepherd, R. L., J. N. Jenkins, W. L. Parrott, and J. C. McCarty, Jr. 1985. Notice of release of eight noncommercial nectariless-frego bract germplasm lines of Upland cotton, *Gossypium hirsutum* L. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and 1986 Crop Sci. 26:1260.

Shepherd, R. L., W. L. Parrott, J. C. McCarty, Jr., and J. N. Jenkins, . 1985. Notice of release of eight noncommercial okra leaf-frego bract germplasm lines of Upland cotton, *Gossypium hirsutum* L. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and 1986 Crop Sci. 26:1260.

Shepherd, R. L., J. C. McCarty, Jr., J. N. Jenkins, and W. L. Parrott. 1987. Notice of release of 12 root-knot-nematode-resistant, noncommercial, flowering germplasm lines of Upland cotton involving *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp. and 1988 Crop Sci. 28:868-869.

Shepherd, R. L., J. C. McCarty, Jr., J. N. Jenkins, and W. L. Parrott. 1989. Notice of release of 12 root-knot-nematode-resistant, nectariless germplasm lines of Upland cotton *Gossypium hirsutum* L. race accessions. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 3 pp.

Shepherd, R. L., W. L. Parrott, J. C. McCarty, Jr., and J. N. Jenkins. 1989. Notice of release of nine root-knot-nematode-resistant germplasm lines of Upland cotton *Gossypium hirsutum* L. USDA and Miss. Agric. and Forestry Exp. Stn. Memo. 4 pp.

Turcotte, E. L., Carl V. Feaster. 1985. Notice to plant breeders and geneticists relative to release of five noncommercial germplasm lines of Pima cotton. Ariz. Agric. Exp. Stn. and USDA Memo. 3 p. and Registration of five American Pima cotton germplasm lines (Reg. No. GP-225 to GP-259). Crop Sci. 26:206. 1986.
Five germplasm lines of *Gossypium barbadense* L. incorporating the genetic traits okra leaf, fertility restoration, frego bract, glandless, and nectariless into Pima backgrounds were released.

Turcotte, E. L., Carl V. Feaster, and E. F. Young, Jr. 1989. Notice to plant breeders and geneticists relative to release of six noncommercial germplasm lines of Pima cotton. Ariz. Agric. Exp. Stn. and USDA Memo. 5 p. and Registration of six American Pima cotton germplasm lines (Reg. No. GP-479 to GP-484). Crop Sci. 31:495. 1991.
Six germplasm lines of Pima cotton, P45, P51, P53, P62, P66, and E15, representing a range of yield potential, plant height, earliness, tolerance to heat stress, boll and fiber properties, and spinning performance were released.

Turcotte, E. L., R. G. Percy, and Carl V. Feaster. 1991. Notice of release of a commercial variety of American Pima cotton, 'Pima S-7.' USDA and Ariz. Agric. Exp. Stn. Memo. 3 p. and Registration of 'Pima S-7' American Pima cotton. (Reg. No. CV-101, PI 560140). Crop Sci. 32:1291 (1991).
The advantages of Pima S-7 over Pima S-6 are earlier maturity, greater heat tolerance, higher yield potential at low and intermediate elevations, and earliness at high elevations of Pima cotton belt. Also slightly longer, 6 percent stronger, and slightly finer fiber. In processing, Pima S-7 gives 6 percent stronger yarns than Pima S-6.

Qualitative Genetics

G. barbadense

Golden veins is an incompletely dominant mutant that is characterized by golden-colored leaf veins and glossy leaf appearance. Homozygous dominant plants are extremely dwarfed and do not flower. The name golden veins and the gene symbol *Gv* are assigned to the mutant. Linkage tests between *Gv* and 20 *Gossypium* mutant genes were negative.

Male-sterile-12 is a dominant male-sterile mutant, which is assigned the gene symbol Ms_{12}. Linkage tests between Ms_{12} and 23 *Gossypium* marker genes were negative. Because dominant male steriles cannot be intercrossed, distinct loci designations are based on phenotypic differences, and gene designations have to be considered tentative.

An incomplete dominant leaf trait was described in which heterozygous plants express several characteristics including small, yellow-green, and waxy leaves that are often rounded, modified narrow bracts, and normal branches arising from low mainstem nodes. Homozygous dominant plants express an extreme phenotype, and they rarely shed pollen, making them functionally lethal. The name Round leaf-3 and the gene symbol R_{13} is assigned to the mutant. Linkage tests between R_{13} and 23 other *Gossypium* mutant genes were negative.

The monogenic recessive wrinkled leaf-2 mutant was described. The mutant expresses on successive leaves beginning with the first sympodial branch produced from nodes 6 through 8 on field-grown plants. The wrinkled leaf trait was not allelic with three other leaf mutant genes nor was it linked with 22 *Gossypium* mutant genes. The name wrinkled leaf-2 and the gene symbol wr_2 were assigned to the mutant.

The monogenic recessive virescent-21 mutant was described. Genetic studies showed that the virescent trait is not linked with 22 *Gossypium* mutant genes or allelic with v_7 in *G. barbadense* L. or v_1 and v_2 in *G. hirsutum* L. The name virescent-21 and the gene symbol v_{21}were assigned to the mutant.

Kidney seed cottons are a distinctive type in which the seeds of each locule are conjoined into a single kidney-shaped mass. Genetic studies of kidney seed showed that it was inherited as a monogenic recessive, and that it was not linked with 21 *Gossypium* mutant genes. The gene symbol *k* was assigned to the kidney seed trait. Several kidney cottons in the *G. barbadense* germplasm collection are characterized by a complex of traits and are known collectively as *G. barbadense* var. *braziliense*. The present study expanded the trait complex associated with *braziliense*.

G. hirsutum

Ephemeral leaf, conditioned by a recessive gene, *ep*, is characterized by misshapen leaves from about nodes 6 to 15 on greenhouse plants and fewer nodes on field-grown plants in Arizona. The *ep* gene is not allelic to *veins-fused* or *strap*.

Undulate leaf, also conditioned by a recessive gene, *ul*, is characterized by undulate leaf margins and a light-green color, caused by a reduced amount of chlorophyll.

Pink filament, conditioned by duplicate, partially dominant factors, Pf_1 and Pf_2 shows a variable amount of anthocyanin coloring of the filaments and is hypostatis to petal spot, R_2.

Resistance to cotton leaf crumple virus is also conditioned by duplicate, partially dominant factors, C_1 and C_2.

The complementary lethal factor of *G. davidsonii* was transferred to tetraploid cotton via a cross compatible *G. barbadense* stock ('15-4'). The lethality factor from *G. davidsoni* was designated Le^{dav}. The cross compatible *G. barbadense* was $le_1le_1le_2le_2$. Cultivated tetraploids were identified as carrying two factors, Le_1 and Le_2, or were monomeric for the factors. Le^{dav} in combination with Le_1 and/or Le_2 results in lethality. Linkage analyses established linkage of Le^{dav} and Gl_3^{dav} with 26 percent RC. Further analyses established linkage of Gl_2 with Le_1 (28 percent RC) and Gl_3 with Le_2 (23 percent RC).

Levels of tomentum on vegetative parts of cotton plants had been described by a series of genes that increased tomentum (*H*) and a series of genes that reduced or eliminated tomentum (*Sm*). Detailed genetic analysis established redundancy in allelic and loci designations, and the designations were revised to identify the five loci and their alleles that regulate the relative amounts of trichomes with the symbol (*T*). These relations are summarized in Table 1.

A mutant called crinkle-yellow was assigned the gene symbol *cy* and was conditioned by homozygous recessive alleles at a single locus. The mutant plant is reduced in size with the most prominent feature being a crinkled condition of the leaves and a yellow flush of leaf laminal areas on seedlings and fall regrowth. Environmental stresses reduce or eliminate the mutant expression, so expression was not consistent. No linkage or chromosome associations were found.

A spontaneous mutant in which the leaves tend to have a slight downward roll to the edges, prominent veins, and a yellowish color of the leaves is more noticeably associated with the veins. The degree of expression varied with seasonal variation. The mutant was named yellow- veins and assigned the symbol *yv*. Expression is conditioned by the homozygous recessive alleles. Linkage tests found associations with virescent-1 and Rugate to for linkage group XVII (Ru-37-yv-30-v_1).

In the effort to increase genetic mutant stocks, a concerted effort was made to increase virescent mutants. A series of spontaneous virescent mutants were obtained from various workers and locations. Several were allelic with the 11 known loci, and 5 new virescent mutants were identified. Four were simple recessives, v_{12}, v_{13}, v_{14}, and v_{15}, and one was a duplicate recessive, v_{16}-v_{17}. Virescent-14 tests suggested that it was a member of the homoelogous linkage groups II and VII, but not allelic with v_5-v_6. Additional virescent mutants in *G. hirsutum* have been identified by workers not associated with S-77; v_{18}, v_{19} , v_{20}, and v_{21} have been identified in *G. barbadense*.

The dominant glandless described in Egyptian cottons was analyzed in *G. barbadense* and *G. hirsutum* backgrounds. The mutant was determined to be a new allele at the Gl_2 locus, Gl_2^e. Seedling classification determined it to be clearly expressed as incompletely dominant to normal. In combination with the duplicate recessive glandless gl_2, gl_2, gl_3, gl_3, Gl_2^e enhances glandlessness of the heterozygous combinations.

Numerous fiber color stocks exist in cotton germplasm. Variation exists for intensities of brown and green lint and fuzz variants. Fourteen lines, 12 brown and 2 green were tested with the known brown lint loci, Lc_1, Lc_2, and *Dw*, and green lint locus, *Lg*. The green fuzz variants were alleles of *Lg*, Lg^f. The brown lint lines were found to be either allelic at known loci, or new loci. A dark brown line was conditioned by two new linked loci, Lc_3 and Lc_5. Two light brown lines were identified as Lc_4 and Lc_6. The lint color lines are incomplete dominants, but the intensity of the coloration determines whether or not the heterozygote or homozygote can be readily distinguished from normal background variation.

A mutant was observed with multiple occurrences in cotton fields. Seedlings were observed in which the seedling became white and died. It was found that transplanting the seedlings to low-light conditions would allow some to turn green and set seed. This process allowed genetic analysis. It was established that the white seedling lethal condition was controlled by duplicate recessive genes, wht_1, wht_2.

Few mutants are known that influence cotton fiber development. Two new mutants were found in production fields. One mutant was found in California in which the phenotype resembles bolls that have opened prematurely. This mutant was named immature fiber, and it is controlled by homozygous recessive alleles, *im im*. Since plants normally produce bolls that open prematurely, this mutation is often difficult to identify with certainty. Fibers of this mutant have reduced secondary wall development. The second fiber mutant was found in a Texas cotton field. This mutant produces normal plants but has short fibers that resemble Ligon lintless-1. It was found to be independent of Ligon lintless-1, and, like Ligon lintless-1, it is a complete dominant. It was called Ligon lintless-2 and assigned the gene symbol Li_2. Based on the independence with Ligon lintless-1 and similar fiber phenotype, it is considered to be a possible homoeologue.

An extremely debilitating mutant was found in a field of 'Rex' cotton. Mutant expression begins prior to flowering and increases in intensity, resulting in a very depauperate and unproductive plant. Leaves are misshapen and have a rounded appearance, plants have reduced hairs, stems often develop a corky epidermis, and bracts are small and misshapen to almost a frego-bract appearance. The mutant is conditioned by homozygous recessive genes, and it was named rex with the gene symbol *rx*. It was found to be a member of linkage group X with the gene order *rx*-17-*Rg*-21-rl_1.

Quantitative Genetics

Most characteristics of economic significance in cotton are inherited in a quantitative manner, including yield, fiber and seed quality, and resistance to pests and stress. Inheritance of these characteristics involves separation of environmental and genetic effects. The objective of increased knowledge of quantitative traits is an increase in breeding efficiency and generally involves two areas of research: identification by methodology or instrumentation of useful genetic variability and efficient use of that variability. Geneticists and breeders have been very successful in their efforts as evidenced by modern and obsolete cultivar comparisons which show yield has been increased by about 1 percent per year since 1960. Simultaneous improvements in pest resistance, earliness, and fiber quality have accompanied these yield increases.

Combining Ability and Gene Action

Combining ability studies give general directions as to which crosses are likely to be superior in producing desirable segregates and the possibility of utilizing heterosis. A half-diallel analysis of tannin content, using 'Stoneville 213,' 'Tamcot CD3H1,' and breeding lines 86-E-3, 86-E-8, and 86E-20, which have elevated levels of tannins or have resistance to spider mites, was conducted in Texas. General combining ability was significant for tannin content of the mature leaf. No significant specific combining ability was detected. Stoneville 213 consistently had high general combining ability for tannin concentration while the other entries had low or inconsistent combining ability estimates.

At Mississippi State University research indicated that plant height, first fruiting node number, height of first fruiting node, number of monopodial and sympodial branches, and nodes above white bloom were conditioned by general combining ability. Narrow sense heritabilities ranged from 0.5 to 0.85. Significant combining ability was not detected for any trait measured.

Gene action for resistance to *Phymatatrichum omnivorium* was determined in a seven-parent half diallel mating scheme and analyses (P, F_1, and F_2 populations) at College Station, Texas. Additive and non-additive effects were significant. The magnitude of the dominance component was much larger than the additive component. Narrow sense and broad sense heritability estimated averaged 11 percent and 35 percent, respectively. Resistance to root rot was conditioned by polygenes with minor effects. Also, research at College Station showed that resistance to *Pythium ultimums* and *Rhizoctonia solani* was polygenetically inherited and conditioned by a complex of minor genes. Additive and epistatic effects were smaller in magnitude than the dominance effects. Average degree of dominance ranged from partial to over-dominance with different responses to both pathogens. Narrow sense heritabilities were low - ranging from 0.1 to 21 percent. General combining ability effects were important for the expression of resistance to *R. solani* and specific combining effects were important for resistance to *P. ultimum*.

Resistance to reniform nematode, *Rotylenchos reniformis* is inherited in a quantitative and complex manner. Major resistance to root-knot nematode, *Meloidogyne incognita*, is inherited as a single-/or two-gene model.

Heterosis

Progress in utilizing heterosis for yield and fiber quality has been made in two areas. First, the use of interspecific hybrids of *G. hirsutum* x *G. barbadense*, which was promoted by Dr. Dick Davis and associates at New Mexico State University, has produced exceptional yields, fiber strength, and fineness. However, interspecific hybrids result in large amounts of aborted ovules, neps, and fiber immaturity, which result in dyeing and fabric quality problems. Some improvements in yield and reduction in fiber quality problems have been achieved by use of short-statured, early-maturing, and coarse-fiber Pima lines. Hybrids produced with these lines exceed their parents for yield at low desert locations, but in high-elevation environments the hybrids produced significantly higher yields than their parents.

The second area of practical use of heterosis involves the use of F_2 hybrids as cultivars. Several studies indicate that F_2 hybrids from upland x upland strains have good potential in producing higher yield-fiber quality cultivars than conventional cultivars. These studies also indicated fiber quality variability from F_2 hybrids should not be a problem for the textile industry. Two methods of producing the F_1's have been used: use of male gametocides and hand pollination. The major limiting factor for the successful use of F_2 hybrids as cultivars is the practicality of working out the logistics of producing hybrids. The use of F_2 hybrids has progressed to cultivar use by growers and several commercial companies are testing potential new F_2 cultivars.

Selection and Breeding

Germplasm enhancement for host-plant resistance, seed characteristics, and fiber quality continues to be an important objective for many breeders and geneticists. Screening for resistance to all major insect and disease pests is being conducted by numerous researchers who have developed improved techniques for detecting resistance. Stomatal conductance of Pima germplasm has been found to be highly correlated with yield ($r = 0.95 - 0.99$). Additive gene action for stomatal conductance predominated in wide crosses, but in narrower crosses the gene action was complex.

Okra leaf has some major desirable characteristics (improved harvest index, earliness, less boll rot, and insect resistance) over normal leaf cottons. Okra leaf's primary limiting factor is its low leaf area index in the early development of the crop. Subokra leaf was found to result in an increase of about 5 percent in canopy photosynthesis and an increase in yield of about 5 percent over normal leaf in some cultivar backgrounds.

Use of cluster analysis has proven to be an effective way of characterizing germplasm involving species introgressions into *G. hirsutum* or with commercial cultivars used in national tests.

Results at the Pee Dee Experiment Station, South Carolina, indicate that the performance of F_2 populations is a good indicator of a cross' potential to produce high-yielding and high-fiber-quality segregates. Individual plant selections for yield and quality parameters was not an effective method in selecting high-yield and high-fiber-quality progenies.

Fiber Quality

Members of S-77 have conducted studies on fiber quality of both upland (*G. hirsutum*) and Pima cottons (*G. barbadense*). Investigations have evaluated breeding methods to improve fiber traits, methods of measuring fiber strength, effect of morphological traits on nonlint trash, effect of parental genotype on interspecific hybrid fiber length, and ovule abortion rates in upland, Pima, and interspecific hybrids.

Progress from breeding for longer and stronger fiber without a reduction in lint yield continued to be made in the Pee Dee cotton breeding program. Germplasm lines possessing unusual combinations of fiber length, fiber strength, fiber fineness, and lint yield were released. Three cultivars combining superior fiber and spinning properties, along with lint yields equivalent to southeastern commercial cultivars, were also released. A simple breeding procedure consisting of pedigree selection in populations derived from single crosses among Pee Dee lines and between Pee Dee germplasm and commercial cultivars was utilized to develop superior genotypes. However, such a simple breeding procedure was deemed ineffective in improving fiber traits in single-cross populations from Pee Dee x Chinese cultivar crosses. Selections produced adequate seedcotton yields but fibers were generally short, coarse, and weak.

The relationship between two fiber strength measurements, stelometer and HVI strength, as well as their association with yarn strength were assessed in three populations at Florence, SC. Neither fiber strength measurement was found to be consistently correlated with yarn strength. Additionally, the genetic correlation between stelometer and HVI fiber strength was low (r=0.10). The genetic correlation between stelometer strength and yarn strength was 0.70, while that between HVI strength and yarn strength was less than 0.01. This discrepancy in genetic correlation between fiber strength measurements and yarn strength was evidence that the two methods of assessing fiber strength are not the same genetic properties. Thus, it is not known whether or not equivalent progress in improving yarn strength could be made by selecting for stelometer or HVI fiber strength alone. Additionally, higher yarn strength may require selection for fiber properties in addition to fiber strength.

Morphological trait effects on nonlint trash in cotton fiber were studied in Louisiana. Twelve near-isolines involving four leaf shapes (normal, semi-okra, okra, and super-okra), two bract types (normal and frego), and two leaf-pubescence levels (hairy and semismooth) were evaluated for nonlint trash content before and after ginning followed by zero, one, and two lint cleanings. Semismooth and super-okra leaf traits reduced motes, small-leaf trash before ginning, and resulted in grades similar to the check with one less lint cleaner. Frego-bract isolines had less leaf and bract trash in lint than the normal bract check at any level of lint cleaning.

Progress in improving fiber traits of Pima cottons was also made in this time period. The cultivar Pima S-7, released as a replacement for 'Pima S-6,' has longer and stronger fiber with higher yarn strength. Fiber properties were measured on 234 doubled haploids from 48 American Pima germplasm sources. The doubled haploids were uniform within but varied extensively among genotypes for fiber traits. Doubled haploids of American Pima cotton, however, were found with few exceptions to be inferior to standards in at least one fiber property.

An investigation of the effect of *G. barbadense* parental genotype upon interspecific hybrid fiber length and micronaire revealed a significant parental contribution. Simple regressions of hybrid on parental 2.5 percent span length and micronaire resulted in R2 of 0.95 and 0.52, respectively. Heterotic effects in hybrids far exceeded the observed incremental effects due to *G. barbadense* parental genotype. In this investigation, heterosis opposed the direction of selection practiced in the *G. barbadense* parents. Assuming that extrapolation beyond the range of data were valid, a *G. barbadense* parent fiber length of 17.3 mm and micronaire of 6.38 would be required to produce an interspecific hybrid with an Acala-type fiber with a length of 30.5 mm and micronaire of 4.20.

Ovule abortion and mote production result in fiber immaturity, low fiber strength, poor dyeing quality, and reduced yield potential. In an investigation of ovule abortion rates in *G. hirsutum, G. barbadense*, and interspecific hybrids, lowest mote numbers were observed in *G. hirsutum*, with increased numbers in *G. barbadense*, and highest numbers in hybrids. These results were in agreement with previous studies. Ovule abortion rates, as a response to environmental stress, were also found to vary between the two species and their hybrids. Increase in percent motes between a high elevation, moderate environment (daily maximum and minimum = 36.8 and 19.8 °C, respectively) and a low elevation, extreme environment (daily maximum and minimum = 40.6 and 23.7 °C, respectively) in Arizona were -1.5 percent in *G. hirsutum*, 3 percent in *G. barbadense*, and 8.8 percent in hybrids. The rate of mote production decrease under a moderating environment also varied between species and their hybrid. In a situation in which mean maximum temperature 21 days pre-anthesis moderated from 41.1 to 27.6 °C and in which mean minimum temperature moderated from 25.1 to 23.3 °C, the percentage of motes decreased 20 percent in *G. hirsutum*, 31 percent in *G. barbadense*, and 33 percent in hybrids. Previous studies have suggested that a genetic incompatability is responsible for increased mote production in interspecific hybrids. This study reveals that hybrids also possess an increased environmental sensitivity, leading to greater mote production under stress environments.

TABLE 2. LIST OF OLD AND NEW SYMBOLS AND PHENOTYPES FOR GENES REGULATING TRICHOMES.

Symbol		Phenotype
New	**Old**	
T_1	H_2	Densely pubescent leaves, stems, and fruits
T_1^{to}	H_2	Densely pubescent leaves and stems, glabrous fruits
T_1^{an}	H_2	Densely pubescent leaves and stems, glabrous fruits
T_1^{h}	H_1	Densely pubescent leaves and stems, glabrous fruits, (tomentum longer and less dense)
T_1^{sm}	Sm_2	Trichomes confined to margins of leaves
t_1	h_1,sm_2	"normally pubescent"
T_2	Sm_1	Glabrous stems and pubescent leaves
T_2^{arm}	Sm,Sm_1^{sl}	Glabrous stems and nearly glabrous leaves
T_2^{b}	Sm_1^{sl}	Removes trichomes only from stems in *G. barbadense*
T_2^{to}		Glabrous stem and semi-glabrous leaves in *G. hirsutum*
T_2^{rai}	H_6	Densely pubescent leaves and stems
t_2	H_3sm_1	"normally pubescent"
T_3	Sm_3	Trichomes confined to leaf veins and margin and stems
t_3^{h}	Sm_3^{h}	"normally pubescent"
t_3	sm_3	phenotype of T_3 when homozygous
T_4	H_4	Trichomes on adaxial surface with T_1^{h}
t_4		"normal"
T_5	H_5	Increases length of trichomes
t_5		"normal"

Annotated Bibliography

Annotated Bibliography

Altman, D. W., P. A. Fryxell, and R. D. Harvey. 1993. Sydney Cross Harland and Joseph B. Hutchinson: Pioneer botanists and geneticists defining relationships in the cotton genus. Huntia 9: [in press]. Biographical accounts of two noted British cotton scientists whose careers were intertwined, together with a documenting of their papers held in the archives of the John Innes Institute, Norwich, England.

Altman, D. W., P. A. Fryxell, and C. R. Howell. 1987. Development of a tissue culture method for collecting wild germplasm of Gossypium. FAO/IBPGR Plant Genet. Resources Newsl. 71: 14-15. A method was developed, using tissue culture techniques under tropical field conditions, for collecting vegetative specimens for propagation -- i.e. using only readily available reagents like laundry bleach and rubbing alcohol, and requiring no refrigeration or special equipment.

Altman, D. W., P. A. Fryxell, S. D. Koch, and C. R. Howell. 1990. *Gossypium* germplasm conservation augmented by tissue culture techniques for field collecting. Econ. Bot. 44: 106-113. A reliable method is presented for preserving vegetative samples under field conditions for subsequent propagation. This method is especially valuable when seeds are not available.

Altman, D. W., D. M. Stelly, and R. J. Kohel. 1987. Introgression of the glanded-plant and glandless-seed trait from *Gossypium sturtianum* Willis into cultivated upland cotton using ovule culture. Crop Sci. 27: 880-884. The application of embryo rescue techniques are described to increase the success of introgression. Introgression into the BC4 was successful when conventional hybridizations failed at BC1.

Ano, G., J. Schwendiman, and A. E. Percival. 1983. Rapport de mission en Equateur sur la preservation des ressources genetiques du cotonnier. F.A.O.-I.B.P.G.R., AGR-PR 3/11, Sept.-Oct. et December 1983. 42 pp. A collecting mission to obtain seeds of the *Gossypium* spp., *G. barbadense, G. darwinii,* and *G. klotzschianum*.

Anthony, W. S., W. R. Meredith, Jr., and J. R. Williford. 1988. Neps in ginned lint: The effect of varieties, harvesting, and ginning practices. Textile Res. J. 58: 633-640. The effects of varieties, harvesting practices, and ginning techniques on the nep content of ginned lint were evaluated in a 2-year study in the Mississippi Delta. Neps increased more with lint cleaning than with harvesting practices or varieties. Two stages of lint cleaning increased the neps in ginned lint from 15.9 to 36.2 neps/645 cm^2 of web. The nep content was not significantly related to the number of seedcoat fragments, foreign matter, or grade.

Anthony, W. S., W. R. Meredith, Jr., J. R. Williford, and G. J. Mangialardi. 1988. Seed-coat fragments in ginned lint: The effects of varieties, harvesting, and ginning practices. Textile Research J. 58: 111-116. Weather, varietal, harvesting, and ginning effects on seed-coat fragment count and weight in ginned lint cotton were evaluated in a 2-year study in the Mississippi Delta. Harvest and lint cleaner treatments had little effect on fragment count, while year and variety had strong influences.

Banks, J. C., L. M. Verhalen, G. W. Cuperus, and M. A. Karner (ed.). 1992. Cotton production and pest management in Oklahoma. Oklahoma Coop. Ext. Serv. Circ. E-883. This manual contains 16 chapters on various aspects of cotton production in Oklahoma. Its usefulness should also extend onto the Rolling Plains of Texas. Several chapters contain information related to cotton genetics and breeding.

Bayles, Melanie B. 1991. Two breeding studies: I. Trends in cotton cultivars released over time by the

Oklahoma Agricultural Experiment Station; and II. Reconstitution of the recurrent parent in cotton when backcrossing. Ph.D. Dissertation, Oklahoma State University. In the first study, 12 cotton cultivars, released by the Oklahoma Agric. Exp. Stn. between 1918 and 1982 inclusive, were evaluated to determine selection progress over time in that cotton breeding program. Lint yield increased 2.3 kg/ha each year under dryland conditions and 3.3 kg under irrigation. A yield plateau for cotton has not yet been reached in the state. Trends were also evident for fiber length, strength, lint percentage, boll size, weight of lint/boll, lint index, seed weight, lock tenacity, and resistance to fusarium wilt/nematodes and bacterial blight. No trends were noted for uniformity index, micronaire, bur size, and resistance to verticillium wilt. In the second study, after four generations of backcrossing, significant differences were detected between the BC_4F_4 and the recurrent parent in only 18 of 90 comparisons, and 12 of those were concentrated in 2 of the 6 families investigated. Results indicated that the backcross method can be a highly successful tool in cotton breeding.

Beasley, J. P. and J. E. Jones. 1985. The current status in the development of resistance to the reniform nematode in cotton in Louisiana. Proc. Beltwide Cotton Prod. Res. Conf., pp. 23-25. Different techniques to determine resistance to reniform nematode were used to evaluate *Gossypium* strains previously identified as resistant and to evaluate various race stocks and breeding lines. Visual examination and subjective rating were not as effective in determining resistance as evaluating nematode egg production. La. 434-1031, Texas race stock 19 (TR19), and the day-neutral converted Texas race stocks 19, 22, and 44 were identified as producing significantly fewer reniform nematode eggs than the 'Deltapine 41' check.

Beasley, J. P., J. E. Jones, and S. J. Stringer. 1984. Evaluation of cotton genotypes for attractiveness to the boll weevil for use in a trap crop situation. Proc. Beltwide Cotton Prod. Res. Conf., pp. 368-369. Field tests were conducted in 1982 and 1983 to identify cotton genotypes that were more attractive to the boll weevil than common commercial varieties. More attractive genotypes could be used in a trap cropping system. Based on a combination of weevil damaged squares and fruiting rate, La. E76C-3, La. 1363 Lsne, TX CAMD 21-S-81, and CAMD E were significantly more attractive to boll weevils than the check variety, Stoneville 213.

Bergey, D. R., D. M. Stelly, H. J. Price, and T. D. McKnight. 1989. *In situ* hybridization of biotinylated DNA probes to cotton meiotic chromosomes. Stain Tech. V. 64, pp. 25-27. A modified procedure for *in situ* hybridization of biotinylated probes to meiotic chromosomes of cotton was developed with high retention of squashed cells on slides, preservation of acid-fixed chromosome morphology, exceptionally low levels of background precipitate at nonspecific hybridization sites and improved photomicrographic recording. Salient features of the techniques include pretreatment of slides before squashing, cold storage of squash preparations, and use of interference filters for distinguishing precipitate from chromatin. A cloned 18S/28S ribosomal DNA fragment from soybean was biotinylated via nick-translation and hybridization to microsporocyte meiotic chromosomes of cotton (*Gossypium hirsutum* L. and *G. hirsutum* L. x *G. barbadense* L.). Enzymatically formed precipitate from streptavidin-bound peroxidase marked the *in situ* hybridization. Three pairs of ISH sites were detected.

Bhat, M. G., R. J. Kohel, and D. W. Altman. 1990. A study on host plant resistance to bollworms (*Heliothis* spp.) in cotton using tissue isogenic lines. J. Cotton Res. Dev. 3: 140-146. Isolines of AET-5 with nectariless, glabrous and okra leaf traits were evaluated for *Heliothis* damage in unsprayed plots. The combination of all three traits gave the highest degree of protection and the normal parent the least. Green boll damage showed the greatest differential response.

Bowman, D. T. and C. C. Green. 1991. Screening cotton germplasm for Columbia lance and reniform nematode resistance. Proc. Beltwide Cotton Prod. Conf., pp. 551-552. One hundred seventeen genotypes were screened in the greenhouse for tolerance to Columbia lance nematodes. Of 29 genotypes determined to have tolerance in the greenhouse, 11 were field tested and 6 showed field tolerance to this nematode. Seven genotypes were grown in reniform-infested soil and differential results were obtained depending on initial infestation levels.

Bowman, D. T. and J. E. Jones. 1982. Inheritance studies of bract size in cotton. Crop Sci. 22: 1041-1045. Bracts in upland cotton have been implicated in byssinosis in textile mill workers. Inheritance studies of bract size were conducted prior to initiating a breeding program for reduced bract size. In the first study, heritability was calculated from regression of F_3 plot means on F_2 plant values. Highly significant regression and

correlation coefficients of 0.69 and 0.75, respectively, were computed for heritability estimates. A second study included 7 parents, their 21 F_1, and 21 F_2 progeny. Narrow- sense heritability estimates indicated that bract size was primarily additive although dominance gene effects contributed significantly.

Bowman, D. T. and J. E. Jones. 1983. Associations between bracts and several agronomic traits in cotton. Crop Sci. 23: 565-568. A low ratio of bract surface area/lint weight per boll would denote a low bract trash potential and may denote a low byssinosis potential. The ratio of bract surface area/lint weight per boll appeared to be positively associated (genotypically) with 50 percent span length, and negatively associated with fiber micronaire and lint percent. These associations would suggest that parents with high lint percent and parents with small bracts should be selected. The potential problem with fiber length and micronaire should be considered in breeding cottons for low bract trash potential.

Bowman, D. T. and J. E. Jones. 1984. A diallel study of bract surface area/lint weight per boll ratio in cotton. Crop Sci. 24: 1137-1141. Additive effects were found to be more important than dominance and epistasis effects in the seven-parent diallel study. Narrow-sense heritability estimates ranged from 0.20 to 0.92 and averaged 0.47, indicating about one-half of the genetic variance was additive in nature. Partial dominance was expressed at most loci exhibiting dominance, and these dominant alleles mostly affected smaller ratios. The high significance of genotype-year interactions and variability of heritability estimates suggest a need to test selected lines over years.

Bridge, R. R. and W. R. Meredith, Jr. 1983. Comparative performance of obsolete and current cotton cultivars. Crop Sci. 23: 949-952. We evaluated 17 cultivars over a 2-year period to determine what genetic improvements the new cultivars had over older ones. The average rate of yield increase from 1910 through 1979 due to cultivar improvements was found to be 9.5 kg/ha/year. The average lint yields in Mississippi from 1910 through 1979 shows that yields have actually increased at the rate of 8.62 kg/ha/year.

Brinkerhoff, L. A., L. M. Verhalen, W. M. Johnson, M. Essenberg, and P. E. Richardson. 1984. Development of immunity to bacterial blight of cotton and its implications for other diseases. Plant Dis. 68: 168-173. Immunity to bacterial blight of cotton was developed by combining several single-gene resistance factors onto a polygenic resistance background. The initial breeding procedure involved backcrossing, with the recurrent parent possessing the polygenic resistance; screening the segregating progeny after each backcross with a compatible mixture of virulent races of the pathogen; and selfing the selected plants. Pedigree breeding with continued screening and selfing was employed in later generations. In experiments subsequently conducted in many cotton-growing areas of the world, this immunity remained stable for more than 20 years. The likelihood is advanced that similar breeding and screening procedures would prove useful for deriving long-term immunity in other disease/crop complexes.

Brown, M. S., S. A. Naqi, M. Y. Menzel, and D. M. Stelly. 1985. Knob-6, a cytological marker for chromosome 6 of *Gossypium hirsutum* L. J. of Hered. 76: 25-216. A cytological marker consisting of a knob of extra chromatin at the end of one arm of a large chromosome was discovered in homozygous condition in a strain of cotton (*Gossypium hirsutum*) from Uganda. That the knobbed chromosome was large suggested that it belonged to the A genome. Tests with translocations involving A-genome chromosomes localized the knob to chromosome 6. The knob greatly reduced chiasma formation in the arm bearing it but not in the other arm or in other chromosomes. Knob-6 is a useful marker because it is easily maintained in homozygous condition by self-pollination and is readily discerned cytologically.

Bryson, C. T., McCarty, J. C., Jr., Jenkins, J. N., and Parrott, W. L. 1983. Frequency of pigment glands and capitate and covering trichomes in nascent leaves of selected cottons. Crop Sci. 23: 369-371. Frequency of pigment glands, and covering and capitate trichomes on the laminae of nascent terminal leaves of 29 cotton strains were evaluated. Frequency of glands and of each of the two types of trichomes seemed to be independent of one another.

Buranaviriyakul, Sunthorn. 1980. Evaluation of partial vs. complete diallel crosses in upland cotton, *Gossypium hirsutum* L. Ph.D. Dissertation, Oklahoma State University. Griffing's complete diallel design was compared to the factorial partial diallel (FPD) design 4 with four crosses (FPD4) per line and the circulant partial diallel (CPD) design with sample sizes (= number of crosses per line) of three (CPD3) and five (CPD5). Points of comparison included detection of GCA and SCA, estimates of narrow- and broad-sense heritabilities and of average degree of dominance, selection of lines based on relative GCA effects, and relative magnitudes of the average standard errors of the difference of GCA effects. The Jinks- Hayman method of analyzing a complete diallel was compared to Griffing's analysis on the basis of detection of additive and dominance variation and on the relative size of their estimates of heritability and degree of dominance. Computer simulations were used to study the distribution of estimates of heritability and average degree of dominance and the relationships of those estimates between the complete vs. partial diallels. Because of space limitations, results are not reported here.

Burandt, C. L. Jr. and P. A. Fryxell. 1990. A reappraisal of *Abutilon reflexum* (Malvaceae) and its allies. Syst. Bot. 15: 49-56. A critical analysis of a group of four red-flowered species of *Abutilon* from western South America.

Burke, H. R., W. E. Clark, J. R. Cate, and P. A. Fryxell. 1986. Origin and dispersal of the boll weevil. Bull. Entomol. Soc. Amer. 32: 228-238. Knowledge of the origin and dispersal of the boll weevil is summarized, including its alternate host plants, its probable tropical origin, and its historical spread as a cotton pest.

Butler, G. D., Jr., T. J. Henneberry, and F. D. Wilson. 1986. *Bemisia tabaci* (Homoptera:Aleyrodidae) on cotton: adult activity and cultivar oviposition preference. J. Econ. Entomol. 79: 350-354. In a greenhouse study, among six normal-leaf, okra-leaf paired isolines, one okra-leaf isoline had fewer adult whiteflies, two had more, and the other three did not differ significantly from the respective normal-leaf counterparts. Stoneville 825 Smoothleaf harbored fewer adults than did the semi-smoothleaf or hirsute isolines. When half of a normally hirsute Stoneville 825 leaf was shaved with an electric shaver, it supported fewer whitefly adults and eggs than did the unshaved half.

Butler, G. D., Jr. and F. D. Wilson. 1984. Activity of adult whiteflies (Hemiptera:Aleyrodidae) within plantings of different cotton strains and cultivars as determined by sticky-trap catches. J. Econ. Entomol. 77: 1137-1140. Among eight lines in AET-5 background, carrying all combinations of nectariless, smoothleaf, and okra leaf and their normal counterparts, only the smoothleaf combinations averaged fewer sweetpotato and bandedwinged whiteflies. However, AET-5 smoothleaf and various lines in DES 24 and DES 56 backgrounds carrying nectariless, okra leaf, or semi- smoothleaf did not have fewer whiteflies than the control cultivar, Deltapine 61.

Butler, G. D., Jr., F. D. Wilson, and G. Fishler. 1991. Cotton leaf trichomes and populations of *Empoasca lybica* (Homoptera:Cicadellidae) and *Bemisia tabaci* (Homoptera:Aleyrodidae). Plant Prot. 10: 461-464. Leafhopper (*Empoasca lybica*) and whitefly (*Bemisia tabaci*) populations were observed on 31 cotton entries planted at Bet She'an, Israel. Leafhopper populations decreased while whitefly populations increased as the number of leaf trichomes increased. Various management strategies to deal with this dilemma are discussed.

Butler, G. D., Jr., F. D. Wilson, and T. J. Henneberry. 1985. Cotton leaf crumple virus disease in Okra-leaf and normal-leaf cottons. J. Econ. Entomol. 78: 1500-1502. Cotton crumple leaf virus is transmitted by the sweetpotato whitefly. Five normal-leaf cultivars and their okra-leaf isolines were infected as seedlings. Infected plants were 25 percent shorter, produced 47 percent fewer bolls, and 50 percent lower seedcotton yields than the control plants. Disease symptoms were expressed less in two okra-leaf isolines, but yields were not higher than in the respective normal-leaf cultivars.

Calhoun, D. Steve. 1993. Near-term contribution of plant resistance to cotton pest management *in* S. A. Harrison (ed.). Proc. La. Assn. Agron., Alexandria, LA, 10-12 Mar. 1992. LA State Univ. [in press]. The effects of various morphological and physiological traits (including reduced pubescence, nectariless, frego bract, high flower bud gossypol gland density, and early maturity) on insect damage are reviewed, and current or experimental varieties expressing those traits are listed. Data from field tests of Bt cottons in Louisiana are presented. Resistance to root-knot nematode in experimental strains and 'Stoneville LA887' is also discussed.

Calhoun, D. S., J. E. Jones. E. Burris, W. D. Caldwell, B. R. Leonard, S. H. Moore, and W. Aguillard. 1992. Breeding insect resistant cottons for Louisiana. Louisiana Agric. 35: 20-22. Long-term performance of four experimental insect resistant strains is presented. Strains included LA850082 (frego bract, nectariless), LA850075 [frego bract, high flower bud gossypol gland density (HG)], LA870210 (HG), and LA870222 (HG).

With the exception of LA850075 compared to 'DES 119,' these strains yielded from 6 to 16 percent more lint than 'Deltapine 41' (DP41) and DES 119, averaged over from 12 to 34 tests. The frego bract strains suffered less than half as much bollworm/tobacco budworm (BW/TBW) damage, and less than one-third as much boll weevil damage as DP41. LA870210 and LA870222 suffered 33 and 25 percent less BW/TBW damage than did DP41.

Cathey, G. W. and W. R. Meredith, Jr. 1988. Cotton response to planting date and mepiquat chloride. Agron. J. 80: 463-466. The response of five cultivars at three planting dates to mepiquat chloride (MC) was measured in 1982, 1983, and 1984 at Stoneville, MS. For yield and fiber properties, no major interaction for cultivar x planting date or cultivar x MC interaction was detected. However, an MC x planting date interaction was evident. MC caused a 4.5 percent reduction in lint yield from the mid-April plantings, and 5.4 and 12.7 percent yield increase for the early-May and late-May plantings, respectively. These studies indicated that MC application would be most beneficial in late-planted cotton, which tends to produce more vegetative growth than earlier plantings.

Chan, B. G., A. C. Waiss, Jr., V. Sevacharian, F. D. Wilson, and B. W. George. 1982. Allelochemical inhibition of larval growth of pink bollworm. Proc. Beltwide Cotton Prod. Res. Conf. pp. 133-135. Antibiotic activity on the larval growth of pink bollworm was found in non-polar and polar extracts of carpel walls from 14-day-old bolls of *Gossypium arboreum* var. *sanguineum*. This activity was attributed to the presence of terpene aldehydes in the boll glands.

Chan, B. G. and F. D. Wilson. 1988. A new coumarin in cotton. Proc. Beltwide Cotton Prod. Res. Conf. pp. 106-107. A new coumarin, scoparone [6,7-dimethoxycoumarin], was found in ammonia-stressed Pima cotton stems along with scopoletin which had been discovered previously. Neither compound showed biological activity against pink bollworm or cotton bollworm.

Chan, B. G., F. D. Wilson, N. Mahoney, and M. J. Lukefahr. 1988. A holistic approach to study HPR in cotton. Proc. Beltwide Cotton Prod. Res. Conf. pp. 100-105. The *Heliothis* complex overcomes cotton allelochemical defense because: (1) neonate larvae feed on floral primordial tissue, containing little secondary plant products; (2) larvae become more tolerant as they grow older; (3) larvae have the ability to recover rapidly from the ill effects of allelochemicals. Allelochemicals, in order to be more effective, must be turned on earlier so as to be available at feeding sites of the younger, more susceptible larvae.

Cherry, J. P., R. J. Kohel, L. A. Jones, and W. H. Powell. 1986. Food and feeding quality of cottonseed. Cotton Physiol. No. 1. Sec. V., Special Topics, Ch. 37, pp. 557-595. A comprehensive review of research on the use and potential use of cottonseed in food and feed applications.

Cornish, K., J. W. Radin, E. L. Turcotte, Z. Lu, and E. Zeiger. 1991. Enhanced photosynthesis and stomatal conductance of Pima cotton (*Gossypium barbadense* L.) bred for increased yield. Plant Physiol. 97: 484-489. Gas exchange properties of six Pima cotton lines that differ in yield response to heat stress indicated that selection for high yield has been accompanied by increased photosynthetic capacity and stomatal conductance, and altered diurnal regulations of photosynthesis.

Culp, T. W. 1981. Lint yield and fiber quality improvements in PD lines of upland cotton. South Carolina Agric. Exp. Sta. Tech. Bull. 1081. Eight experimental lines of upland cotton (*Gossypium hirsutum* L.) with unusual combinations of lint yield, fiber, and spinning properties were developed. Most lines produced lint yield equal to or superior to the commercial check cultivars, Coker 201, Coker 310, and SC-1. Several of the high-yielding lines were superior to SC-1 and PD 2165 in fiber and yarn strength and resistance to the fusarium wilt-rootknot nematode complex. PD 4548 has an unusually high lint percentage, uniformity ratio, and wide adaptation for a high-strength cotton.

Culp, T. W. 1981. Registration of Pee Dee 4548 germplasm line of cotton. Crop Sci. 21: 992. Pee Dee 4548, an improved germplasm line of upland cotton (*Gossypium hirsutum* L.) was released by USDA-ARS and the South Carolina Agricultural Experiment Station in 1981. Pee Dee 4548 possesses high yield potential, high fiber and yarn strength, unusually high lint percentage, and wide adaptation.

Culp, T. W. 1982. The present state of the art and science of cotton breeding for fiber quality. p. 99-111. *in* J. M. Brown (Ed.) Proc. Belt. Cotton Prod. Res. Conf., Las Vegas, NV. 3-7 Jan. Natl. Cotton Counc. Am., Memphis, TN. The history, importance, inheritance, and breeding methods to improve fiber quality were summarized. Breeding for both improved lint yield and fiber quality in the Pee Dee cotton breeding program is summarized. The importance of linkage versus pleitropy in the negative genetic correlation between lint yield and fiber strength is discussed.

Culp, T. W. 1985. Lectures presented to Chinese researchers at the Cotton Research Institute, Anyang (Henan Province), Peoples Republic of China in September 1984. Publ. by USDA NTIS (National Technical Information System). Results of an academic exchange on germplasm development between U.S. and Chinese researchers are summarized. Topics include cotton production history in the U.S., breeding cotton for yield, fiber quality, and insect resistance, hybrid cotton, influence of yield components on lint yield of high fiber strength cotton, maintenance of varieties, and the effect of planting date and cultivar on late-season insects and yield of cotton.

Culp, T. W. and C. C. Green. 1988. Some considerations in the development of cottons with extra-fiber strength. p. 131-133. *in* J. M. Brown (Ed.) Proc. Belt. Cotton Prod. Res. Conf., New Orleans, LA. 3-8 Jan. Natl. Cotton Counc. Am., Memphis, TN. A simple breeding method of pedigree selection for high yield and fiber strength in populations derived from crossing PD germplasm with commercial cultivars produced 11 superior genotypes. Comparison of progeny from crosses between current and obsolete PD parents suggest that genetic linkages between lint yield and fiber strength have been broken. Crosses of Chinese and PD cottons failed to produce selections equivalent to the cultivars PD-1 or PD-3 in fiber quality. Breeding procedures other than single crosses followed by pedigree selection will be necessary to simultaneously improve lint yield and fiber quality in populations derived from PD germplasm and highly diverse upland cottons.

Culp, T. W. and R. F. Moore. 1987. Performance of Chinese and U.S. cottons. p. 115-117. *in* J. M. Brown (Ed.) Proc. Belt. Cotton Prod. Res. Conf., Dallas, TX. 4-8 Jan. Natl. Cotton Counc. Am., Memphis, TN. Three U.S. cultivars, Coker 315, DeltaPine 50, and PD-3, along with three Chinese cultivars, Jimian 8, Ering 92, and 86-1 were compared for yield and fiber quality at Florence, SC. The Chinese cultivars produced similar yields to the U.S. cultivars, but fiber length and fiber strength of Chinese cultivars was inferior to U.S. cultivars.

Culp, T. W., R. F. Moore, L. H. Harvey, and J. B. Pitner. 1988. Registration of 'PD-3' cotton. Crop Sci. 28:190. The cultivar PD-3 developed by USDA-ARS and the South Carolina Experiment Station was released in 1987 as a replacement for 'PD-1.' PD-3 has wider adaptation, higher lint yield potential, stronger fiber, higher yarn tenacity, and fewer neps.

Culp, T. W., R. F. Moore, and J. B. Pitner. 1984. Simultaneous improvement of lint yield and fiber strength in cotton. South Carolina Agric. Exp. Sta. Tech. Bull. 1090. Seven germplasm lines of upland (*Gossypium hirsutum* L.) cotton with unusual combinations of lint yield, fiber, and spinning properties were developed. The seven germplasm lines produced lint yields equal to the check cultivars Coker 201, Coker 310, and SC-1. Two PD lines had higher fiber strength than SC-1 and PD 2165, and all seven had higher yarn strength. These findings indicate that a new level in fiber quality has been reached in the PD material.

Culp, T. W., R. F. Moore, and J. B. Pitner. 1985. Registration of 'PD-1' cotton. Crop Sci. 25:198. 'PD-1' cotton, developed by USDA-ARS and the South Carolina Agricultural Experiment Station, was released in 1984 as a replacement for 'SC-1.' SC-1 was the first cultivar in South Carolina with extra-fiber strength genes of triple hybrid origin that yielded similar to commercial cultivars. Compared with SC-1, PD-1 has higher lint yield, stronger fiber, and better resistance to the fusarium wilt-rootknot nematode complex.

Culp, T. W., R. F. Moore, and J. B. Pitner. 1985. Registration of seven germplasm lines of upland cotton. Crop Sci. 25: 201-202. Seven germplasm lines of upland (*Gossypium hirsutum* L.) cotton developed by USDA-ARS and the South Carolina Agricultural Experiment Station were released. The germplasm lines combine high-yield potential, extra fiber strength, wide adaptation, and unusual combinations of fiber properties.

Dani, R. G. and R. J. Kohel. 1987. Effects of time on boll set on seed-oil content in cotton. Indian J. Agric. Sci. 57: 391-394. The effect of boll set on seed-oil content was determined by weekly measures over a 6-week

period. Performance was most consistent in the first 3 to 4 weeks of bolling. Significant differences and interactions were found with the weekly measurements.

Dani, R. G. and R. J. Kohel. 1989. Maternal effects and generation mean analysis of seed-oil content in cotton (*Gossypium hirsutum* L.). Theor. Appl. Genet. 77: 569-575. Four lines in P_1 , P_2, F_0, F_1, F_2, BC_1 and BC_2 generations with reciprocal cross combinations were analyzed. Significant maternal, non-cytoplasmic effects were found. Genetic components and their interactions were measured.

Dobson, S. L. S. 1983. Selection for drought resistance in cotton utilizing stomatal resistance measurements. M. S. Thesis, Oklahoma State University. A two-way selection study for stomatal resistance was conducted within 16 F_2 populations of cotton to determine what proportion of the selected differences were transmitted to the F_3 and to study indirect effects on agronomic and fiber quality characteristics. Direct selection was generally ineffective. Only one population displayed a significant and positive response. Indirect selection response in that population revealed a reduction in lint percentage and an increase in fiber strength (at the 0.20 prob. level). Based on these results, this method of screening for drought resistance is probably not of value to cotton breeders.

Eissa, A. M., J. N. Jenkins, and C. E. Vaughan. 1983. Inheritance of seedling root length and relative root weight in cotton. Crop Sci. 23: 1107-1111. Using the standard cotton cool temperature (18 °C) germination test, 124 day-neutral composite F_3 strains were evaluated for root length and relative root weight. Genetic analysis of five strains indicated that selection should be delayed to the F_3 to allow recombination of epistatic genes to occur. Recurrent selection is suggested as a breeding method that should be applicable to developing plants with long roots with a high relative root weight.

Endrizzi, J. E. and R. Nelson. 1989. Linkage analysis and arm location of the open bud (ob_1) and yellow petal (Y_2) loci in chromosome 18 of cotton. Genome. 32: 1041-1043. It was shown that the open bud and yellow petal genes are located, respectively, on the short and long arms of chromosome 18. The ob_1 gene is 3.4 and the Y_2 gene is 8 Map | Ethics Line | units from the centromere; thus the two loci are at least 11 Map | Ethics Line | units apart.

Endrizzi, J. E. and G. Ramsay. 1980. Identification of 10 chromosome deficiencies of cotton. J. Hered. 71: 45-48. Monosomes for chromosomes 9, 10, 12, 20, and 25 and telosomes for chromosomes 5, 14, 20, and 26 have been identified. Twenty-six marker genes were tested in different combinations with the chromosome deficiencies and the results showed the following associations; chromosome 3 and *fg* (linkage group VI), chromosome 5 and P_1 (XI), chromosome 12 and $N_1gl_1bw_1ne_1$ (V), chromosome 18 Y_1ob (XVI), and chromosome 26 and $n_2gl_3ne_2$ (IX). Genetic results establish that chromosomes 12 and 26 are homeologs.

Endrizzi, J. E. and G. Ramsay. 1983. Inheritance of the H_1, H_2, and Sm_2 genes in cotton. Crop Sci. 23: 449-452. Used aneuploids to show that the H_1 and Sm_2 genes also are located 4 Map | Ethics Line | units from the centromere in the long arm of chromosome 6. F_2 populations of the three crosses of H_1 x H_2, H_1 x Sm_2 , and Sm_2 x H_2 and found that the three genes segregated as alleles.

Endrizzi, J. E. and D. T. Ray. 1991. Linkage analysis of open bud (ob_2) and yellow petal (Y_1) loci in chromosome 18 of cotton. Genome. 34: 461-463. In this study ob_2 and Y_1 were found to have a mean recombination percentage of 3.14 for backcross and 3.40 for self-pollinated families from 2*n* parental heterzygotes and 10.73 in families from mono-18 parental heterzygotes.

Endrizzi, J. E. and D. T. Ray. 1992. Mapping of the cl_1 R_1, yg_1, and *Dw* loci in the long arm of chromosome 16 of cotton. J. Hered. 83: 1-5. The four loci are in the long arm of chromosome 16 and, including the centromere, the Map | Ethics Line | order and Map | Ethics Line | distances between loci were determined to be: centromere 30.0 ± 6.3 cl_1 18.6 ± 1.3 R_1 19.8 ± 1.4 yg_1 33.8 ± 1.6 *Dw*.

Endrizzi, J. E., D. T. Ray, and A. C. Gathman. 1983. Centromere orientation of quadrivalents of heterozygous translocations and an autoploid of *Gossypium hirsutum* L. Genetics 105: 723-731. Cytological observations of

quadrivalents of heterzygous translocations demonstrate that, in addition to alternate-1 and alternate-2 orientations, a third alternate orientation (alternate-3), which occurs as a three-dimensional, V-type configuration, can be identified.

Endrizzi, J. E., E. L. Turcotte, and R. J. Kohel. 1984. Cytology, Genetics, and Evolution of *Gossypium*. Cotton. Amer. Soc. Agron. Ch. 4, pp. 81-129. A review of cotton qualitative genetics and cytogenetics of cotton.

Endrizzi, J. E., E. L. Turcotte, and R. J. Kohel. 1984. Qualitative genetics, cytology, and cytogenetics. Cotton Amer. Soc. Agron. 24: 81-129. A review of qualitative genetics, cytology, and cytogenetics of cotton is presented.

Endrizzi, J. E., E. L. Turcotte, and R. J. Kohel. 1985. Genetics, cytology and evolution of *Gossypium*. Advances in Genetics. 23: 271-375. A comprehensive review of the published information on the cytology, genetics, and evolution of *Gossypium* is presented.

Feaster, C. V. and E. L. Turcotte. 1983. Notice to growers relative to release of a commercial variety of American Pima cotton, 'Pima S-6.' USDA, and Ariz., New Mex., and Tex. Agric. Exp. Stn. Memo. 3p. and Registration of Pima S-6 cotton. (Reg. No. 81). Crop Sci. 24: 382. 1984. Pima S-6 was released as a replacement for 'Pima S-5' in a major portion of the Pima cotton belt. The advantages of Pima S-6 are earlier maturity and higher yield.

Flint, H. M., N. J. Curtice, and F. D. Wilson. 1986. A comparison of related nectaried and nectariless cottons for control of the pink bollworm in field plots treated with gossyplure, insecticide, or untreated. J. Agric. Entomol. 3: 362-368. The nectariless Deltapine NSL had significantly fewer pink bollworm per boll and yielded 23 percent more lint than the control cultivar, Deltapine 61, in untreated plots. Pink bollworm infestation was lowest in insecticide-treated plots, intermediate in untreated plots, and highest in gossyplure-treated plots. Lint yield was highest in insecticide-treated plots, but not significantly different in untreated and gossyplure-treated plots.

Flint, H. M., N. J. Curtice, and F. D. Wilson. 1988. Development of pink bollworm populations (Lepidoptera:Gelechiidae) on nectaried and nectariless Deltapine cottons in field cages. Environ. Entomol. 17: 306-308. Seasonal increases in populations of pink bollworm, from moths released in separate cages of nectaried 'Deltapine 61' and nectariless 'Deltapine NSL,' were 21-fold for the nectaried cultivar and 15-fold for the nectariless one, a highly significant reduction for the latter.

Flint, H. M., N. J. Parks, D. L. Hendrix, F. D. Wilson, and J. W. Radin. Whitefly population growth in cotton. A 3-year study in Maricopa, Arizona. USDA-ARS-93. Sweetpotato whitefly is a late-season pest of cotton at Maricopa. Reproduction on cotton is associated with water-stressed plants following irrigation termination. The initial source of the late season adult whiteflies, which are assumed to be immigrants, is unknown. A control measure would be to chemically defoliate the plants as soon as possible after irrigation is terminated.

Flint, H. M., F. D. Wilson, and N. J. Parks. 1989. Causes of square shed in cotton in central Arizona. Southw. Entomol. 14: 271-278. Square shed in WC-12NL, a nectariless, okra-leaf germplasm line, was compared with that in the nectaried, normal-leaf cultivar, Deltapine 61. Causes of square shed were (1) physiological stress; (2) thrips; (3) lygus bugs; (4) bollworms. WC-12NL set 23 percent more squares than Deltapine 61 in early season. Over the season, WC-12NL shed more squares caused by physiological stress, and shed fewer due to thrips damage than did Deltapine 61. Abnormal (4-bract) squares on Deltapine 61, but not on WC- 12NL, had greater feeding damage caused by thrips than did normal (3-bract) squares.

Flint, H. M., F. D. Wilson, N. J. Parks, R. Y. Reynoso, B. R. Stapp, and J. L. Szaro. 1992. Suppression of pink bollworm (Lepidoptera:Gelechiidae) and effect on beneficial insects of nectariless okra-leaf germplasm line. Bull. Entomol. Res. 82: 379-384. At two locations over three seasons, boll infestations of pink bollworm were significantly lower on the nectariless, okra-leaf germplasm line WC-12NL than on the nectaried, normal-leaf Deltapine 61. The numbers of *Lygus* spp. and three beneficial insects were not different on the two cottons. Collops beetle numbers were higher on WC-12NL, while lady beetle numbers were higher on Deltapine 61.

Foster, J. David, Jr. 1987. Prometryn tolerance of glanded vs. glandless isolines in selected cotton cultivars. M.

S. Thesis, Oklahoma State University. Experiments were conducted in a growth chamber to compare the prometryn tolerance of glanded vs. glandless 'Empire 61 (WR)' and 'Westburn M' isolines. Two intermediately glanded Empire isolines (*$Gl_2Gl_2gl_3gl_3$* and *$gl_2gl_2Gl_3Gl_3$*) were also available. Ratios derived from leaf fluorescence measurement curves established that photosynthetic inhibition caused by prometryn in glanded plants was of less intensity and shorter duration than in glandless plants. Comparisons involving the intermediately glanded Empire isolines suggested that *Gl_2* enhances tolerance more than does *Gl_3*. Glanded vs. glandless isolines on five genetic backgrounds (i.e., Empire 61 (WR), Westburn M, 'Delcot 277,' 'TH 149,' and 'Stoneville 213') plus the two intermediate Empire isolines were also evaluated for prometryn tolerance in the field. Visual injury ratings and measured lint yields support the growth chamber data. The treated glanded isoline on each background displayed less injury (20 to 56 percent) and higher yield (44 to 60 percent) than the corresponding glandless isoline. Again, *Gl_2* showed less injury than *Gl_3*, though differences in lint yield were not significant. Clearly, lysigenous glands enhance prometryn tolerance in cotton, and higher gland density is directly associated with increased tolerance.

Foy, C. D., J. E. Jones, and H. W. Webb. 1980. Adaptation of cotton genotypes to and acid, aluminum toxic soil. Agron. J. 72: 833-839.   Fifty-four cotton genotypes were screened for Al tolerance in greenhouse pots of an acid, Al-toxic Tatum subsoil (clayey, mixed, thermic, typic Hapludult) with pH adjusted to approximately 4.8 or 5.3 with CaCO. Tolerance was measured as relative growth in lower vs. higher pH. Genotypes showing greatest tolerance to acid subsoil included 'Pima S-2,' 'Acala 4-42,' La DASS 5194, La DASS 5187, 'Stoneville 213,' 'Delcot 277,' 'McNair 612,' and 'Dixie King 3.' More sensitive genotypes included 'Auburn 56,' 'Coker 201,' 'Deltapine 16' and several experimental lines.

Foy, C. D., H. W. Webb, and J. E. Jones. 1981. Adaptation of cotton genotypes to an acid, Manganese toxic soil. Agron. J. 73: 107-111. Sixty-five cotton genotypes were screened in greenhouse pots of an acid (pH 5.1), Mn-toxic Grenada (fine silty, mixed, thermic, typic, Fragiudalffs) silt loam. Nine of these genotypes, plus two from Brazil, were compared on the same soil at pH 5.1 vs. pH 6.9. Genotypes showing the greatest resistance included C-310,73-307; LaDSIS 12513; and LaDASB 12609. Manganese sensitive genotypes included C-Sgl,70-517; C-417-2912; and Coker 201.

Fryxell, P. A. 1980. A new species of *Hampea* (Malvaceae) from El Salvador. Syst. Bot. 5: 442-444. *Hampea reynae* is described and illustrated.

Fryxell, P. A. 1981. Revision and expansion of the neotropical genus *Wercklea* (Malvaceae). J. Arnold Arbor. 62: 457-486. The 12 species of *Wercklea* are described, illustrated and discussed in detail. They occur in Central America, the West Indies, and northwestern South America, i.e. around the periphery of the Caribbean Sea.

Fryxell, P. A. 1982. *Billieturnera* (Malvaceae), a new genus from Texas and Mexico. Sida 9: 195-200. A distinctive new genus is recognized with one species occurring in saline habitats in southern Texas and northeastern Mexico.

Fryxell, P. A. 1983. Very peronal generic names (nomina perpropria): A contribution to whimsical botany. Sida 10: 95-102. A survey and analysis is made of generic names of angiosperms honoring individuals based on their full names (given name and surname) which is found to be a long-standing and continuing practice.

Fryxell. P. A. 1984. Evolucion de las especies cultivadas de algodon. Ceiba 25: 156-163. Evolution in *Gossypium* is discussed in broad outline, with particular attention to the origin of the cultivated species.

Fryxell, P. A. 1984. Four new species of Malvaceae from Mexico. Syst. Bot. 9: 415-422. *Pavonia discolor, Periptera ctenotricha, Robinsonellachiangii,* and *Dirhamphis mexicanaare* described and illustrated.

Fryxell, P. A. 1984. La evoluciùn de las especies cultivadas de algodùn. Ceiba 25: 156-163. A semi-popular account, in Spanish, of evolution in *Gossypium*, with special reference to the cultivated species, taken from a talk given to a workshop in Central America.

Fryxell, P. A. 1984. *Rojasimalva* (Malvacea), un nuevo genero de Venezuela. Ernstia 28: 11-14. A new genus is

recognized with one species occurring in Venezuela.

Fryxell, P. A. 1984. Taxonomy and germplasm resources.A Cotton Monograph, Amer. Soc. Agron. Monograph Ser. # 24. Chapter 2, pp. 27-57. The taxonomy of *Gossypium* is summarized, including botanical descriptions of all of the known species, and a discussion of the range of variation available in the genus. Against this background, the history and development of cotton germplasm collections is discussed, followed by a consideration of examples of the successful utilization of these resources.

Fryxell, P. A. 1985. Additional novelties in Mexican Malvaceae. Syst. Bot. 10: 268-272. *Horsfordia exalata, Robinsonella glabrifolia,*and *Abutilon procerum* are described and illustrated.

Fryxell, P. A. 1985. Four new species of Malvaceae from Venezuela. Syst. Bot. 10: 273-281. *Abutilothamnus yaracuyensis, Batesimalva killipii, Dendrosida wingfieldii*, and *Peltaea krapovickasiorum* are described and illustrated.

Fryxell, P. A. 1985. *Sidus sidarum* V. The North and Central American species of *Sida*. Sida 11: 62-91. The 42 species of *Sida* that occur in North and Central America (incl. the West Indies) are treated and sorted into 11 sections of the genus. The sectional divisions are applicable on a world-wide basis.

Fryxell, P. A. 1985. Up with diversity. BioScience 36: 735-737. Presidential address to the American Society of Plant Taxonomists, discussing problems and trends in the education of the next generation of systematic botanists.

Fryxell, P. A. 1986. "The Cotton Gazetteer" by Arlen W. Frank. Econ. Bot. 40: 251-252. Book review of an interesting summarization of cotton statistics world-wide.

Fryxell, P. A. 1986. Ecological adaptations in *Gossypium* species. *in* Mauney, J. R. and J. M. Stewart (eds.), Cotton Physiology, The Cotton Foundation, Memphis, TN. Ch. 1, pp. 1-7. The wild species of cotton are adapted to a wide array of ecological habitats. The adaptations to these ecological factors that have evolved in the various species are described, to indicate the range of germplasm available in the genus *Gossypium* and to indicate the physiological background against which studies of the physiology of the cultivated species can be understood.

Fryxell, P. A. 1988. "Charles Wright on the boundary, 1849-1852, or Plantae Wrightianae revisited" by Elizabeth A. Shaw. Econ. Bot. 42: 53. Book review of a detailed analysis of the life and work of an important plant collector, at least with that portion of his career when he worked on the U.S. - Mexican border.

Fryxell, P. A. 1988. The genus *Pavonia* in Australia. Nuytsia 6: 305-308. A review of what is known of the three species of *Pavonia* that have been recorded from Australia.

Fryxell, P. A. 1988. Malvaceae of Mexico. Syst. Bot. Monogr. 25: 1-522. A book-length illustrated monograph on the 55 genera and over 370 species of Malvaceae that occur in Mexico. A treatment of the 14 species of *Gossypium* that occur in the country is included, as well as treatments of other genera of the cotton tribe: *Hampea* (11 Mexican species), *Cienfuegosia* (3 Mexican species), and *Thespesia* (1 Mexican species).

Fryxell, P. A. 1990. Malvaceae. Flora of Chipas, Calif. Acad. Sci., San Francisco, CA. pp 1- 86. A treatment of the 35 genera and 129 species of Malvaceae that occur in Chiapas, the southernmost state of Mexico. Selected species are illustrated.

Fryxell, P. A. 1990. New species of Malvaceae from South America. Contr. Univ. Michigan Herb. 17: 163-172. *Briquetia brasiliensis, Nototriche ecuadoriensis, Pavonia falconensis, Pavonia insperabilis,*and *Urocarpidium stipulatum* are described and mostly illustrated.

Fryxell, P. A. 1992. A revised taxonomic interpretation of *Gossypium*. Rheedea 2: 108-165. An updated account of current understanding of the taxonomy of *Gossypium*, taking into account several recently described species and newly acquired data relevant to classification in the genus. The classification into subgenera,

sections and subsections is revised, and one new section and one new species are described, bringing the total number of species to 50.

Fryxell, P. A., L. A. Craven, and J. M. Stewart. 1992. A revision of *Gossypium* sect. *Grandicalyx*, including the description of six new species. Syst. Bot. 17: 91-114. The 11 species of this group are from the Kimberley region of northwestern Australia. Their history and ecological context are fully discussed; the species are described and their distributions mapped; chromosome counts (all 2n=26) are reported for seven of the species; and six new species are described and illustrated: *G. enthyle, G. exiguum, G. londonderriense, G. marchantii, G. nobile*, and *G.rotundifolium*.

Fryxell, P. A. and S. D. Koch. 1987. New or noteworthy species from the Sierra del Sur of Guerrero and Michoacçn, Mexico. Aliso 11: 539-561. A description of several new species from Mexico, including *Gossypium schwendimanii*, together with commentary on these and other noteworthy collections and illustrations of the new species.

Fryxell, P. A. and S. D. Koch. 1991. *Pavonia ecostata* (Malvaceae), a new species from Jalisco, Mexico. The new species is described and illustrated.

Fryxell, P. A. and A. Krapovickas. 1986. Proposal to conserve Peltaea against *Peltostegia*. Taxon 35: 389-390. A proposal [subsequently approved] to stabilize a nomenclatural matter in the Malvaceae.

Fryxell, P. A. and A. Krapovickas. 1990. The Malvaceae published by Turczaninow. Contr. Univ. Michigan Herb. 17: 173-182. An analysis of the 58 names published Malvaceae by N. S. Turczaninow (1796-1864), including two new generic names, based on an examination of the specimens studied by him that are kept at the Ukrainian Academy of Sciences in Kiev.

Fryxell, P. A. and J. Valdes. Observations on *Fryxellia pygmaea* (Malvaceae). Sida 14: 399-404. The rediscovery of this rare plant in central Coahiula is noted, and observations are presented on its ecology, chromosome number (2n=16), and probable taxonomic affinities.

Fryxell, P. A., J. Valdes, and J. A. Vallarreal. 1991. A new species of *Sphaeralcea* (Malvaceae) from Coahiula, Mexico. Southwestern Naturalist 36: 358-360. *Sphaeralcea reflexa* is described and illustrated and its chromosome number (2n=20) reported.

Fryxell, P. A. and F. D. Wilson. 1986. Clarification of the status of *Hibiscus* (sect. *Furcaria) uncinellus* DC. (Malvaceae). Brittonia 38: 107-110. *H. uncinellus*, a vigorous, red-flowered vine of Mexico, has been confused with *H. bifurcatus* Cav., a pink-flowered shrub of Central and South America.

George, B. W. and F. D. Wilson. 1983. Pink bollworm: Effects of natural infestation on upland and Pima cottons untreated and treated with insecticide. J. Econ. Entomol. 76: 1152-1155. The economic level of seed damage caused to cotton by pink bollworm was 3 to 10 percent in the susceptible upland cultivar, Deltapine 61; 5 to 17 percent in the susceptible Pima cultivar, Pima S- 5; and above 17 percent in the resistant upland breeding stock, AET-5. Over 3 seasons, lint yields in unsprayed plots were 84 percent (Deltapine 61), 73 percent (Pima S-5), and 101 percent (AET-5) of yields in insecticide-treated plots.

George, B. W., F. D. Wilson, and R. L. Wilson. 1983. Methods of evaluating cotton for resistance to pink bollworm, cotton leafperforator, and lygus bugs. So. Coop. Ser. Bull. 280. pp. 41-45. A review of the host-plant resistance methods used at the Western Cotton Research Laboratory, Phoenix, Arizona.

Girma, Bedada. 1981. Breeding behavior of tufted seed in crosses involving two tufted lines and three commercial cotton cultivars. M. S. Thesis. University of Arkansas. Seed tip-fuzz inheritance was examined in upland cotton. The tuft character derived from Yugloslav 72 appeared controlled by a single recessive gene. The gene was not allelic to the naked character derived from D-15 x Stripper 31. A tufted trait also derived from D-15 x Stripper 31 differed from the Yugloslaw trait. Whereas the D-15 x Stripper 31 mutants accompanied low lint perccent, the Yugoslav 72 trait did not.

Green, C. C. and T. W. Culp. 1988. Utilization of fiber strength measurements in the development of high fiber strength cottons. p. 613-614. in J. M. Brown (Ed.) Proc. Belt. Cotton Prod. Res. Conf., New Orleans, LA. 3-8 Jan. Natl. Cotton Counc. Am., Memphis, TN. Stelometer and HVI fiber strength measurements were evaluated as selection criteria to improve yarn strength in three cotton populations. Neither fiber strength measurement was more consistently correlated with yarn strength over the three populations. Stelometer and HVI fiber strength were only moderately correlated, suggesting that the two strength measurements may not be measuring the same genetic properties.

Greenhagen, Bruce E. 1988. Magnitude and consistency of heterosis in crosses among Plains- type cotton cultivars. M.S. Thesis, Oklahoma State University. The magnitude and consistency of midparent (MP) and high parent (HP) heterosis over three irrigated locations and/or 3 years were studied for cotton in Oklahoma. Parents, F_1s, and F_2s were evaluated for all possible crosses, ignoring reciprocals, among five Plains-type cultivars [(1) 'Lockett 77,' (2) 'Tamcot SP21,' (3) 'Paymaster 303,' (4) 'Tamcot SP37,' and (5) 'Westburn M']. Six parental combinations (1 x 3, 1 x 4, 1 x 5, 2 x 4, 3 x 5, and 4 x 5) displayed significant F_1 MP heterosis for lint yield ranging from 11.5 to 34.0 percent. That heterosis was consistent over locations and years. The four other combinations sporadically displayed significant F_1MP heterosis over environments. Five parental combinations (1 x 3, 1 x 4, 1 x 5, 3 x 4, and 3 x 5) exhibited significant F_1HP heterosis for lint yield ranging from 12.6 to 26.6 percent. That heterosis was consistent over locations and years, and those five combinations have economic potential. One of the remaining combinations (2 x 3) did not exhibit significant F_1HP heterosis. The four other combinations sporadically exhibited significant F_1HP heterosis over environments, and their potential is questionable.

Gwyn, J. J. and D. M. Stelly. 1989. Method to evalute pollen viability of upland cotton: Tests with chromosome translocations. Crop Sci. 29: 1165-1169. A modified fluorochrome reaction (FCR) method, using fluorescein diacetate, was evaluated for application as a pollen from normal and reciprocal chromosome translocation cytotypes grown in greenhouse and field environments. Analyzed materials included 44 different true-breeding translocation homozygotes, respective F_1 heterozygotes, and three differenct cytogenetically analyzed BC_1F_1 families. Results were concordant with cytogenetic expectations and meiotic analyses, indicating that the pollen technique works well.

Ha, Sam B. 1986. Effects of selected morphological traits in cotton on natural insect infestations, lint yield, lint percent, and fiber quality. Ph.D. Dissertation, Oklahoma State University. Five morphological traits (i.e., okra leaf, nectariless, frego bract, smooth leaf, and glandless) vs. the normal check were compared in each of eight genetic backgrounds under irrigation and without insecticides at two locations for 3 years. The smooth-leaf trait reduced cotton fleahopper populations by 54 percent when averaged over years, locations, backgrounds, and sampling dates. Frego bract increased fleahopper numbers by 64 percent over the same variables. The okra-leaf, nectariless, and glandless traits occasionally influenced fleahopper infestations, but not consistently. Smooth leaf did suppress, to some extent, bollworm oviposition; but the other traits had little effect on that trait. The nectariless lines were comparable to the checks for lint yield and lint percent. The okra-leaf lines were also comparable to the checks for lint yield, but were frequently lower for lint percent. Large and consistently significant reductions in lint yield and lint percent of the frego-bract lines were exhibited. The smooth-leaf lines often displayed lower lint yield than the checks, possibly resulting from lower lint percent. The lint yield and lint percent of the glandless lines were reduced in some genetic backgrounds. Based on these results, frego-bract should not be incorporated into the Oklahoma cotton breeding program; smooth leaf and glandless appear unpromising and probably should not be used; and nectariless and okra-leaf should receive some attention.

Ha, S. B. and L. M. Verhalen. 1986. Inheritance of the multilock boll in upland cotton. Proc. Beltwide Cotton Prod. Res. Conf. p. 103. (Abstr.) Upland cotton normally has four- or five-lock bolls and occasionally bolls with three- or six- locks. A mutant type which consistently has 6- to 10-lock bolls (averaging between 7 and 8) was obtained from the Regional Cotton Germplasm Collection at Stoneville, MS (S.A. 0981 "Multiple Lock, West Tex"). Two multilock lines derived from S.A. 0981 were crossed with TM-1 and 'Westburn M,' respectively. The parental, F_1, F_2, and backcross populations were examined. Multilock boll appears to be governed by a single, largely recessive gene.

Hampton, R. E., D. M. Oosterhuis, J. McD. Stewart, and K. S. Kim. 1987. Antomical differences in cotton

related to drought tolerance Ark. Farm. Res. 36(6):4. Various genotypes represented by Stoneville 506, DeRidder Red Leaf, Pilose, D_2 and a *G. barbadense* were measured for epidermal wall thickness, cuticle thickness, trichome density, capitate gland density and stomate density. Physiological measurements were leaf temperature, stomatal resistance and transpiration. Pilose has the lowest surface temperature. Stomatal number did not correlate with stomatal resistance or transpiration.

Hsieh, C., J. N. Jenkins, J. C. McCarty, Jr., R. L. Shepherd, and W. L. Parrott. 1987. Breeding potential of cotton germplasm tolerant to tobacco budworm *Heliothis virescens* (Fab.). Miss. Agric. and For. Exp. Stn. Tech. Bull. 144. 7 pp. Genetic analysis of resistance to tobacco budworm in M-DH-118, M-DH-126, and M-DH-128 indicate that there should be no major complicating factors in using these three lines as parents to develop cultivars with resistance to tobacco budworm. Analysis suggest that delaying selection until F4 and selecting on a progeny row basis should be successful. Variance for resistance was primarily additive with smaller but significant dominance and epistatic effects present.

Hsu, C. L. and J. McD. Stewart. 1982. A rapid stain method for suspension cultured plant cells. J. Tiss. Cult. Meth. 7: 69-72. A procedure based on partial hydrolysis of cells with HCL followed by toluidine blue O staining is described for visualizing cell walls and chromosomes of cultured plant cells including cotton.

James, D. and J .E. Jones. 1985. Effect of leaf and bract isolines on spray penetration and insecticidal efficacy. Proc. Beltwide Cotton Prod. Res. Conf., pp. 395-396. Four isolines of cotton differing in leaf (okra vs. normal) and bract (frego vs. normal) types in all combinations were evaluated under four insecticide regimes to evaluate the effects of these morphological traits on insecticide efficacy and spray penetration. Spray penetration was measured when cotton was 4 feet tall by spraying the crop with non- active agricultural dye using a J.D. Hy-Cycle delivering 8 gal/a at 40 p.s.i. and evaluating paper cards that had been placed at three depths within the canopy. Okra leaf was found to significantly increase spray penetration both in terms of drops per square inch and percent area covered. Insecticide efficacy results were inconclusive

Jenkins, J. N., P. A. Hedin, W. L. Parrott, J. C. McCarty, Jr., and White, W. H. 1983. Cotton allelochemics and growth of tobacco budworm larvae. Crop Sci. 23: 1195-1198. Putative allelochemicals for resistance to tobacco budworm were fed in wheat germ diet and their relationship to larvae weight were determined. Chemicals were cyanidin, delphinidin, gossypol, condensed tannin, chrysanthemin, isoquercitrin and quercetin. Regression equations are presented to describe effects on larvae growth.

Jenkins, J. N., J. C. McCarty, Jr., and W. L. Parrott. 1990. Effectiveness of fruiting sites in cotton: yield. Crop Sci. 30: 365-369. Plant maps of bolls at harvest were developed for eight cultivars. From 66 to 75 percent of yield came from position one bolls, 18-21 percent from position two bolls, with 2-4 percent from all other position bolls. Monopodial branches produced from 3-9 percent of yield. The newer short-season cultivars produced more of their yield at nodes 5-8 than older cultivars.

Jenkins, J. N., J. C. McCarty, Jr., and W. L. Parrott. 1990. Fruiting efficiency in cotton: Boll size and boll set percentage. Crop Sci. 30: 857-860. Plant maps of bolls at harvest were developed for eight cultivars. Boll set varied by cultivar and node. Bolls at position 1 were 14 percent and 21 percent larger than bolls at positions 2 and 3, respectively.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., K. A. Barton, and P. F. Umbeck. 1991. Field test of transgenic cottons containing a *Bacillus thuringiensis* gene. Miss. Agric. and For. Expt. Stn. Technical Bulletin 174. 6 pp. Describes field test and regulatory protocol for evaluation of transgenic cotton containing a gene from *Bacillus thuringiensis* which codes for the delta endotoxin. The cotton plants did not express the toxin as levels sufficient to offer field control of tobacco budworm.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., and L. Dearing. 1986. Performance of cottons when infested with tobacco budworm. Crop Sci. 26: 93-95. Resistance to tobacco budworm defined as ability to set and mature bolls in the presence of high levels of tobacco budworm was measured in 13 cotton strains. Resistance was identified in ST 506 and confirmed in PEE DEE 875, PEE DEE 8619 and Tamcot CAMD-E. Regression analysis suggest that about 65 percent of the measured resistance is associated with early, rapid fruiting.

Jenkins, J. N., W. L. Parrott, J. C. McCarty, Jr., and W. H. White. 1982. Breeding cotton for resistance to the tobacco budworm: techniques to achieve uniform field infestations. Crop Sci. 22: 400-404. Techniques, equipment, and procedures for handling tobacco budworm pupae, adults, eggs, and first instar larvae are described, as well as procedures for uniformily infesting progeny rows of cotton with first instar larvae.

Jenkins, J. N., and F. D. Wilson. Host plant resistance. p. *in* E. G. King and J. R. Phillips (eds.) Cotton insects and mites: characterization and management. No. 3. Cotton Foundation Ref. Book Ser. A review of resistance of cotton to insects and mites.

John, M. E. and J. McD. Stewart. 1992. Genes for better jeans: biotechnological advances in cotton. Biotechnology 10: 165-170. A review of the current status of biotechnology applications in cotton. Emphasis is placed on the status of molecular manipulation of cotton fiber chracteristic.

Jones, J. E. 1982. The present state of the art and science of cotton breeding for leaf-morphological types. Proc. Beltwide Cotton Prod. Res. Conf. pp. 93-99. Literature review on the effects of leaf shape (including normal, okra, sub-okra, sea-island, and laciniate) on boll rot, earliness, yield, leaf area, within-canopy microclimate, reaction to insects, weed control, and special adaptation. (44 references).

Jones, J. E., J. P. Beasley, J. I. Dickson, and W. D. Caldwell. 1988. Registration of four cotton germplasm lines with resistance to reinform and root-knot nematodes. Crop Sci. 28: 199- 200. Lines included La. RN 4-4, La. RN 909, La. RN 910, and La. RN 1032. All were selections from LA 434-RKR. LA 434-RKR originated from a cross of Bayou 7769 x 'Deltapine 16.' Bayou 7769 is resistant to root-knot nematode (RKN) and was developed from a cross of 'Deltapine 15' x 'Clevewilt-6.' The germplasm lines were evaluated for nematode resistance in the greenhouse in RKN and reinform nematode (RN) infested soil, and in the field on natural RN-infested soil at Baton Rouge, LA.

Jones, J. E., E. Burris, W. D. Caldwell, J. G. Marshall, J. I. Dickson, and D. F. Clower. 1987. Field performance of some new cotton strains with resistance to *Heliothis* spp. Proc. Beltwide Cotton Prod. Res. Conf. pp.94-96. Five new high glandulosity (HG) cotton strains were found to exhibit significant levels of resistance to natural field infestations of *Heliothis* spp., as measured by fruit damage, fruit infestation, and lint yield, when compared to the susceptible cultivar, Stoneville 213. La. HG 810063 and La. HG 820660, in particular, represent improvements in yield potential, earliness, and fiber quality while maintaining a moderately high level of resistance to *Heliothis* spp.

Jones, J. E., E. Burris, S. J. Stringer, and D. F. Clower. 1984. Further breeding studies with frego bract cottons. Proc. Beltwide Cotton Prod. Res. Conf. pp. 369-371. Several frego and frego-nectariless strains were evaluated under a moderate plant bug infestation which was left uncontrolled until 27 July, about 3 weeks after first bloom. La. 243-47-FN, La. 271-53-FN, and La. 271-58-FN were significantly more tolerant and/or resistant to plant bugs than La. 81-560-FN, the frego-nectariless check strain. These strains represent a significant step forward in developing useable frego bract cottons.

Jones, J. E., W. D. Caldwell, D. T. Bowman, J. W. Brand, A. Coco, T. G. Marshall, D. J. Boquet, R. Hutchinson, W. Aguillard, and D. F. Clower. 1981. Gumbo 500: An advancement in breeding open-canopy cottons. Louisiana Agric. 24: 8-13. 'Gumbo 500' was released in 1981 by the Louisiana State Univ. Agric. Exp. Stn. as a replacement for 'Gumbo.' Gumbo 500, like Gumbo, is characterized by the okra-leaf trait that gives it an open-type canopy. However, Gumbo 500 represents an improvement over Gumbo for yield, earliness, lint percentage, fiber quality, and resistance to *Fusarium* wilt.

Jones, J. E., D. F. Clower, E. Burris, J. G. Marshall, and S. J. Stringer. 1983. Progress in breeding frego-nectariless cottons for reduced plant bug sensitivity. Proc. Beltwide Cotton Prod. Res. Conf. pp. 81-83. Literature and unpublished studies relating the advantages of frego bract and it sensitivity to plant bug are reviewed. The nectariless trait was an aid in reducing plant bug sensitivity in frego bract, but did not completely solve the plant bug problem. Ar-Frego 3 and Ar-Frego 25 were found to flower at a high rate during July, a trait that either reflects reduced square shed due to plant bug damage, or is a mechanism of tolerating yield loss due to plant bug feeding.

Jones, J. E., J. I. Dickson, W. Aguillard, W. D. Caldwell, S. H. Moore, R. L. Hutchinson, and R. L. Rogers. 1991. Registration of 'LA 887' Cotton. Crop Sci. 31: 1701. 'LA 887,' tested experimentally as LA 830887, was developed from a cross of LA 434-RKR x DES 11-9. LA 434-RKR is an experimental strain with superior fiber quality and resistance to root-knot nematode (RKN). DES 11-9 is an experimental strain obtained from R. R. Bridge, Delta Branch Experiment Station, Stoneville, MS. A selection (DES 11913) from DES 11-9 was subsequently released as 'DES 119.' LA 887 is characterized by premium fiber quality, resistance to RKN/fusarium wilt complex, and high-yield potential.

Jones, J. E., J. I. Dickson, and J. P. Beasley. 1987. Preference and nonpreference of boll weevils to selected cotton. Proc. Beltwide Cotton Prod. Res. Conf. pp. 98-102. Certain genotypes were shown to be several times more attractive to boll weevils than the commercial cultivars, Stoneville 213 and Deltapine 41. Their greater attractiveness was due in part to an early and more rapid fruiting rate, but in the case of 'Tamcot CAB-CS,' TX CAMD 21S-7-81, and TX BLLEBOS 1-83, an additional attractiveness factor was indicated. A number of breeding strains with red-stem, red-stem-nectariless, frego bract, and frego- nectariless traits were nonpreferred by boll weevil. Field resistance to boll weevil was confirmed in six day-neutral-converted race stocks (MT-109, MT-293, MT-326, MT-330, MT- 763, and MT-1180) and in one day-neutral race-stock-derived strain (T277-2-6).

Jones, J. E., J. I. Dickson, E. Burris, D. F. Clower, W. D. Caldwell, J. G. Marshall, and S. J. Stringer. 1988. Registration of three insect resistant cotton germplasm lines. Crop Sci. 28: 200. Lines included La. HG-063, La. HG-065, and La. HG-660, which combine resistance to bollworm/tobacco budworm (BW/TBW) with early maturity, good yielding ability, acceptable fiber quality, and reduced pubescence. BW/TBW resistance is attributed to a high frequency of normal-size gossypol glands (HG) located over the calyx (including lobes), ovary wall, and other plant parts. The lines were developed from a cross between two HG lines, La. HG 83-1-1546 x La. HG 1838-1497. The two parents were selected from an intercross population involving Louisiana advanced breeding lines, 'Stoneville 213,' and GT5A-10-152XG15. The strain, GT5A-10-15-2XG15, obtained from M. J. Lukefahr, was the original source of the HG trait.

Jones, J. E., J. I. Dickson, J. B. Graves, A. M. Pavloff, B. R. Leonard, E. Burris, W. D. Caldwell, S. Macinski, and S. H. Moore. 1989. Agronomically enhanced insect-resistant cottons. Proc. Beltwide Cotton Prod. Res. Conf. pp. 135-137. Yield and insect damage of five experimental strains is discussed. LA850074-F, LA850075-F, LA850082-FN, LA860280-F, and LA860284-F were equal to or superior than La HG-660 in terms of lint yield and reduced bollworm/tobacco budworm (BW/TBW) damage. LA850074-F and LA850075-F produced lint yields equal to or superior than 'Deltapine 41' and 'DES 119' in the absences of BW/TBW. All strains are frego bract and would be expected to be resistant to boll weevils as well.

Jones, J. E., J. I. Dickson, and R. G. Novick. 1988. Another look at effects of leaf shape traits on agronomic performance of upland cotton. Proc. Beltwide Cotton Prod. Res. Conf. p. 94. Four leaf shape near-isolines [normal, semi-okra (sea-island or sub-okra), okra, and super-okra] on each of two genetic backgrounds (La 213-613 and MD 65-11) were evaluated in nine environments. Okra leaf was the superior leaf shape on the La. 213-613 background in terms of lint yield; sub-okra was the superior leaf shape on the MD 65-11 background. Super-okra was affected by environments more than the other leaf types; its yield was inferior to normal leaf in environments where rank growth was not a problem, but equal or superior to normal leaf when rank growth occurred. Super-okra leaf increased earliness on both genetic backgrounds, and okra leaf increased earliness on the La. 213-613 background.

Jones, J. E., R. G. Novick, and J. I. Dickson. 1988. Boll weevil resistance in day-neutral converted primitive race stocks of *Gossypium hirsutum* L. Proc. Beltwide Cotton Prod. Res. Conf. p. 99. Nine race-stock-derived, day-neutral strains were compared with the boll-weevil-susceptible cultivars, Stoneville 213 and Deltapine 41, and the resistant frego-nectariless breeding line La.81-560FN for relative field resistance to boll weevils and for anther number and mass per flower. Field resistance was confirmed in four strains (MT 109, MT 330, MT 763, and MT 1180) and identified for the first time in MT 323 and T 1219). The race-stock-derived strains had as many or more anthers per flower, but less than or equally as much anther mass per flower as the checks. All race-stock-derived strains were late and unproductive, but provide sources of boll weevil resistance that should be used in cultivar development.

Jones, R. W., J. R. Cate, and P. A. Fryxell. 1991. Phenology and ecology of *Cienfuegosia intermedia* Fryx. (Malvaceae) and evaluation as a host plant of the boll weevil, *Anthonomus grandis* Boheman. Southwestern Naturalist 36: 75-83. It is concluded that boll weevils are not hosted by *C. intermedia*, and the plant plays no role in the population dynamics of the weevils in north central Mexico.

Katterman, F. R. H. and V. I. Shattuck. 1983. An effective method of DNA isolation from the mature leaves of *Gossypium* species that contain large amounts of phenolic terpenoids and tannins. Preparative Biochemistry 13(4): 347-359. Purified and unstained nuclei were isolated from the leaves of several *Gossypium* species (diploid and tetraploid). DNA, previously unobtainable, was then extracted from the nuclei by conventional means.

Kennedy, C. W., M. T. Ba, A. G. Caldwell, R. L. Hutchinson, and J. E. Jones. 1987. Differences in root and shoot growth and soil moisture extraction between cultivars in an acid subsoil. Plant and Soil 101: 241-246. Research was conducted to determine if differences in yield and crop growth of field-grown cultivars (Stoneville 825, Deltapine 41, Auburn 56, and Pima S-5) would be related to root length density and end-of-season soil moisture content in an acid soil. Normalization of root density on a percentage of total root density basis indicated that Stoneville 825 and Pima S-5 had a consistently greater percentage of roots in the acidic subsoil than did Auburn 56 and Deltapine 41. Subsoil moisture remaining at the end of the season was least for Stoneville 825 and greatest for Deltapine 41. Differences in root length density and implied soil moisture extraction in acidic subsoil may partly explain differences in adaptation by some cultivars to nonirrigated, drought-prone, acidic soils.

Kennedy, C. W. and J. E. Jones. 1991. Evaluating quantitative screening methods for manganese toxicity in cotton genotypes. J. Plant Nutrition 14: 1331-1339. Cotton genotypes LaDSIS 12513, LADASS 5175, Coker gl 79-501, and Pima S-5 were used to compare several quantitative and semi-quantitative measures of reaction to high levels of soil manganese. Indole-3-acetic acid oxidase (IAAO) is the functional enzyme of Mn toxicity, but has a relatively slow assay method. Peroxidase activity, with a faster assay method, was found to most closely parallel IAAO activity. Specific leaf weight and "percentage of leaves that were damaged" correlated the least with IAAO activity.

Kennedy, C. W., W. C. Smith, and J. E. Jones. 1986. Effect of early season square removal on three leaf types of cotton. Crop Sci. 26: 139-145. Square removal was carried out in the field on normal leaf (NL), okra leaf (OL), and super- okra leaf (SOL) near-isogeneic lines of 'Stoneville 213' for 3 and 6 weeks to determine (1) if improved yield could be obtained in OL and/or SOL types by enlarging the canopy, and (2) if delaying fruit set produced differential response in these leaf types. Results would form the basis for development of a boll weevil trap crop system using exogenous chemicals for square abscission. Square removal increased plant height, LAI and number of sympodial branches. Fruit set was more rapid and occurred in a shorter interval for all leaf types undergoing square removal for 3 weeks. These responses were greatest and most consistent in SOL. Rapid fruit set was due primarily to more sympodia fruiting simultaneously. Yield of SOL was 23.5 percent greater with 3 weeks of square removal than without square removal. Yield was not improved in NL or OL by square removal.

Kennedy, C. W., W. C. Smith, and J. E. Jones. 1986. Effect of reduced light intensity on reproductive growth of three isogeneic lines differing in leaf type. Proc. Beltwide Cotton Prod. Res. Conf. p. 63. Isogeneic lines of 'Stoneville 213' differing in leaf type [normal (NL), okra (OL), and super- okra (SOL)] were evaluated in the field under full sun, 55 percent shade cloth, and 80 percent shade cloth for 3 years. Shaded OL maintained a flowering rate comparable to control plants, while flower production in NL and SOL declined numerically or statistically across shade treatments. Boll accumulation rates of leaf types declined in shade treatments, but the reduction was smallest in OL. Relative to controls, OL and SOL had greater boll retention percent than NL in the 80 percent shade treatment. Seed cotton yield was significantly greater in OL than NL or SOL in 80 percent shade treatment.

Kittock, D. L., E. L. Turcotte, and W. C. Hofmann. 1988. Estimation of heat tolerance improvement in recent American Pima cotton cultivars. J. Agron. and Crop Sci. 161: 305- 309. This report estimated change in heat tolerance of Pima cotton through yield response over 30 years in six Arizona counties that differ in elevation and mean summer temperatures. Pima lint yield increased from 57 percent of upland yield in 1956 to 75 percent in 1985 when averaged over the six counties. Comparison of regression coefficients suggest that nearly 50 percent of the 30- year lint yield increase of Pima cotton at lower elevations was the result of increased tolerance to high temperature in improved cultivars.

Kohel, R. J. 1980. Genetic studies of seed oil in cotton. Crop Sci. 20: 784-787. Twenty lines with a wide range of seed oil were studied for genetic control of seed oil in F_3. Heritability estimate for seed oil was 35 percent. Seed oil and seed components were measured.

Kohel, R. J. 1982. Crinkle-yellow, a new mutant in *Gossypium hirsutum* L. J. Hered. 73:382- 383. A new completely recessive mutant, crinkle-yellow, was described. Linkage analysis with 41 loci found no linkage associations.

Kohel, R. J. 1983. Genetic analysis of virescent mutants and the identification of virescents v- 12, v-13, v-14, v-15, and v-16v-17 in upland cotton. Crop Sci. 23: 289-291. Nine virescent lines were tested for relation to existing virescents. The tests identified some alleles with existing virescents and identified six new loci, four simply inherited and one duplicate recessive.

Kohel, R. J. 1983. Genetic analysis of the yellow-veins mutant in cotton. Crop Sci. 23: 291- 293. A new completely recessive mutant was described. Linkage analysis with 38 loci determined it was a member of linkage group XVII with Rugate and virescent-1.

Kohel, R. J. 1985. Genetic analysis of fiber color variants in cotton. Crop Sci. 25: 793-797. Lines with combinations of brown and green fuzz and lint were analysed for their relation to known genes. Four new brown lint loci were described. All green lint and fuzz lines were allelic to green lint.

Kohel, R. J. 1988. Genetic analysis of a white mutant in cotton. Crop Sci. 28: 1016-1018. A new mutant was described that is controlled by duplicate recessive genes. The mutant is usually expressed as a seedling lethal. Linkage analysis found no linkage with the 14 loci tested.

Kohel, R. J. 1989. Cotton. Ch. 21. pp. 404-415. Oil Crops of the World. Robbelen, G., R.K. Downey, and A. Ashri (eds.). McGraw Hill Publ. Co., New York, N.Y. The genetics of seed-oil of cotton was reviewed. A discussion was presented on the status and potential for breeding of seed traits in cotton was given.

Kohel, R. J. and C. R. Benedict. 1987. Growth analysis of cottons with differing maturities. Agron. J. 79: 31-34. Performance of differing maturing cotton were evaluated for timing of reproductive events, amounts, and partioning of dry weight. It was determined that early maturity limits productivity per plant, but plant yield components can be modified with genetic selection.

Kohel, R. J. and J. P. Cherry. 1983. Variation of cottonseed quality with stratified harvests. Crop Sci. 23: 1119-1124. Two years data from stratified harvests were obtained for seed quality factors including fatty acid and amino acid profiles. Significant interactions demonstrated the care needed in sampling experiments and they pointed out the need for more research to understand the environmental factors influencing seed development.

Kohel, R. J., J. Glueck, and L. W. Rooney. 1985. Comparison of cotton germplasm collections for seed-protein content. Crop Sci. 25: 961-963. Seed protein was determined for the *Gossypium hirsutum* lines in the germplasm collection. These values were related to earlier determinations of seed-oil content.

Kohel, R. J. and McMichael. 1990. Immature fiber mutant of Upland cotton. Crop Sci. 30: 419- 421. A simple recessive mutant, immature, is described. The mutant phenotype is characterized by fibers with immature development.

Kohel, R. J. and A. E. Percival. 1989. Genetic analysis of the "rex" mutant in cotton. J. Hered. 80: 78-80. A complete recessive mutant termed rex was described. It was found as a spontaneous mutant in the cv. Rex. Linkage analysis found it linked to Ragged leaf, 17.45 percent, and therefore a member of linkage group X.

La Duke, J. C. and P. A. Fryxell. 1988. Lecotypification of *Malva angustifolia* Cav. Anales Jard. Bot. Madrid 45: 159-163. The type specimen of *Malva angustifolia* (= *Sphaeralcea angustifolia*) has previously been problematical. The problem is reviewed and resolved by the choice of a lectotype.

Lambert, L., Jenkins, J. N., Parrott, W. L., and McCarty, J. C. 1980. Evaluation of foreign and domestic cotton cultivars and strains for boll weevil resistance. Crop Sci. 20: 804-806. Forty-four domestic and introduced cotton strains were evaluated for resistance to boll weevil oviposition. Introduced lines, Lasani 11, AC 134, Albar 627, GO77-2, BP 52/NC 63, and domestic lines TX-LY-18-72, DES-HERB 16, and DES-ARB 16 received significantly less oviposition than DPL 16, but not less than ST 213.

Lambert, L., Jenkins, J. N., Parrott, W. L., and McCarty, J. C. 1980. Evaluation of 38 foreign and domestic cotton cultivars for tarnished plant bug resistance. Miss. Agric. and Forestry Exp. Stn. Res. Report 5(1). 4 pp. Thirty-eight foreign and domestic cotton cultivars were evaluated for tarnished plant bug resistance. Four lines from Bulgaria showed significant resistance.

Lambert, L., Jenkins, J. N., Parrott, W. L., and McCarty, J. C. 1982. Effect of 43 foreign and domestic cotton cultivars and strains on growth of tobacco budworm larvae. Crop Sci. 22: 543-545. Thirty-five foreign and eight USA cotton lines were evaluated for antibiosis to tobacco budworm. Significant antibiosis was present in foreign entries BJA 592, Laxmi, SATU 65 and US strains MO-HG and HG-BR-8-N.

Lambert, L., Jenkins, J. N., Parrott, W. L., and McCarty, J. C. 1982. Greenhouse technique for evaluating resistance to the bandedwinged whitefly (Homoptera: Aleyrodidae) used to evaluate thirty-five foregin cotton cultivars. J. Econ. Entomol. 75: 1166-1168. A greenhouse procedure for evaluation of cotton lines for banded winged white flies was developed and used to evaluate 36 cotton lines. One foreign line C 1211 had significantly less white fly colonization than DPL 16. No line had less white fly emergence than DPL 16.

Lee, J. A. 1981. A genetical scheme for isolating cotton cultivars. Crop Sci. 21: 339-341. A complementary lethality interaction occurs when *G. davidsonii* Kell., a diploid cotton, is crossed with either *G. hirsutum* L. or *G. barbadense* L., tetraploid cottons. The tetraploids contribute Le_1 and Le_2 while the diploid contributes Le^{dav}. This latter allele was transferred via hexaploid bridging. The *le* and Le^{dav} alleles can be used to genetically isolate cottons for special purposes, e.g. productions of hybrids and gossypol-free seeds.

Lee, J. A. 1981. Genetics of the D3 complementary lethality system in *Gossypium hirsutum* and *G. barbadense*. J. Hered. 72: 299-300. Two alleles, Le_1 and Le_2, were identified as the complementary lethal factors located in the *G. hirsutum* and *G. barbadense* genomes. The allele Le^{dav} is found in the diploid *G. davidsonii* genome.

Lee, J. A. 1981. A new linkage relationship in cotton. Crop Sci. 21: 346-347. Linkage between the gland-determining allele, GL_3^{dav}, and the complementary lethal factor, Le^{dav}, was estimated at 25.9 + 3.0 recombination units.

Lee, J. A. 1982. Linkage relationships between Le and Gl alleles in cotton. Crop Sci. 22: 1211- 1213. Indirect results and reconstruction of probable pathways in the evolution alleles at the *le* loci in various *Gossypium* taxa led to the tentative conclusion that Le_2 and Le^{dav} are alleles at a common locus. Direct methods of testing allelism are not possible since combination of the two alleles results in lethality of the embryo or plant.

Lee, J. A. 1984. Effect of plant smoothness on agronomic traits of upland cotton-fiber properties. Crop Sci. 24: 716-720. Degree of plant smoothness was not related to any consistent deleterious effect on fiber properties; however, specific smoothness alleles did confer fiber quality deficits. The Sm_2 allele reduced 2.5 percent fiber span length and increased fiber micronaire. The Sm_1^{sl} allele reduced fiber tenacity. There was evidence for maternal and reciprocal effects for some fiber traits.

Lee, J. A. 1984. Effects of plant smoothness on agronomic traits of upland cotton-lint percentage. Crop Sci. 24: 583-587. The degree of plant smoothness was not correlated with values for number of seeds per boll seed index, lint index, and grams of seed cotton per boll. The Sm_2 allele significantly reduced lint percent, and increasing plant smoothness does not further reduce lint percent.

Lee, J. A. 1984. Effects of two pilosity alleles on agronomic and fiber traits of upland cotton. Crop Sci. 24: 127-129. The pilosity alleles, H_2 and Pilose, impart dense pubescence to plant parts of cotton. Pilose differed from H_2 by having pubescent bolls. Pilose reduced 2.5 percent fiber span length and 50 percent fiber span length and fiber tensile strength while it increased fiber length uniformity index and fiber micronaire.

Lee, J. A. 1984. Two new alleles at the sm_1 locus in cotton. Crop Sci. 24: 945-947. One allele from the wild Hawaiian tetraploid species, *G. tomentosum* Nutt. ex. Seem., removes all trichomes from stems and most trichomes from mature leaves. This allele is dominant to normal pubescence. The second allele is from the Peruvian diploid species, *G. raimondii* Ulbr., and increases the density of trichomes acting as a dominant allele. This finding suggests that the sm_1 locus of the D subgenome is the homeologue of the sm_2 or h_1 of the A subgenome.

Lee, J. A. 1985. Effects of the density of pubescence on some traits of extra-long-stapled cotton. Crop Sci. 25: 517-520. Glabrous reduced lint percent in AS-2 and Pima S-5, reduced 2.5 percent span fiber length in AS-2 and reduced fiber tenacity and fiber length uniformity index in Coastland compared with normal pubescence. Hirsuteness increased lint percent in AS-2 and Pima S-5, reduced g seed cotton boll-1, lint index, fiber length uniformity index, and fiber elongation in Coastland compared with normal pubescence.

Lee, J. A. 1985. Revision of the genetics of the hairiness-smoothness system of *Gossypium*. J. Hered. 76: 123-126. The symbols *T* and *t*, denoting trichomes, replace the earlier symbols of glabrousness, *Sm* and *sm*, and hirsute enhancing, *H* and *h*. Five loci were identified with the t_1 and t_2 loci each bearing six alleles; the t_3 locus, three alleles; and the t_4 and t_5 loci each bearing two alleles.

Lee, J. A. 1986. Effects of boll pilosity on some traits of 'Pima' cotton. Crop Sci. 26: 741-743. Boll pilosity (dense pubescence) resulted in significantly higher micronaire values (5.9 and 5.8 versus 5.0 and 5.3) than glabrous bolls in a genetic stock, E-2, of 'Pima' cotton (*Gossypium barbadense* L.).

Lee, J. A. 1987. Induction of adventitious shoots in cotton. Crop Sci. 27: 349-350. Adventitious buds were discovered in the upland cotton cultivar, 'Coker 201,' although the numbers were low. However, the primitive *G. hirsutum cotton* 'Orinoco' appeared to have a well-developed capacity for the generation of shoots from roots and/or stumps.

Leonard, B. R., J. E. Jones, and J. B. Graves. 1989. *Heliothis* spp. management in cotton utilizing host plant resistance in combination with selected insecticides. Proc. Beltwide Cotton Prod. Res. Conf. pp. 323-327. Yield and insect damage of La HG-660 [partially resistant to bollworm/tobacco budworm (BW/TBW)] and 'Deltapine 41' (DP41, susceptible to BW/TBW) were compared under three BW/TBW control regimes: larvicide, ovicide and no control. DP41 without BW/TBW control suffered significantly more BW/TBW damage than all other treatments. A larvicide in combination with La HG-660 was the most effective treatment for controlling BW/TBW damage, though not significantly more effective than a larvicide in combination with DP41. Lint yields of both strains were highest with a larvicide and lowest without insecticide. No strain x insecticide treatment interaction was observed for lint yield.

Li, R., D. M. Stelly, and N. L. Trolinder. 1989. Cytogenetic abnormalities in cotton (*Gossypium hirsutum* L.) cell cultures. Genome. 32: 1128-1134. Paired samples from cotton suspension cultures established from 21-month old 'Coker 312' and 8-month-old 'Coker 315' calli were pretreated or not pretreated with colchicine to detect cytogenetic abnormalities at metaphase or anaphase-telophase, respectively. Cell cultures established from both calli were found to vary in chromosome number. Hypoaneuploidy was common, but hyperaneuploidy and polyploidy were rare. Bridges at anaphase and telophase were frequent in the 'Coker 312' cultures but rare in the 'Coker 315' cultures. Cytogenetic differences between the cultures could be due to effects of culture age, genotype, their interaction, or other factors. The occurrence of hypoaneuploidy and bridges, including multiple bridges within single cells, is concordant with the hypothesis that breakage-fusion-bridge cycles may accumulate during *in vitro* culture of cotton.

Lott, E. J. and P. A. Fryxell. 1983. A new species of *Sicyos* (Cucurbitaceae) from Chiapas, Mexico. Brittonia 35: 34-36. *Sicyos motozintlensis* is described and illustrated.

McCall, Lloyd L. 1981. Multidirectional selection in upland cotton for three fiber properties. Ph.D. Dissertation, Oklahoma State University. Three long-term, selection studies were conducted through five cycles within genetically variable populations of cotton. One population was selected only for fiber length, another for fineness, and the last for strength. In each selection cycle, the upper and lower 10 percent of the plants in the population were selected; and selfed seed from those plants were bulked to form new high and low populations for subsequent tests and further selections. Response to selection for fiber length appeared to be linear, but more effective for shorter than for longer fiber. Even after four cycles of selection under enforced selfing, most populations possessed sufficient variability to show significant selection responses in the fifth selection cycle. Reverse selection was effective in most cases, but it also suggested that the first selection made for fiber length is the most important. Selections for longer fiber tended to result in lower lint yield, lint percentages, uniformity index, and delayed maturity; tending to increase were another measure of fiber length, fiber fineness, and fiber strength. Selections toward coarser fiber were generally effective through five cycles; whereas, those toward finer fiber apparently reached a limit after only two selections. One reverse selection for fiber fineness apparently greatly reduced the genetic variability of the trait. Selections for coarser fiber tended to result in shorter fiber and in higher uniformity index. All other traits (except earliness) displayed significant correlated responses, but no general trends in direction were evident. The fiber strength results have been published elsewhere (Crop Sci. 26:744-750. 1986) and are not duplicated here.

McCall, L. L., L. M. Verhalen, and R. W. McNew. 1982. Genotype-environment interaction study of lock tenacity in upland cotton. Crop Sci. 22: 794-797. Sixteen cotton cultivars were grown in experiments under irrigation and on dryland at two Oklahoma locations over a 3-year period. The storm resistance trait, measured as "lock tenacity," was studied in genotype x environment interaction analyses over years for all four experiments, for the two irrigated tests, and for the two dryland tests. A number of genotype x environment interaction mean squares for lock tenacity were significant for both observed and log-transformed data; however, the magnitudes of the interaction variance components were relatively small compared to their respective cultivar components. Classifications into major boll-type categories and selections for the trait in one environment should be relatively stable in other environments. However, because the range of values observed was greater and because the separation of boll types was more distinct under irrigation, more effective selections for the trait are probably made under that situation.

McCall, L. L., L. M. Verhalen, and R. W. McNew. 1986. Multidirectional selection for fiber strength in upland cotton. Crop Sci. 26: 744-750. This selection experiment for T_1 fiber strength was conducted through five cycles within a genetically variable population of cotton to investigate the direct and correlated responses to selection for that trait. The stronger-fibered 10 percent of the plants, as well as the weaker-fibered 10 percent, were selected within each population in each cycle. Selfed seed from selected plants were used to form new populations for testing and further selection. Selection for fiber strength was effective. After four cycles of selection under enforced self-pollination, half the populations still possessed sufficient genetic variability to show a significant selection response in the fifth selection cycle. One generation of reverse selection for fiber strength was often followed by dramatic increases in variability and in subsequent selection response; however, two or more low-strength selections had a detrimental effect on later selections for high-fiber strength. Selection for stronger fiber tended to result in lower lint percentages, but it increased fiber lengths, uniformity index, and earliness, and it had variable response for lint yield and fiber fineness.

McCarty, J. C., Jr. and J. N. Jenkins. 1992. Cotton germplasm: characteristics of 79 day-neutral primitive race accessions. Miss. Agric. and Forestry Exp. Stn. Tech. Bull. #184 17 pp. Useful genetic variability was measured for several agronomic and fiber traits. Day-neutral lines had more main-stem nodes and were taller than cultivars. Lint percentage for most of the day-neutral lines was in the mid to low 30's and they generally produced less seed cotton than cultivars. A few of the day-neutral lines had greater fiber strength than Delta cultivars. The micronaire tended to be equal to or higher than for cultivars, and they generally had shorter fibers. Two years of data are presented for traits measured.

McCarty, J. C., Jr., J. N. Jenkins, and W. L. Parrott. 1982. Partial suppression of boll weevil oviposition by a primitive cotton. Crop Sci. 22: 490-492. Boll weevils oviposited significantly less on a BC_2F_3 progeny of T-78

than on the cultivars Deltapine 61 and Stoneville 213. The level of resistance in the day-neutral T-78 progeny approached that of the original photoperiodic stock.

McCarty, J. C., Jr., J. N. Jenkins, and W. L. Parrott. 1986. Yield response of two cotton cultivars to tobacco budworm infestation. Crop Sci. 26: 136-139. The yield of Tamcot CAMD-E (short-season) was not reduced or delayed as much as that of Stoneville 213 (full-season) when tobacco budworm larvae were applied during early-, mid-, and full-season. The application of larvae during the early stage of fruiting had a greater impact on reducing yield and delaying maturity than when larvae were applied during mid- and late-season.

McCarty, J. C., Jr., J. N. Jenkins, and W. L. Parrott. 1987. Genetic resistance to boll weevil oviposition in primitive cotton. Crop Sci. 27: 263-264. Significantly less boll weevil oviposition was found on day-neutral backcross progeny of T-326 and T-1180. The resistance had been transferred from primitive, day-length sensitive, to day-neutral lines of cotton.

McCarty, J. C., Jr., J. N. Jenkins, R. L. Shepherd, and W. L. Parrott. 1987. Vegetative growth response of primitive cotton race stocks to PIXR. Miss. Agric. and Forestry Exp. Stn. Res. Report 12(15). 4 pp. The plant growth regulator PIX was applied to 16 day-neutral primtive race stocks of cotton. PIX did not affect seed cotton yield. The major effect of PIX was to reduce the number of mainstem nodes and plant height.

McCarty, J. C., Jr. and J. E. Jones. 1989. Boll weevil (Coleoptera: Curculionidae) nonpreference for primitive cotton. J. Econ. Entomol. 82: 298-300. Six day-neutral lines (T-109DN, T-277-2-6DN, T-330DN, T-759DN, T-763DN, and T-790DN) had significantly less boll weevil oviposition and significantly fewer boll weevil-damaged squares than the susceptible checks, Stoneville 213 and Deltapine 41 or 61 in both laboratory and field tests. Resistance was not attributed to any morphological trait.

McCarty, J. C., Jr., W. R. Meredith, J. N. Jenkins, W. L. Parrott, and J. C. Bailey. 1983. Genotype x environment interaction of cottons varying in insect resistance. Crop Sci. 23: 970-973. The yield potential and adaptability of nine nectariless-nectaried pairs of cotton were evaluated for 1 to 3 years at six locations with and without early season insect control. Significant strain x location interactions were detected for first harvest and total lint yields. Over 3 years nectariless cottons averaged 5.7 percent higher total yields than nectaried cottons when grown without early season insect control. No differences in total yield were detected between the nectaried/nectariless cottons when grown with early season insect control. The nectariless cottons used in the study had high adaptability potentials, but other traits (glandless, high gossypol, okra leaf, and frego bract) investigated did not.

Mahill, J. F., J. N. Jenkins, J. C. McCarty, Jr, and W. L. Parrott. 1983. Evaluation of exotic germplasm of *Gossypium hirsutum* L. for resistance to bacterial blight. Miss. Agric. and Forestry Exp. Stn. Tech. Bull. 114. Day-neutral lines (165) from 124 accessions were evaluated for resistance to bacterial blight, mixed inoculum (races 1, 2, 7, 10, and 18). Fifty-four were significantly more susceptible than DPL 61 and ST 213. Most others were intermediate in resistance. We consider 77 of these to be potential sources of intermediate levels of resistance. It should be profitable to conduct research with individual races of blight on T-805 and M-7914-0815, M-7914-0209 and their progenitor races T-815 and T-209.

Mahill, J. F., J. N. Jenkins, J. C. McCarty, Jr., and W. L. Parrott. 1983. Evaluation of F_3 and F_4 lines of cotton from crosses of race accessions with upland for resistance to bacterial blight. Miss. Agric. and Forestry Exp. Stn. Res. Bull. 911. Day neutral selections in 210 cotton lines in the day neutral conversion program were evaluated for reaction to bacterial blight mixed inoculum from races 1, 2, 7, 10, and 18. Resistance was not associated with any cotton race or geographic origin. Two cotton strains from the Bahamas were intermediate in resistance.

Mahill, J. F., J. N. Jenkins, J. C. McCarty, Jr., and W. L. Parrott. 1984. Performance and stability of doubled haploid lines of upland cotton derived via semigamy. Crop Sci. 24: 271-277. Doubled haploids were derived via semigamy for 15 lines and these were evaluated for environmental stability of agronomic traits and putative tobacco budworm allelochemics. Doubled haploids were as environmentally stable for yield performance as cultivars and were as stable for allelochemical level within a growing season.

Mahill, J. F., J. N. Jenkins, W. R. Meredith, Jr. and V. Meyer. 1982. Influence of *Gossypium* cytoplasms on expression of bacterial blight. Miss. Agric. and Forestry Exp. Stn. Res. Report 7(17). Five exotic cytoplasms (A1, A2, B1, AD2, AD3) in five cultivar backgrounds, B3080, Coker 201, Delcot 277, St 213, and DPL 16 were evaluated for bacterial blight. In the AD1 cytoplasm, B3080 was the most resistant cultivar and DPL 16 was more resistant than C 201 or Delcot 277. Small but significant differences were found among the five exotic cytoplasms. None of the cytoplasms were more susceptible than AD1.

Menzel, M. Y., P. A. Fryxell, and F. D. Wilson. 1983. Relationships among New World species of *Hibiscus* sect. *Furcaria* (Malvaceae). Brittonia 35: 204-221. Seventeen species of *Hibiscus* sect. *Furcaria* are native to the New World at four ploidy levels (diploid to decaploid). Most are tetraploid (2n=72), including four species reported here for the first time (*H. cucurbitaceus, H. flagelliformis, H. flagelliformis, H. kitaibelifolius*, and *H. laxiflorus*). Interspecific hybrids showed meiotic chromosome homology (genome formula GGPP). A Key to the New World species is presented, and *H. cerradoensis* is described as new and illustrated.

Menzel, M. Y., C. A. Hasenkampf, and J. McD. Stewart. 1982. Incipient genome differentiation in *Gossypium*. III. Comparison of chromosomes of *Gossypium hirsutum* and asiatic diploids using heterozygous translocations. Genetics 100: 89-103. Three diploid A-genome lines representing *G. herbaceum* and *G. arboreum* were hybridized by *in ovulo* culture of embryos (1) with a standard line of *G. hirsutum* and (2) with six lines homozygous for translocations involving chromosomes *6, 7, 10, 11, 12,* and *13*. Chiasma frequencies in hybrids were compared with those in appropriate *G. hirsutum* controls. In every comparison overall chiasma frequencies were slightly lower in the hybrids. Therefore, A_h appears to be differentiated from the diploid *A* genomes. No localized differentiation was detected in chromosomes marked by translocations. The differentiation may be localized mainly in chromosome *4* and *5*.

Meredith, W. R., Jr. 1980. Performance of paired nectaried and nectariless F_3 cotton hybrids. Crop Sci. 20: 757-760. Nectaried and nectariless F_3 bulk populations were derived from crosses of DES 24-8ne with 8 pairs of diverse parents in 1976, and 11 pairs in 1977. Averaged over both years, nectaried populations had 1.8 percent larger seeds on 1.6 and 0.9 percent longer fiber (50- and 2.5- percent span length respectively) than nectaried plants. In 1977 boll size in nectaried populations averaged 1.5 percent larger than that for nectariless plants. No significant deleterious association of yield, yield components, and fiber properties was detected. Little problems in breeding for nectariless cottons should be expected.

Meredith, W. R., Jr. 1983. Effect of environments and genetic backgrounds on evaluation of cotton isolines. Crop Sci. 23: 51-54. Near isogenic lines (BC_5 were developed in 24-8ne and ORH 55 and 2 segregating F_4 strains for all combinations of homozygous combination of normal and frego bract and normal and Okra leaf morphological types. The 16 genotypes were evaluated for yield in 1979 and 1980 under 2 insect-control regimes for a total of 4 environments. The effect of Okra leaf on lint yield was influenced greatly by environments but relatively little by genetic backgrounds. Average yield for Okra and normal leaf was 597 and 625 kg/ha, respectively. Bract types were more sensitive than leaf types to environments and genetic backgrounds. The average yield for normal and frego-bract types grown under insect control environments was 751 and 582 kg/ha; and under the no control regime was 674 and 435 kg/ha, respectively. Varying environments were more important in the evaluation of these traits than varying genetic backgrounds.

Meredith, W. R., Jr. 1984. Influence of leaf morphology on lint yield of cotton - enhancement by the sub okra trait. Crop Sci. 8: 855-857. The average yield of eight near-isogenic lines of sub-okra leaf was significantly higher than their normal counterparts by 4.8 percent. The research was conducted at three Delta locations in 1982.

Meredith, W. R., Jr. 1984. Quantitative genetics, *In* Kohel, R. J. and Lewis, C. F. (eds.) Cotton. Am. Society of Agronomy. pp 131-150. A review of cotton quantitative inheritance studies were made. Topics covered were genotype x environment interaction, heterosis, gene action, combining ability, association of traits, and selection progress.

Meredith, W. R., Jr. 1985. Lint yield genotype x environment interactions in upland cotton as influenced by leaf canopy isolines. Crop Sci. 25: 509-512. Near isogenic lines of normal, okra leaf, and normal x okra leaf F_1 and

F_2 populations for eight cotton cultivars were evaluated in 1979 and 1980 with two planting dates and three seeding rates at Stoneville, MS. F_2 leaf canopy types produced the most stable yields across all environments. Strong leaf type x environment interactions were detected.

Meredith, W. R., Jr. 1988. Registration of eight sub-okra cotton germplasms. Crop Sci. 28: 1035-1036. Eight sub okra cotton germplasms were released.

Meredith, W. R., Jr. 1990. Contributions of introductions to cotton improvement. *in* Shands, H. L. (ed.) Contributions of introductions to crop improvement. Am. Society of Agronomy. pp 127-146. The history of cotton breeding is mostly the history of introductions and their use. Three improvement programs that have made major use of introductions are the Texas Multiple Adversity Resistant Improvement Program; Acala program in California; and Pee Dee, South Carolina program. Several species which have contributed to these programs are *Gossypium arboreum*, *G. thurberi*, and *G. barbadense*, as well as the Mexican Race stocks. From these introductions, progress in disease and insect resistance, fiber quality, and yield have been obtained.

Meredith, W. R., Jr. 1990. Yield and fiber-quality potential for second-generation cotton hybrids. Crop Sci. 30: 1045-1048. The objective of this study was to evaluate the potential of using F_2 hybrids by comparing them with parents and F_1's for yield, fiber quality, and interaction with environments. The genetic design was a half-diallel consisting of seven mid-South parents, 21 F_1's, and 21 F_2's. The 49 genotypes were grown in 1987 and 1988 at three sites near Stoneville, MS. Average first-harvest yield was 594, 688, and 643 kg/ha for the parents, F_1's, and F_2's, respectively. Average yarn tenacity was 130, 134, and 132 kN m/kg for the parents, F_1 and F_2 hybrids, respectively. Both F_1 and F_2 hybrids had significantly fewer short fibers than the parents. The results indicate that F_2 hybrids have the genetic potential for increasing cotton yields and fiber quality.

Meredith, W. R., Jr. and R. R. Bridge. 1984. Genetic contributions to yield changes in cotton. *in* Fehr, W. R. (ed.) Genetic contributions to yield gains of major crop plants. Am. Society of Agronomy. pp. 75-87. (Book chapter). Both regression techniques and comparison of obsolete and modern cultivars indicate cotton breeders have been increasing the yield of cotton through genetics by about 1 percent for the period beginning in about 1910.

Meredith, W. R., Jr., T. W. Culp, K. Q. Robert, G. F. Ruppenicker, W. S. Anthony, and J. R. Williford. 1991. Determining future cotton variety fiber quality objectives. Textile Research J. 61(12), 715-720. Two plantings of 19 varieties with 2 replications each were made in both Mississippi and South Carolina in 1986. The varieties represented a broad range of types grown across the U.S.A. Yarn tenacities of 42 tex (14 N_e) and 27 tex (22 N_e) open-end and 30 tex (20 N_e) and 12 tex (50 N_e) ring spinning were determined for the 152 samples. Correlation of yarn tenacity values between spinning methods was high; r_2 = 93 percent. Variety bundle strength (T_1) consistently gave the highest correlation with yarn tenacity, with an average r_2 of 89 percent. Fiber fineness and length also were correlated with yarn tenacity with an r_2 of about 50 percent.

Meredith, W. R., Jr. and R. Wells. 1986. Normal vs. okra leaf yield interactions in cotton. I. Performance of near-isogenic lines from bulk populations. Crop Sci. 26: 219-222. Okra leaf selections in a Deltapine 5540 x Stoneville 7A okra-leaf, nectariless strain F_7 population yielded 7 percent more lint than their normal leaf near-isolines. Stoneville 213 normal leaf yielded 10 percent more lint than its back-crossed (BC_5) okra leaf near isoline. The results from these experiments imply that certain populations have the genetic potential of producing okra-leaf cottons with higher yielding ability than that of normal-leaf cottons.

Meredith, W. R. Jr. and R. Wells. 1987. Sub-okra leaf influence on cotton yield. Crop Sci. 27: 47-48. A study in three diverse environments in 1985 near Stoneville, MS, compared the yield of eight BC_4F_3-derived sub okra-leaf (L^{u}_{2}) and normal-leaf (l_2) cotton plants. Sub-okra leaf averaged significantly higher lint yields (3 percent) than normal-leaf cotton. Significant cultivar x leaf type interactions for yield were detected. This study indicates that for some genetic backgrounds and environments that the use of sub okra to replace normal leaf offers a potential yield increase of 3 to 5 percent.

Meredith, W. R., Jr. and R. Wells. 1989. Potential for increasing cotton yields through enhanced partitioning to reproductive structures. Crop Sci. 29: 636-639. The objective of this study was to determine if yield increases through breeding would likely continue through changes in partitioning of dry matter from vegetative to reproductive structures. Five obsolete cultivars, 5 current cultivars, and 15 advanced strains from 5 cotton breeding organizations were used for yield and growth analyses at 3 environments, 2 in 1985 and 1 in 1986. The 20 current cultivars and advanced strains showed significant yield variability, which showed strong negative genetic correlations with plant height and stem weight to total dry weight ratio; r = 0.44 and -0.80, respectively. This study suggests that yield increases through the use of conventional breeding methods are likely to be achieved through continued partitioning of dry matter from vegetative to reproductive structures.

Milam, M. R., J. N. Jenkins, J. C. McCarty, Jr., and W. L. Parrott. 1985. Combining tarnished plant bug resistance with frego bract. Miss. Agric. and For. Exp. Sta. Bulletin No. 939. 4 pp. Frego bract and the resistance of Timok 811 were combined into one line. Development of a frego bract strain as resistant as Timok 811 and with the lint yield of D 7146N was reported. Thus, the susceptibility of frego bract can be mitigated by resistance genes from other sources.

Milam, M. R., J. N. Jenkins, J. C. McCarty, Jr., and W. L. Parrott. 1989. Breeding upland cotton for resistance to the tarnished plant bug. Field Crops Res. 21: 227-238. Generation mean analyses were used to determine gene action in four sets of crosses. Three of the four crosses had genes segregating for resistance to tarnished plant bugs. Dominant gene action was primarily responsible for resistance measured as yield and earliness when grown under high levels of tarnished plant bugs.

Millner, P. D. and J. E. Jones. 1987. The influence of leaf and bract shape and insect resistance traits on bacterial and endotoxin content of cotton fiber. Proc. 11th Cotton Dust Res. Conf. pp. 26-27. Fiber from field tests was used to assess the effect of the frego bract, okra leaf, and nectariless characteristics on the amounts of gram-negative bacteria and endotoxin present in extracts of the fiber. Isolines with either okra leaf or frego bract traits grown at Baton Rouge, LA, in 1984 were found to have comparable numbers of gram-negative bacteria, but significantly less endotoxin than normal leaf-normal bract cotton. The bacterial or endotoxin status of the fibers may not be reflected in the status of dust generated by carding the respective fibers.

Minton, E. B. and W. R. Meredith, Jr. 1987. Root-knot nematode effect on nine cotton cultivars in Mississippi. Crop Sci. 27: 1001-1004. Performance of nine cotton cultivars when grown in fumigated and nonfumigated soils was related to root-knot nematode (*Meloidogyne incognita*) galling. Root-knot juveniles and root-gall indices were reduced by fumigation. The greatest reduction in root galling occurred on nematode-susceptible cultivars. Lint yields of most susceptible cultivars were increased 2 to 6 percent by Telone II, while lint yield of resistant cultivars was slightly decreased. Regression analysis of yield differences between nonfumigated and fumigated treatments on the root- knot indices of the cultivars grown in the nonfumigated plots showed that *M. incognita* reduced yield 35.7 kg/ ha for each unit increase in root-gall index.

Muhammad, N. and J. E. Jones. 1990. Genetics of resistance to reniform nematode in upland cotton. Crop Sci. 30: 13-16. Generation mean analysis was used to evaluate the inheritance of resistance to reniform nematode (RN) in three crosses of resistant x susceptible cotton strains. The study indicated that resistance to RN was under genetic control and inherited in a quantitative manner. No pattern was observed for the significance of additive and dominance gene effects, but significant epistatic gene effects occurred in most cases.

Myles, E. L., Jr. and J. E. Endrizzi. 1989. Aneuploids induced by deficiencies of chromosome 9 and analysis of the time of nondisjunction in cotton. Genome 32: 12-18. Plants monosomic for chromosome 9 or haplodeficient for the long arm of the chromosome produce a high frequency of aneuploid progeny. The aneuploids include monosomes, trisomes, and multiple monosomic and trisomic combinations that are the result of chromosome nondisjunction, which is induced by the deficiency of the long arm of chromosome 9.

Narbuth, E. V. and R. J. Kohel. 1990. Inheritance and linkage analysis of a new fiber mutant in cotton. J. Hered. 81: 131-133. A completely dominant mutant, Ligon lintless-2, is described. Mutant plants have short fibers similar to Ligon lintless-1. The plant morphology is normal. No linkages were found with the 24 loci tested from 12 linkage groups.

Negrotto, D. V. 1988. Comparison of *Agrobacterium* strains in the transformation of cotton. M.S. Thesis, University of Arkansas. Twenty-seven strains of *Agrobacterium* were tested for their ability to transform four cultivars of cotton. The cotton genotypes did not differ in the percentage of hypoctyl segments transformed. The strains of *Agrobacterium*, however, differed. Twenty out of 27 strains were capable of inciting tumors on seedling epicotyl stumps. Seven out of 24 strains were able to transfer marker DNA to cotton hyocotyl sections. *A. tumefaciens* strain 208 was the most efficient in transfer of t-DNA to cotton.

Novick, R. G., J. E. Jones, W. S. Anthony, W. Aguillard, and J. I Dickson. 1991. Genetic trait effects on nonlint trash of cotton. Crop Sci. 31: 1029-1034. Twelve near-isolines involving four leaf shapes (normal, semi-okra, okra, and super-okra), two bract types (normal and frego), and two leaf-pubescence levels (hairy and semismooth) were evaluated for nonlint trash content before ginning and after ginning, followed by zero, one, and two lint cleanings. Semismooth and super-okra leaf traits reduced motes and small-leaf trash before ginning. They produced grades similar to the check with one less lint cleaner. Frego-bract isolines had less leaf and bract trash in lint than the normal-bract check at any level of lint cleaning.

Oosterhuis. D. M., S. D. Wullschleger, and J. McD. Stewart. 1988. Diversity in cotton root anatomy. Ark. Farm Res. 37(3):19. The root vascular arrangement was examined in 21 genotypes of *G. hirsutum* including 5 race stocks, 1 *G. barbadense*, 1 *G. arboreum*, and 6 wild diploid species representing the C, D, and E genomes. All diploids were tetrarch while *G. hirsutum* was predominantly 4 to 5. However, T-25 and the *G. barbadense* had vascular bundles arranged from pentarch to heptarch.

Pan, J. J. and R. J. Kohel. 1982. Mapping of translocation breakpoints on chromosome 12 of upland cotton, *Gossypium hirsutum* L. J. Nanjing Agric. Coll. 12: 17-32. Naked seed, glandless-2, and nectariless-1 were mapped with translocation stocks T 7-12, T 11-12, T 12-19, and T5-12.

Parrott, W. L., J. N. Jenkins, and J. C. McCarty, Jr. 1983. Feeding behavior of first-stage tobacco budworm (Lepidoptera: Noctuidae) on three cotton cultivars. Ann. Ent. Soc. Amer. 76: 167-170. Describes the feeding behavior of tobacco budworm early stage larvae. First stage larvae do not eat gossypol glands. After the first molt and between 48 and 72 hours of age, larvae stop avoiding feeding on gossypol glands.

Parrott, W. L., W. R. Meredith, Jr., J. N. Jenkins, and J. C. McCarty, Jr. Effects of cotton genotype and early or no insecticide treatment on abundance of selected cotton insects in the Mississippi Delta, 1976. USDA-ARS, Agricultural Research Results, Southern Series #12 (ARS-S-12), Aug. 1982. Two nectariless near isolines, a smooth-leaf line, and a high-gossypol line were evaluated at four Delta locations under two insect management systems. Data are presented on 45 species or groups of insects sampled for several weeks during the season.

Penna, Julio C. V. 1980. Comparisons among selected upland cotton cultivars and strains utilizing the methods of numerical taxonomy. Ph.D. Dissertation, Oklahoma State University. Twenty-four selected cotton cultivars and strains from eight countries were described for 52 characteristics to determine the phenotypic relationships among them utilizing cluster analysis and to estimate within-country variability. The most dissimilar cultivars were '4F' from Pakistan vs. 'Del Cerro' from Peru, while the most similar were 'Deltapine 16' from the USA and 'Minas Dona Beja' from Brazil. Four groups of multiple cultivars were formed. Group I included three U.S.A., three Brazil, and two U.S.S.R. entries; Group II, two from the U.S.S.R.; Group IV, two from the U.S.S.R. and two from Bulgaria; and Group VIII, two from the U.S.A. All other groups were single entries. Excluding South American entries, the U.S.A. cultivars clustered into a distinct group from the Old World cultivars. Within the latter, the Bulgarian entries were the most similar, followed by those from the U.S.S.R., and then individually by entries from Thailand, Uganda, and Pakistan. The U.S.A. cultivars formed three groups -- Group I, Plains-type cultivars; Group II, a surprising grouping of a Coker with an Acala cultivar; and Group III, Delta-types. Estimates of within-country variability were possible for the four countries contributing two or more entries to this study. The mean estimates among the entries from the U.S.A., the U.S.S.R., and Brazil were similar; whereas, all three were considerably higher than for Bulgaria which is in a genetically more vulnerable position.

Penna, J. C. V., L. M. Verhalen, and W. M. Johnson. 1984. Reacao de 24 cultivares de algodao a fusariose, bacteriose e verticiliose no campo. (In Portuguese) Pesq. Agropec. Bras. 19: 243-246. Responses of 24 cotton cultivars to fusarium wilt, bacterial blight, and verticillium wilt were determined. The highest level of tolerance to fusarium wilt was exhibited by the cultivar 'IAC-RM$_4$-SM$_5$' from Brazil, followed by '4F' from Pakistan, 'Acala

SJ-5' from the U.S.A., 'Minas Dona Beja' from Brazil, and 'C-4727' from the U.S.S.R. The most tolerant accessions to bacterial blight were 'CA(68)41' from Uganda, 'Westburn M' and 'Paymaster 303' from the U.S.A., and 4F from Pakistan. The most tolerant to verticillium wilt were Acala SJ-5, Paymaster 303, and 'Lankart LX 571,' all from the U.S.A.

Percival, A. E. 1987. The National Collection of *Gossypium* Germplasm. South. Coop. Ser. Bull. No. 321, June 1987, 362 pp. A catalog of the seed accessions maintained by the National Cotton Germplasm Collection.

Percival, A. E. 1987. The National Cotton Germplasm Collection - What is it? Proc. Beltwide Cott. Prod. Res. Conf., Abst. p. 112 A description of the components that comprises the National Cotton Germplasm Collection.

Percival, A. E. 1991. Collectors track cotton in Latin America to stay ahead of habitat destruction. Diversity, vol. 7, nos 1&2 pp. 66-68. The importance of obtaining cotton germplasm through plant explorations to several Latin American and Caribbean countries is reviewed.

Percival, A. E. 1991. Norte y suramerica colaboran en algodon. Diversity, vol. 7, nos. 1&2 pp. 71-74. The importance of collaborating with the Latin American and Caribbean countries, where cotton is endemic, to secure cotton germplasm is reviewed.

Percival, A. E. and R. J. Kohel. 1990. Distribution, collection, and evaluation of *Gossypium*. (ed. N.C. Brady.) Adv. Agron. 44: 225-256. A review of the history of cultivated cotton, its domestication, and origins. The distribution of wild and cultivated forms is given. Major collections of germplasm and the status of evaluations are reported.

Percival, A. E., J. Schwendiman, and J. L. Belot. 1986. Cotton collecting on nine Caribbean islands and South Florida. Plant Genetic Resources - Newsletter, AGP/86/66:2-5.

Percival, A. E. and J. M. Stewart. 1985. 1984 survey and collection in the Yucatan Peninsula of Mexico. Proc. Beltwide Cott. Prod. Res. Conf., Abst. p. 44. Seeds of dooryard and wild accessions of *G. barbadense* were collected.

Percival, A. E., James McD. Stewart, Lorenzo Perez, Alejandro Garcia, and Arturo Hernandez. 1992. Collecting cotton endemic to northwest Mexico. Proc. Beltwide Cott. Prod. Res. Conf., Abst. p. 607. A cotton exploration to northeast Mexico was successful in obtaining seeds of *Gossypium hirsutumL., G. thurberi Tod., G. armourianum Kearn., G. harknessii Brandeg., G. davidsonii Watt*, and *G. turneri* Fryxell. An extensive location where *G. aridum* Skov. is endemic was also determined.

Percy, R. G. 1986. Effects of environment upon ovule abortion in interspecific F_1 hybrids and single species cultivars of cotton. Crop Sci. 26: 938-942. Difference in ovule abortion numbers occurred between the *G. hirsutum* and *G. barbadense* species, but highest numbers were observed in interspecific hybrids. The rate of increase in ovule abortion number with increasing environmental stress was far greater in hybrids than in parent species.

Percy R. G. and L. S. Bird. 1985. Rust resistance expression in cotyledons, petioles, and stems of *Gossypium hirsutum* L. J. Hered. 76: 202-204. Rust resistance inheritance was re-examined to determine if single-gene resistance fit observed resistance expression. Resistance in petioles and stems was found to be independent of cotyledon resistance. An association of petiole and stem resistance was detected.

Percy, R. G. and C. M. Rush. 1985. Evaluation of four upland cotton genotypes for a rate-limiting resistance to *Phymatotrichum* root rot. Phytopathology 75: 463-466. Rates of fungal growth and symptom development were observed in rows of four genotypes of upland cotton using viewing ports and a boroscope. Genotype had no effect on the rate of linear growth of the pathogen from plant to plant. Symptom progression from plant to plant and symptom-expression interval (time between fungal contact and symptom expression) did not vary with genotype. No rate-limiting resistance was observed.

Percy, R. G. and E. L. Turcotte. 1988. Development of short and coarse-fibered America Pima cotton for use as

parents of interspecific hybrids. Crop Sci. 28: 913-916. In diallel analyses, significant genotype mean squares and general combining ability (GCA) estimates indicated useful variability for shorter, coarser fiber. Ratios of GCA sums of squares to total sums of squares indicated greater additive variability was available for micronaire (GCA SS/total SS=0.70) than for length (GCA SS/total SS=0.34). Selective advance toward a short, coarse Acala type fiber appeared feasible within the elite Pima germplasm.

Percy, R. G. and J. F. Wendel. 1990. Allozyme evidence for the origin and diversification of *Gossypium barbadense* L. Theor. Appl. Genet. 79: 529-542. Allozyme analysis was performed on 153 accessions representing the spectrum of *G. barbadense* diversity to ascertain the geographic center of diversity, patterns of diffusion, and to reveal infraspecific relationships. Northwestern South America contained the greatest genetic variability and is probably the species center of origin. Advanced cultivars appeared to be derived from west Andean germplasm, but displayed evidence of introgression with *G. hirsutum*. Caribbean and Central American accessions were low in genetic variability and appeared to be derived from northern South America, east of the Andes. Evidence of introgression with *G. hirsutum* was low or absent in areas of sympatry in the Caribbean and Central America.

Percy, R. G. and E. L. Turcotte. 1991. Early-maturing, short-statured American Pima cotton parents improve agronomic traits of interspecific hybrids. Crop Sci. 31: 709-712. A study was conducted to determine if four *G. barbadense* strains bred for short stature and earliness would favorably affect plant height, earliness and yield potential of *G. hirsutum* x *G. barbadense* interspecific hybrids. Significant parental effects were noted in hybrids for all three of the above traits. At higher elevation test sites, which maximized the observed hybrid yield heterosis, parent earliness was a better predictor of hybrid yield than was parent yield.

Percy, R. G. and E. L. Turcotte. 1991. Inheritance of male-sterile mutant Ms_{13} in American Pima cotton. Crop Sci. 31: 1520-1521. A single gene, recessive mutant conferring complete, stable male sterility described. Tests for allelism with previously described recessive male sterility genes were negative. Linkage tests between the new male sterility gene, designated ms_{13}, and 23 *Gossypium* mutant genes were negative.

Percy, R. G. and E. L. Turcotte. 1992. Interspecific hybrid fiber characteristics of cotton altered by unconventional *Gossypium barbadense* L. fiber genotypes. Crop Sci. 32: 1437-1441. A regression of hybrid on *G. barbadense* parent fiber traits produced an R^2 of 0.95 for 2.5 percent span length and R^2 of 0.52 for micronaire. Heterotic effects in hybrids exceeded reposes due to parent contribution and opposed the direction of selection practiced on the *G. barbadense* parents in the study. Assuming the validity of extrapolation, a parent fiber length of 17.3 mm and micronaire of 6.38 would be required to produce a hybrid fiber with an Acala type 30.5 mm length and 4.20 micronaire.

Percy, R. G. and E. L. Turcotte. 1992. Notice to plant breeders and geneticists relative to release of three noncommercial germplasm lines of *Gossypium barbadense* L. cotton. USDA and Arizona Agric. Exp. Stn. Memo. 3 p. and Registration. Three *G. barbadense* germplasm lines were released for use as parental lines in interspecific hybrid and extra-long staple breeding efforts. These lines represent a range of short-statured, early maturing, uniquely fibered phenotypes.

Pettigrew, W. T., J. J. Heitholt, and W. R. Meredith, Jr. 1992. Early season floral bud removal and cotton growth, yield, and fiber quality. Agronomy J. 84: 209-214. In a 2-year study, early season defruiting with ethephon reduced yields 7 percent in 1990, but there was no difference in yield in 1989. Fiber quality was not affected by ethephon treatments. Cotton demonstrated a great potential to compensate for early square loss.

Porter, J. B. 1989. Adhesion of *Agrobacterium* to *Gossypium hirsutum* suspension cultures. M. S. Thesis, University of Arkansas. Twelve strains of *Agrobacterium* representing the three biotypes were examined for their ability to bind to eight genotypes of cotton cells grown in suspension. Binding was indluenced by pH and termperature with a pH 6.0 and 26-28C being optimal. Significant (P = 0.01) differences occurred among bacterial strains in the number of colony forming units (cfu) per plant cell with strain A 208 giving the highest. Differences (P = 0.05) occured among the cotton genotypes with Delcot 344 giving the most cfu.

Price, H. J., D. M. Stelly, T. D. McKnight, C. F. Scheuring, D. Raska, M. J. Michaelson, and D. Bergey. 1990. Molecular cytogenetic mapping of a nucleolar organizer region in cotton. J. of Hered. 81: 365-370. A biotinlabeled cloned fragment of 18S-28S ribosomal DNA from soybean was hybridized to DNA in meiotic chromosomes of cotton *Gossypium hirsutum* L. by in situ hybridization. Hybridization sites were detected enzymatically by the strptavidin-peroxidase procedure. Analysis of in situ hybridization to metaphase I meiocytes from two translocation heterozygotes and monosomics involving chromosome 9 indicated that a cluster of ribosomal RNA cistrons on chromosome are 9L. This is the first molecular marker to be mapped in cotton, and, except for translocation markers and arm deficiencies, it is the first marker to be mapped to chromosome 9. In situ hybridization to cytogenetic tester lines in combination with meiotic analysis is a powerful technique for assigning cloned DNA sequences to chromosomes and chromosome arms.

Quisenberry, J. E., B. Roark, D. W. Fryrear, and R. J. Kohel. 1980. Effectiveness of selection in upland cotton in stress environments. Crop Sci. 20: 450-453. Lines selected for performance at Lubbock were tested at three Texas locations, Lubbock, Big Spring, and College Station. It was determined that the stress environment at Lubbock prevented effective field selection.

Ramalho, F. S., W. L. Parrott, J. N. Jenkins, and J. C. McCarty, Jr. Effects of cotton leaf trichomes on the mobility of newly hatched tobacco budworms (Lepidoptera: Noctuidae). J. Econ. Entomol. 77: 619-621. Observation of movements of newly hatched tobacco budworm larvae on four cotton strains revealed that pubescence provides a mechanism of resistance to movement of newly hatched larvae.

Ramos, L. C. S. and R. J. Kohel. 1987. Seed-oil content of glanded and glandless cottons. JAOCS. 64: 1337-1340. Gene action in glanded vs glandless cotton combinations for seed-oil content. Seed-oil content was higher in the glandless cottons, and gene action was more clearly defined in the glandless backgrounds.

Ranjbar, Gholam A. 1980. Effects of delayed harvest, cultivar, and boll type on weathering damage to yield-related traits and fiber quality in upland cotton. Ph.D. Dissertation, Oklahoma State University. Four stormproof, four storm-resistant, and four open-boll cultivars of cotton were utilized in this study over 3 years at one location. In most cases, cultivars having the same boll type displayed similar trends for weathering effects on traits associated with yield and fiber quality. Trends were frequently different among the boll types. All yield-related traits were reduced by delayed harvests in at least 2 of the 3 years. Adverse effects of weathering on most traits were more serious in open-boll cultivars than in the other boll types, especially compared to the stormproof cultivars. Storm-resistant cultivars generally displayed intermediate responses between the open-boll and stormproof types, but did not differ significantly from the stormproof types for any yield-related trait in any year. Significant differences between storm-resistant and open-boll types were occasionally detected. All fiber quality traits were reduced by delayed harvests in at least 2 of the 3 years. Differences in trends among boll types were not as consistent for fiber quality as they were for the yield- related traits. The loss in a character to be expected with each 2-week delay in harvest is provided for each boll type.

Ray, D. T. 1984. Metaphase I configurations of the reciprocal translocations in a cytogenetic tester set of *Gossypium hirsutum* L. J. Hered. 75: 371-377. Twenty reciprocal translocations of the cytogenetic tester set of *G. hirsutum* were cytologically characterized.

Ray, D. T. and J. E. Endrizzi. 1982. A tester-set of translocations in *Gossypium hirsutum* L. J. Hered. 73: 429-433. A tester-set consisting of 20 translocation lines, which identifies all 26 chromosomes of cotton, was selected for reidentification of their chromosome.

Rooney, W. L. and D. M. Stelly. 1989. Allelic composition of cotton at the Le_1 and Le_2 Loci. Crop Sci. 29: 707-712. Fifty-two cultivars were tested by observing the frequencies of nonviable vs. viable progeny and the timing of necrosis following two types of matings; (1) Cotton cultivar x $le_1le_1Le\ _2^{dav}$ and (2) (cultivar x le_1le_1 le_2le_2) x le_1le_1 $Le_2^{dav}Le_2\ ^{dav}$. All 52 cultivars were found to be $Le_1Le_1Le_2Le_2$, indicating that the frequencies of alleles le_1 and le_2 are zero, or nearly so, in U.S.A.-developed *G. hirsutum* germplasm. Results on necrotic development indicated that the cumulative dosage of alleles Le_1 and Le_2 affected the onset of necrosis in the presence of Le_2^{dav}. Because alleles le_1 and le_2 are rare in American upland cottons, the doubled-haploid breeding system proposed by Stelly et al. will be applicable to these stocks.

Rooney, W. L. and D. M. Stelly. 1990. Genetic effects on the timing of Le_2^{dav} induced necrosis of cotton. Crop

Sci. 30: 70-74. The objectives of this study were to determine: (1) if the timing of necrosis is under genetic control of the loci Le_1 and Le_2; and (2) if the mechanism of timing or node of gene action is consistent across genotypes. Five cultivars ($Le_1Le_1Le_2Le_2$) were used as sources of Le_1 and Le_2 alleles. Seedlings from reciprocal crosses of (cultivar x $le_lle_1le_2le_2$) F_1 plants and an $le_1le_1Le_2^{dav}$ Le_2^{dav} tester were scored for the presence and timing of the lethal reaction. Results indicated that increased dosage of alleles Le_1 and Le_2 with Le_2^{dav} hastens necrosis, but variation among cultivars indicated that Le_1-Le_2^{dav} and Le_2-Le_2^{dav} interactions may not always be distinctly different. Three possible explanations for these differences are: (1) that additional loci are involved; (2) that allelic actions is modified by background genotypic differences; and/or (3) the Le_1 and Le_2 loci are polymorphic.

Rooney, W. L. and D. M. Stelly. 1991. Preferential transmission of somatic elimination of a *Gossypium sturtianum* chromosome in *G. hirsutum*. J. of Hered. 82: 151-155.

Rooney, W. L., D. M. Stelly, and D. W. Altman. 1991. Identification of four *Gossypium sturtianum* monosomic alien addition derivatives from a backcrossing program with *G. hirsutum*. Crop Sci. 31: 337-341. Monosomic addition (MA) stocks were derived from interspecific backcrosses of *Gossypium sturtianum* J. H. Willis ($2n = 2x = 26$, C_1 genome), with *G. hirsutum* L. [$2n = 4x = 52$, $(AD)_1$ genome] as recurrent parent. Using 10 MA plants of varied pedigrees from this project, our objectives were to (1) identify and characterize different MA stocks, (2) determine the phenotypic effect of each addition chromosome, and (3) estimate the frequency of $(AD)_1$-C_1 recombination. We identified 4 distinct *G. sturtianum* MA types among the 10 analyzed, and have temporarily designated these as C_1-A, C_1-B, C_1-C, and C_1-D. The C_1-A, C_1-B, and C_1-D MA stocks differed phenotypically from the recurrent parent, while the C_1-C MA stock was phenotypically indistinguishable from the recurrent parent. Genetic data to substantiate recombination have not yet been obtained, but chiasmata were observed at a frequency of 1.7 percent per meiotic C_1 chromosomes of *G. hirsutum* is occurring, albeit infrequently.

Ross, K. M. 1982. Pigment gland expression in *Gossypium* interspecific hybrids. M. S. Thesis, University of Tennessee. Observations were made on the expression of seed glands in three generations of (*G. hirsutum* x *G. sturtianum* hexaploids. Individual seeds varied in gland number, and low-seed-gland parents did not breed true. However, S1 and S2 progeny from seed selected for low-gland number had range and mean gland number shifted toward glandless relative to the unselected plant population. This implied selectable quantitative inheritance of seed gland number. Number of glands in a seed was not related to the number of glands on vegetative structures of the plant derived from that seed. Observations were made on the foliar gland density of a *G. arboreum* line, *G. anomalum*, and their F_1 and F_2 hybrids. Foliar gland density was quantitatively inherited.

Saha, S., D. M. Stelly, and A. E. Percival. 1988. Isozyme polymorphism among diploid and tetraploid species of cotton. Previews 1988 Beltwide Cott. Conf. p. 47. An evaluation of the phylogenetic relationship among the diploid and tetraploid species of cotton on the basis of several isozyme banding patterns.

Schubert, A. M., C. R. Benedict, and R. J. Kohel. 1986. Carbohydrate distribution in bolls. Sec. III, Boll Development, Ch. 2, pp. 311-323. *in* Mauney, J.R. and J.M. Stewart (eds.). Cotton Physiol. No.1, The Cotton Foundation Reference Book Series. A review of research on carbohydrate source, distribution to bolls, and the development of the boll and its components.

Schuster, M. F., C. W. Smith, and G. A. Niles. 1990. Registration of nine high tannin cotton germplasm lines. Crop Sci. 30: 1375.

Schwendiman, J., G. Ano, and A. E. Percival. 1985. Cotton collecting in continental Ecuador and the Galapagos Islands. Plant Genetic Resources - Newsletter, AGP/85/64:33-37, FAO, Rome, Italy. A collecting mission to obtain seeds of the *Gossypium* spp., *G. barbadense*, *G. darwinii*, and *G. klotzschianum*.

Schwendiman, J., A. E. Percival, and J. L. Belot. 1985. Rapport de mission dans diverses iles de le mer caribe sur la preservation des resources genetique du cotonnier. F.A.O.-I.B.P.G.R., AGR-PR 3/11. Fevrier - Mars 1985. 46 pp. Seeds of dooryard and wild accessions of *G. hirsutum* and *G. barbadense* were collected.

Schwendiman, J., A. E. Percival, and J. L. Belot. 1986. Cotton collecting on nine Caribbean islands and South

Florida. Plant Genetic Resources - Newsletter, AGP/86/66:2-5. Seeds of dooryard and wild accessions of *G. hirsutum* and *G. barbadense* were collected.

Shattuck, V. and F. R. Katterman. 1982. Enhanced unscheduled DNA synthesis in the cotyledons of *Gossypium barbadense* L. by ethyl methanesulfonate (EMS). Biochem. and Biophysical Research Comm. 109: 1017-1025. When cotyledonary tissue are treated with the mutagen ethyl methanesulfonate and then germinated, an enhanced, unscheduled DNA synthesis response is observed.

Shattuck, V. and G. Ramsay. 1983. Induction of a chromosomal structural change in *Gossypium barbadense* L. by ethyl methanesulfonate. J. of the Arizona-Nevada Acad. of Sci. 18: 13-16. Two ethyl-methanesulphonate-induced mutant cotton plants exhibiting atypical vegetative and reproductive morphology were recovered from segregating M_2 population. Both plants possessed duplicate-deficient chromosome segments involving a translocation which was probably responsible for their abnormal phenotype.

Shaver, T. N., R. H. Dilday, and F. D. Wilson. 1980. Use of glandless breeding stocks to evaluate unknown *Heliothis* growth inhibitors (X-factors) in cotton. Crop Sci. 20: 545-548. Texas race stocks with higher than expected resistance to tobacco budworm, based on flowerbud gossypol content (X-factors), were crossed to glandless lines. Glandless progenies were evaluated to determine whether the additional resistance was independent of the toxic compounds found in the pigment glands. Over 300 glandless F_3 lines failed to inhibit growth of tobacco budworm. The X-factor effect therefore was associated with the pigment glands and probably caused by (1) gossypol, (2) gossypol in synergy with related toxic compounds, (3) gossypol-related compounds that are more toxic than gossypol itself.

Shepherd, R. L. 1982. Genetic resistance and its residual effects for control of the root-knot nematode-fusarium wilt complex in cotton. Crop Sci. 22: 1151-1155. Two cultivars (Deltapine 16 and Auburn 56) and a nematode-resistant breeding line (Auburn 623 RNR) were grown in nematicide treatment vs. untreated plots for 3 years. Auburn 623 RNR without fumigation was more effective for controlling root-knot nematodes than Auburn 56 and Deltapine 16 with fumigation for controlling fusarium wilt disease. Susceptible Stoneville 213 was grown the fourth year of the test. Plots that were previously planted to Auburn 623 RNR produced higher lint yield and lower nematode populations than those previously planted to Deltapine 16 or Auburn 56.

Shepherd, R. L. 1983. Indices of resistance to root-knot nematodes for primitive race stocks of upland cotton. USDA-ARS ARM-S-33. None of 471 primitive race stocks evaluated for resistance to the root-knot nematode were as resistant as Auburn 634 RNR, but 18 were more resistant than Clevewilt-6, a strain of a resistant cultivar. A galling index and a reproductive index are given for the stocks evaluated.

Shepherd, R. L. 1983. New sources of resistance to root-knot nematodes among primitive cottons. Crop Sci. 23: 999-1002. Eighteen primitive race stocks were identified as being resistant to the root-knot nematode. Resistance was widely distributed among stocks of different races, indicating potential diversity of the resistant germplasm.

Shepherd, R. L. and A. J. Kappelman. 1986. Cotton resistance to the root-knot-fusarium-wilt complex. I. Relation to fusarium wilt resistance and its implications on breeding for resistance. Crop Sci. 26: 228-232. Results indicated that stem vascular resistance to fusarium wilt (FW) was probably independent of any mechanism of resistance that might have prevented fungal invasion of the vascular system. Evidence presented indicated a low probability of success would be expected for developing cultivars with high field resistance to FW in the RKN-FW complex by either selecting for vascular resistance in the greenhouse or through field selection using present techniques.

Shepherd, R. L. 1986. Cotton resistance to the root-knot-fusarium-wilt complex. II. Relation to root-knot resistance and its implications on breeding for resistance. Crop Sci. 26: 233-237. Results indicated that cotton can be developed with genetic resistance to fusarium wilt (FW) independently of root-knot nematode (RKN) resistance. High field resistance to the RKN-FW complex depends on high-RKN resistance, and cultivars with high-RKN resistance probably would have adequate field resistance to this complex even if they were genetically susceptible to FW.

Shepherd, R. L. and M. G. Huck. 1989. Progression of root-knot nematode symptoms and infection of resistance and susceptible cottons. J. of Nematol. 21(2): 235-241. When exposed to root-knot nematodes, resistant A623 had faster radicle growth, fewer and smaller cracks in the root epidermis and cortex, fewer and smaller root galls, one-twelfth as many egg masses, and one-fourth as many eggs per egg mass as the susceptible, M-8. Root cracking, galling, and giant cell formation are major effects of root-knot nematode that may predispose cotton roots to pathogens resulting in synergistic interaction and diseases.

Shepherd, R. L., J. C. McCarty, Jr., W. L. Parrott, and J. N. Jenkins. 1988. Resistance of cotton cultivars and elite breeding lines to root-knot nematodes. Miss. Agric. and Forestry Exp. Stn. Tech. Bull. #158. 5 pp. Most of the presently grown cotton cultivars were susceptible to root-knot nematode reproduction. In comparison, the nematode was unable to reproduce enough to maintain its population level on resistant breeding lines.

daSilva, F. P., J. E. Endrizzi, and L. S. Stith. 1981. Genetic study of restoration of pollen fertility of cytoplasmic male-sterile cotton. Rev. Brasil. Genet. IV, 3: 411-426. Two methods were employed in the study of pollen fertility restoration for cytoplasmic male- sterile cotton. The conventional genetic study indicated that restoration of pollen fertility may be controlled by three genes, whereby fertility is restored when at least a single dominant allele is present at any two loci. Cytogenetic studies clearly indicated single gene inheritance. None of the tested chromosomes carried the restorer factors.

Smith, C. W. 1983. Registration of UArk1 and UArk2 early-maturing cotton germplasm. Crop Sci. 23: 1226-1227.

Smith C. W. 1983. Registration of UARK-1 and UARK-2 Early maturing cotton germplasm. Crop Sci 23: Germplasm registration.

Smith, C. W. 1988. Registration of 'Arkot 518' upland cotton cultivar. Crop Sci. 28: 190.

Smith, C. W. and A. Niles. 1988. Registration of 14 cotton germplasm lines. Crop Sci. 28: 578-579.

Smith, C. W. and G. A. Niles. 1990. Registration of seven cotton germplasm lines adapted to the Coastal Bend of Texas. Crop Sci. 30: 1373.

Smith, C. W. and G. A. Niles. 1990. Registration of 10 improved-fiber-strength cotton germplasm lines. Crop Sci. 30: 1373-74.

Smith, C. W. and G. A. Niles. 1990. Registration of three cotton germplasm lines. Crop Sci. 30: 1372-1373.

Smith, C. W., M. F. Schuster, and G. A. Niles. 1990. Registration of 11 high-tannin germplasm lines. Crop Sci. 30: 1374.

Smith C. W., M. F. Schuster, and G. A. Niles. 1990 Registration of 17 high-tannin cotton germplasm lines. Crop Sci. 30: 1274-75.

Stanton, M. A. 1992. Evaluation of the Asiatic cottons. PhD. Dissertation, University of Arkansas. The accessions in the U.S. National Plant Germplasm System's Asiatic cotton collection were evaluated to provide mophological descriptors and evaluation data on selected pest resistances. Principal component analysis of morphological measurements on the accession separated the two species, but few infraspecific groupings were found. The racial classification of the Asiatic species is questioned. Ninety-five accessions evaluated for resistance to root-knot nematode ranged from susceptible to resistant compared to Auburn 634 and M-8. *In vitro* evaluations of 182 accessions for resistance to *Heliothis virescens* yielded 101 accessions with reduced larvae growth and 94 with reduced survival compared to a reference *G. hirsutum* cultivar. Two hundred accessions of Asiatic did not have resistance to seedling disease organisms *Rhizoctonia* and *Pythium*. In evaluations for resistance to thrips, 25 of 43 accessions were significantly better than Stoneville 506 in each of 3 years. Data on each accession are available in the NPGS Genetic Resources Information Network.

Stanton, M. A., J. McD Stewart, and N. P. Tugwell. 1992. Evaluation of *Gossypium aboreum* L. germplasm for

resistance to thrips. GRACE: (in press). Forty-three accessions of *G. arboreum* were evaluated for resistance to thrips (Thysanoptera) with Stoneville 506 as control. Seedling damage was standardized to Stonville and ranked into quartiles by year. Four accessions ranked in the lowest quartile in all years and may be of value in a breeding program for resistance to thrips.

Stelly, D. M. 1990. Localization of the Le_2 locus of cotton (*Gossypium hirsutum* L.). J. of Hered. 81: 193-197. Monotelodisomic tests were made to locate the Le_2 locus to an arm of chromosome 26. Segregation among the F_1S_1TC families indicated the Le_2 locus is located in the long arm of chromosome 26, or within 5 cM of the centromere in the short arm. The data also revealed that the $Le_1Le_2^{dav}$ interaction caused necrosis more quickly than did the Le_2-Le_2^{dav} interaction. Estimates of differential emergence for F_1S_1TC seed genotypes were used to amend raw data in an unbiased manner, resulting in better fits to expected segregation ratios and increased homogeneity among families. The results lend credence to previous inferences that differential viability can cause non-Mendelian ratios among individual plants segregating for alleles of this hybrid lethality system, and also indicate that it should be possible to use TE26sh stocks to develop isolines differing at the Le_2 locus.

Stelly, D. M., D. W. Altman, R. J. Kohel, T. S. Rangan, and E. Commiskey. 1989. Cytogenetic abnormalities of cotton somaclones from callus cultures. Genome. 32: 762-770. The objective was to detemine whether cytogenetic variation contributes to somaclonal variation in cotton (*Gossypium hirsutum* L., $2n = 4x = 52$). Of 117 somaclones of cotton regenerated from 18-month-old callus cultures of 'SJ-2' and 'SJ-5' cultivars, 35 were analyzed for meiotic abnormalities. The population of somaclones was extremely varied in phenotype and fertility, both male and female. High frequencies of aneuploidy and tertiary monosomy indicate that cytogenetic anomalies are major source or somaclonal variation in cotton. It was hypothesized that primary cytogenetic events during cotton cell culture give rise to breakage-fusion-bridge (BFB) cycles, which subsequently give rise to secondary types of cytogenetic abnormalities.

Stelly, D. M., K. C. Kautz, and W. L. Rooney. 1990. Pollen fertility of some simple and compound translocations of cotton. Crop Sci. 39: 952-955. Pollen fertility levels of plants either homozygous (TT) or heterozygous (NT) were reported for 20 translocations, including 16 two-chromosome, 3 three-chromosome, and 1 four-chromosome translocations. Fertility ranged from 90 to nearly 100 percent for TT and from 52 to 81 percent for NT plants, indicating that TT and NT cytogenetic types in test-cross populations that are segregating for a single translocation should be distinguishable on the basis of pollen fertility. Thus, all 45 breakpoints of the screened translocations are of potential use as genetic markers. These and previously published results demonstrate collectively that all identified translocations of *G. hirsutum* are amenable to pollen analysis by fluorescene microscopy, even though the species is disomic tetraploid.

Stelly, D. M., J. A. Lee, and W. L. Rooney. 1988. Proposed schemes for mass-extraction of doubled haploids of cotton. Crop Sci. 28: 885-890. Development of a system for mass-extraction from cotton was proposed. Three steps are involved: (1) synthesis of hybrid-eliminating, haploid-inducing (HEHP) lines and populations homozygous for the Le_2^{dav} hybrid lethality allele and the *Se* allele for semigamous reproduction; (2) cross pollination of HEHP plants with pollen of normal cotton (*Gossypium hirsutum* and *G. barbadense*) to form inviable true hybrids, but viable haploids; and (3) bulk treatment of all seed or young viable seedlings with cohchicine to recover doubled haploids en masse.

Stelly, D. M. and W. L. Rooney. 1989. Delimination of the Le_2^{dav} complementary lethality system of *Gossypium* to intracellular interaction. J. of Hered. 80: 100-103. The basis of hybrid necrosis and lethality in cotton (*Gossypium* spp.) caused by interactions of Le_2^{dav} with Le_1 and Le_2 was investigated with regard to the possible roles of intracellular and intercellular genetic interactions in eliciting the hybrid necrosis. Seedlings chimeric for sectors bearing the complementary hybrid lethality factors Le_2 vs. Le_1Le_2 were derived by crossing facultatively apomictic (semigamy) Se-$sesele_1le_1Le_2Le_2$ ovule parents with nonapomictic pollen parents of the genotype $sesele_1le_1Le_2{}^{dav}Le_2{}^{dav}$. Patterns of necrosis in F_1 haploid, and chimeric progenies indicated that events underlying the hybrid lethality reaction are mediated via intracellular interactions and intercellular diffusates are not involved.

Stewart, J. McD. 1981. *In vitro* fertilization and embryo rescue. Environ. Expt. Bot. 21: 301-315. A review of *In vitro* fertilization and embryo rescue. *In vitro* fertilization of cotton ovules is reported for the first time. Also, the following hybrids between *Gossypium* species are reported for the first time: *G. herbaceum* x *G. armourianum, G. herbaceum* x *G. somalense, G. herbaceum* x *G. harknessii, G. herbaceum* x *G. longicalyx, G. arboreum* x *G. armourianum, G. arboreum* x *G. somalense, G. arboreum* x *G. harknessii, G. arboreum* x *G. longicalyx, G. arboreum* x *G.tomentosum, G. arboreum* x *G. mustelinum, G. hirsutum* x *G. somalense, G. hirsutum* x *G. bickii, G. barbadense* x *G. australe.*

Stewart, J. McD. 1982. Habitats of the wild *Gossypium* species of Australia. Proc. Beltwide Cotton Prod. Res. Conf. p. 76. A *Gossypium* germplasm collections trip was conducted in Australia during September 1981. Observations are recorded on the ecological niches and other features on 10 of the 11 indigenous species recognized at that time.

Stewart, J. McD. 1987. Cotton germplasm and biotechnology research. Proc. Cotton Res. Meeting. AAES, pp. 17-19. An overview is given of a new cotton germplasm and biotechnology research program at Arkansas. Elements of the program include germplasm maintenance, evaluation, and enhancement of selected traits and species from the *Gossypium* germplasm pool. Ovule culture and genetic engineering with *Agrobacterium* are emphasized in the area biotechnology.

Stewart, J. McD. 1988. Biotechnology and germplasm improvement. Ark. Farm Res. 37(4): 6. An overview is given of a new cotton germplasm and biotechnology research program at Arkansas. Elements of the program include germplasm maintenance, evaluation, and enhancement of selected traits and species from the *Gossypium* germplasm pool. Ovule culture and genetic engineering with *Agrobacterium* are emphasized in the area biotechnology.

Stewart, J. McD. 1988. Update on the taxonomy of *Gossypium*. Proc. Beltwide Cotton Prod. Res. Conf. pp. 95-97. The taxonomy of the *Gossypium* genus is discussed in relation to germplasm utilization. The new species, realignments and recombinations of the various taxa are presented as they are currently recognized. A list of the subgenera, sections, subsections, and species with authorities as of 1988 is included.

Stewart, J. McD. 1989. Cotton germplasm work at the University of Arkansas. Proc. Cotton Res. Meeting. AAES Special Report 138, pp. 75-79. The various germplasm pools available for cotton improvement are discussed. Emphasis is placed on the germplasm resources held at the University of Arkansas. Brief mention is given to the various resistance screens and germplasm enhancement efforts that are being pursued at Arkansas.

Stewart, J. McD. 1990. New cytoplasms for cotton. Proc. Cotton Res. Meeting. AAES Special Report 144, pp. 55-58. Research strategies and results on the introgression of new cytoplasms into cotton are presented. The cytoplasms of *G. mustelinum, G. darwinii, G. sturtianum, G. trilobum*, and *G. davidsonii* are introgressed into the nuclear background of *G. barbadense* carrying the semigamy trait.

Stewart, J. McD. 1990. The role of genetic engineering in crop pest control. Ark. Farm Res. 39(3): 10. The potential of genetic engineering in the control of crop pests is discussed. It is now possible to engineer plants that produce toxins, repellents, or other compounds that aid in pest control.

Stewart, J. McD. 1991. Biotechnological advances in cotton. Proc. 1991 Cotton Res. Meeting. AAES Special Report 149, pp. 77-82. An update is presented on the commercialization of biotechnology in cotton, including the Bt cottons and herbicide resistant lines.

Stewart, J. McD. 1991. Biotechnology of cotton: achievements and perspectives. ICAC Review Articles on Cotton Production Res. No. 3. CAB International, Wallingford, UK. 54 pp. An extensive review of the advances of biotechnology in cotton with treatments of work that is currently in progress. A broad definition of biotechnology is taken to include biological control, tissue culture, and molecular genetics. A summary of the principles and tools of tissue and molecular biology is presented for the lay reader. The review ends with a discussion of the social and regulatory aspects of genetic engineering.

Stewart, J. McD. 1992. Germplasm resources and enhancement strategies for disease resistance. Proc. Beltwide Cotton Conf. pp. 1323-1325. The germplasm resources that make up the primary, secondary, and tertiary genetic pools for cotton improvement are described. For each pool strategies are presented for efficiently introgressing traits into agronomically acceptable breeding lines.

Stewart, J. McD. 1992. A new cytoplasmic male-sterile and restorer for cotton. Proc. Cotton Res. Meeting. AAES Special Report. pp. 50-53. A new cytoplasmic male-sterile and restorer system based on the cytoplasm of *G. trilobum* in upland cotton is described. The system is unique in that the restorer factor does not give phenotypic segregate in F_2 or F_3 generations. These populations are basically fertile until crossed with a non-restoring (B) line, wherein male-sterile and male-fertile plants result.

Stewart, J. McD., L. A. Craven, and P. A. Fryxell. 1987. *Gossypium* germplasm from Australia. FAO/IBPGR Plant Genet. Resources Newsl. 69: 44-47. A report of a germplasm collecting expedition to Australia in 1985 and an account of the accessions of germplasm obtained of Gossypium and other plants.

Stewart, J. McD. and S. L. Cunningham. 1985. Two new *Gossypium* species from Western Australia. Proc. Beltwide Cotton Prod. Res. Conf. pp. 73-74. Two new species were recognized from germplasm collected in Australia. The suggested specific names, *G. fryxelli* and *G. binatum*, were presented without formal descriptions, hence are *nominea nudea*. The two species are now formally recognized as *G. nobile*, and *G. londonderriense*, respectively.

Stewart, J. McD. and G. Felton. 1991\2. Host plant resistance - the first line of defense. Ark. Farm Res. 41(4): 8-9. Host plant resistance to pests relies on a number of different mechanisms including production of proteins and enzymes that have an antinutritional effect on insects. Accumulation of a variety of these in a single line, either by breeding techniques or genetic engineering, will increase the resistance of the crop to the affected pests and decrease the need for other control measures.

Stewart, J. McD., P. A. Fryxell, and L. A. Craven. 1987. Recognition and distribution of *Gossypium nelsonii*. Brunonia 10: 215-218. *Gossypium nelsonii* and *G. australe* have sometimes been confused. Field observations from central Australia are reported on these two species, clearly distinguishing them morphologically and distributionally.

Stewart, J. McD., A. E. Percival, A. Miranda, E. C. Freier, and J. A. Moreira. 1989. Cotton germplasm collection in Brazil. Proc. Beltwide Cott. Prod. Res. Conf., Abst. p. 135. A cotton plant exploration was conducted in northeast Brazil to collect seeds of "Moco" cotton cultivars and the wild endemic tetraploid species *Gossupium mustelinum* Miers ex Watt.

Stewart, J. McD., A. E. Percival, L. Perez S., and E. A. Garcia C. 1991. Collection of wild *Gossypium* spp. from NW Mexico and Baja, California. Agron. Abs. p. 209. A cotton exploration to northeast Mexico was successful in obtaining seeds of *Gossypium hirsutum* L., *G. thurberi* Tod., *G. armourianum* Kearn., *G. harknessii* Brandeg., *G. davidsonii*, Watt, and *G. turneri* Fryxell. An extensive location where *G.aridum* Skov. is endemic was also determined.

Stewart, J. M., A. E. Percival, and M. A. Stanton. 1987. Verification of the U.S. Asiatic Cotton Germplasm Collection. Agron. Abs. p. 112. A screening, for proper identification, of the Asiatic diploid cottons *Gossupium herbaceum* L. and *G. arboreum* L. in the collection.

Stewart, J. McD. and M. A. Stanton. 1988. Screening for resistance in the Asiatic cottons. Proc. Cotton Res. Meeting. AAES Special Report 132. A program to screen for genetic resistances among the Asiatic cotton germplasm accessions is described. Resistances are being sought for *Heliothis*, root-knot nematode, seedling disease organisms, thrips, plant bugs, and boll weevils.

Stringer, S. J. and J. E. Jones. 1985. Field resistance to *Heliothis* species in cotton strains with genetically differing resistance backgrounds. Proc. Beltwide Cotton Prod. Res. Conf. pp. 388-390. Bollworm/tobacco budworm (BW/TBW) damage in 15 experimental strains was compared with the susceptible cultivars, Stoneville 213 and Deltapine 41, and four BW/TBW-resistant strains. Resistance traits in the study included high flower bud gossypol gland density, yellow pollen, nectariless, glabrous, "Q source," and "X-factor." All experimental and resistant strains except PD 8619 ("Q source") had significantly less fruit damage than the susceptible check cultivars; all but three had fewer live larvae in squares than the susceptible cultivars. In a related study, near isogeneic strains possessing different alleles for red pigmentation showed little or no BW/TBW resistance compared to the Stoneville 213 check.

Turcotte, E. L. 1986. Round leaf-3 mutant in American Pima cotton. J. Hered. 77: 364-366. An incomplete leaf trait is described. Heterozygous plants express several characteristics including small, yellow-green and waxy leaves that are often rounded, modified narrow bracts, and normal branches arising from low mainstem nodes. Homozygous dominant plants express an extreme phenotype and they rarely shed pollen, making them functionally lethal. The name Round leaf-3 and the gene symbol Rl_3 is assigned to the mutant. Linkage tests between Rl_3 and 23 other *Gossypium* mutant genes were negative.

Turcotte, E. L. 1987. Inheritance of a second wrinkled leaf mutant in American Pima cotton. Crop Sci. 27: 702-704. A monogenic recessive wrinkled mutant is described. The mutant expresses on successive leaves beginning with the first sympodial branch produced from nodes 6 through 8 on field-grown plants. The wrinkled leaf trait was not allelic with three other leaf mutant genes nor was it linked with 22 *Gossypium* mutant genes. The name wrinkled leaf-2 and the gene symbol wr_2 are assigned to the mutant.

Turcotte, E. L. and C. V. Feaster. 1982. Doubled haploids of American Pima cotton. USDA- ARS-ARM-W-32.22 p. Five boll and six fiber properties were described for 234 doubled haploids of American Pima cotton (*Gossypium barbadense* L.). These doubled haploids were derived from 48 germplasm sources. Each doubled haploid was uniform within, but varied extensively among, genotypes for boll and fiber properties. The complete homozygosity of doubled haploids had no apparent deleterious effects on seedling vigor and plant growth; however, with few exceptions the fiber properties of doubled haploids were inferior to standards in at least one property.

Turcotte, E. L. and C. V. Feaster. 1983. Inheritance of a golden veins mutant in American Pima cotton. J. Hered. 74: 213-214. An incompletely dominant mutant that is characterized by golden-colored leaf veins and glossy leaf appearance is described. Homozygous dominant plants are extremely dwarfed and do not flower. The name golden veins and the gene symbol *Gv* are assigned to the mutant. Linkage tests between *Gv* and 20 *Gossypium* mutant genes were negative.

Turcotte, E. L. and C. V. Feaster. 1985. Inheritance of male-sterile mutant Ms_{12} in American Pima cotton. Crop Sci. 25: 688-690. A dominant male-sterile mutant is described and assigned the name Male-sterile 12 and the gene symbol Ms_{12} and other genetic male-steriles in cotton are discussed.

Turcotte, E. L. and C. V. Feaster. 1985. Notice to plant breeders and geneticists relative to release of five non-commercial germplasm lines of Pima cotton. Ariz. Agric. Exp. Stn. and USDA Memo. 3p. and Registration of five American Pima cotton germplasm lines (Reg. No. GP-255 to GP-259). Crop Sci. 26: 206. 1986. Five germplasm lines of *Gossypium barbadense* L. incorporating the genetic traits okra leaf, fertility restoration, frego bract, glandless, and nectariless into Pima backgrounds were released.

Turcotte, E. L., C. V. Feaster, and E. F. Young, Jr. 1989. Notice to plant breeders and geneticists relative to release of six non-commercial germplasm lines of Pima cotton. Ariz. Agric. Exp. Stn. and USDA Memo. 5 p. and Registration of six American Pima cotton germplasm lines. (Reg. No. GP-479 to GP-484). Crop Sci. 31: 495. 1991. Six germplasm lines of Pima cotton, P45, P51, P53, P62, P66, and E15, representing a range of yield potential, plant height, earliness, tolerance to heat stress, boll and fiber properties, and spinning performance were released.

Turcotte, E. L. and R. G. Percy. 1988. Inheritance of a second virsescent mutant in American Pima cotton. Crop Sci . 28: 1018-1019. A monogenic recessive virsescent mutant is described. Genetic studies showed that the virsescent trait is not linked with 22 *Gossypium* mutant genes or allelic with v_7 in *G. barbadense* or allelic with v_7 in *G. barbadense* L. or v_1 and v_2 in *G. hirsutum* L. The name virsescent-21 and the gene symbol v_{21} are assigned to the mutant.

Turcotte, E. L. and R. G. Percy. 1990. The genetics of kidney-seed in *Gossypium barbadense* L. Crop Sci. 30: 384-386. Kidney seed cottons are a distinctive type in which the seeds of each locule are conjoined into a single kidney-shaped mass. Genetic studies of kidney seed showed that it is inherited as a monogenic recessive, and that it is not linked with 21 *Gossypium* mutant genes. The gene symbol *k* was assigned to the kidney seed trait. Several kidney cottons in the *G. barbadense* germplasm collection are characterized by a complex of traits and are known collectively as *G. barbadense* var. *braziliense*. The present study expanded the trait complex associated with *braziliense*.

Turcotte, E. L., R. G. Percy, and Carl V. Feaster. 1991. Notice of release of a commercial variety of American Pima cotton, 'Pima S-7.' USDA and Ariz. Agric. Exp. Stn. Memo. 3 p. and Registration of 'Pima S-7' American Pima cotton. (Reg. No. CV-101, PI560140). Crop Sci. 32: 1291. 1992. The advantages of Pima S-7 over Pima S-6 are earlier maturity, greater heat tolerance, higher yield potential at low and intermediate elevations, and earliness at high elevations of the Pima cotton belt. Also, Pima S-7 is slightly longer, 6 percent stronger, and has slightly finer fiber. In processing, Pima S-7 gives 6 percent stronger yarns than Pima S-6.

Umbeck, P. F., K. A. Barton, E. V. Nordheim, J. C. McCarty, Jr., W. L. Parrott, and J. N. Jenkins. 1991. Degree of pollen dispersal by insects from a field test of genetically engineered cotton. J. Econ. Entomol. 84: 1943-1950. This investigation was to evaluate the biosafety procedures used to reduce pollen movement in plots of transgenic cotton grown at Mississippi State, MS, in 1989. Plots were surrounded by 24 border rows and pollen transfer to these was measured. Outcrossing went from 5 to less than 1 percent by 7 meters away from the test plot. A low level of pollen dispersal of less than 1 percent continued to occur sporadically in the remaining border rows out to a distance of 25 meters. Border rows fulfilled their purpose of serving as a pollen sink to reduce pollen dissemination from the test plot.

Umbeck, P. F. and J. McD. Stewart. 1985. Substitution of cotton cytoplasm from wild diploid species for cotton germplasm improvement. Crop Sci. 25: 1015-1019. A program to introgress the cytoplasms of wild *Gossypium* species into cultivated cotton is introduced. Gibberellic acid and embryo rescue are used to recover initial interspecific hybrids. Fertilization and embryo development are strongly dependent on the pollen donor. The degree of hybrid embryo development is more important than size or chronological age in obtaining seedlings. The following hybrids are reported D_8 x AD_1; E_1 x AD_1; E_1 x A_2; E_2 x A_2. Chromosome associations at meiosis in these hybrids agreed with published reports for the reciprocal hybrids, so cytoplasm does not have a major effect on chromosome pairing.

Verhalen, L. M. and J. C. Banks. 1989. Cotton classing in Oklahoma. Oklahoma Coop. Ext. Serv. Current Rep. CR-2107. The purpose of cotton classing and the methods used to accomplish it are described in this publication. The factors on the class card (including grade, grade remarks, color, trash, fiber length, uniformity, micronaire, and fiber strength) are discussed as to their interpretation and their importance in the manufacturing process.

Verhalen, L. M., M. B. Bayles, and N. B. Thomas. 1984. Cotton varieties for Oklahoma: A short-season environment. Proc. Western Cotton Prod. Conf. pp. 8-15. This paper describes the historical importance of cotton production in Oklahoma up to 1984 and the environmental limitations (biotic and abiotic) to that production in the state. The evaluation of cotton cultivars to cope with those limitations in the short-term is discussed. The breeding and genetics of cotton to cope with those limitations in the long-term is also presented.

Verhalen, L. M., R. W. Foraker, R. K. Bowman, R. W. Thacker, B. E. Greenhagen, and R. W. McNew. 1992. Cultivar by planting date by year interaction study for irrigated cotton in Oklahoma. Proc. Beltwide Cotton Conf. p. 612. (Abstr.) These experiments included two cultivars (a stripper and a picker type), seven planting dates/year, and 5 years at one location. Cultivar (C) by planting date (PD) by year (Y) interactions comprised 5.2 percent of the total variation for fiber strength and less than 2 percent for all other traits. The C by Y and PD by Y components generally totaled less than 30 percent of the total variation, except for lint yield where the PD by Y component comprised 41.4 percent and was the major component. The C by PD interaction was significant only for fiber length. Response trends over PD (over Y and C) were quadratic for lint yield; linear for lint percentages and for micronaire; and nonsignificant for uniformity index and fiber strength. Those trends over PD (over Y) for fiber length by cultivars were quadratic in three of four cases. Maximum lint yields were obtained for the 2-week time interval including PDs 3 and 4 (May 15 and 22). Expanding that interval to include PDs 2 (May 8) and 5 (May 29) lowered lint yield in those weeks by 4 and 5 percent, respectively. Expanding that interval to include PDs 1 (May 1) and 6 (June 8) lowered lint yield in those weeks (from the maximum) by 13 and 16 percent, respectively. Expanding that interval to include PD 7 (June 15) lowered lint yield by 30 percent relative to dates 3 and 4. Examining lint yield in individual years showed that extremely early planting was advantageous in 1 year, ambiguous in 2, and disadvantageous in 2 others

Waddle, B. A. 1982. The present state of the art and science of plant breeding for variety-environment interactions. Proc. Beltwide Cotton Prod. Res. Conf. pp. 125-128. Genotype by location of year interactions prevents universal adaptation by a given variety. Interaction have been progressively reduced at the major breeding centers by the use of broadly based testing sites over multiple years and by a policy to stay close to a proven phenotype in all progeny selections. Short season cottons and stormproof types are spin-offs from genotype-cultural practice interactions. The existence of genotype by environment interactions in the germplasm pool is the feed stock supporting the capacity to change phenotypes.

Wallace, T. P. and K. M. El-Zik. 1989. Inheritance of resistance in three cotton cultivars to the HV1 isolate of bacterial blight. Crop Science 29: 1114-1119. The inheritance of resistance to a new isolate of *Xanthomonas campestris* pv *malvacearum*, designated as HV1, in cotton cultivars 'S295,' 'Tamcot CAMD-E,' and 'Stoneville 825' was investigated. Cotyledons and true leaves were wound inoculated with the pathogen and graded for disease reaction on a scale of 1 to 10. Parental, F_1, F_2 and backcross progenies indicated resistance was inherited as a single gene with complete dominance for resistance. Progenies resistant to the HV1 isolate were also resistant to a mixture of U.S.A. races. The gene for resistance to HV1 in cultivar S295 was designated as B_{12}.

Wallace, T. P. and K. M. El-Zik. 1990. Quantitative analysis of resistance in cotton to three new isolates of the bacterial blight pathogen. Theor. Appl. Genet. 79: 443-448. The inheritance of resistance in three cotton cultivars to three new isolates of *Xanthomonas campestris* pv *malvacearum* designated as HV3, HV7, and Sudan were investigated by inoculating parents, F_1font size="-1">$_2$'s, BC_1F_1 and BC_2F_1 with each isolate using the toothpick scratch method. Generation means analysis of progenies indicated that dominance, when significant, was in the direction of resistance. Digenic interaction components indicated a duplicate type. Narrow-sense heritability estimates ranged from 0.59 to 0.68.

Wallace, T.P. and K.M. El-Zik. 1992. Reaction of three cotton (Gossypium hirsutum) cultivars to single and mixed isolates of *Xanthomonas campestris* pv. *malvacearum*. Plant Path. 41: 569-572. Resistant and susceptible cotton cultivars were inoculated with four African isolates of *Xanthomonas campestris* pv *malvacearum* and the USA race 18. Each isolate was used as a single inoculum and in mixtures with other isolates. Plants were wound inoculated at both the cotyledon stage and true leaf growth stage and evaluated 15 days later for disease reaction on a scale of 1 to 10. When the most virulent isolate (HV1) was mixed with any other isolate, disease grades were greatly reduced. The efficiency of selection for germplasm resistant to bacterial blight may be reduced if the most virulent isolate is included in an inoculum mixture.

Waller, G. D., F. D. Wilson, and J. H. Martin. 1981. Influence of cotton phenotype, season, and time-of-day on nectar production. Crop Sci. 21: 507-511. Twenty-five cultivars and breeding stocks of upland cotton and two cultivars of Pima cotton were studied for diurnal and seasonal patterns of floral nectar production. Nectar secretion began at 0800 hours and increased linearly to 1700 hours when the flowers closed. Sugar amounts (approximately 25 µl nectar/flower during mid-season) and concentrations (approximately 20 percent mid-day) in upland cotton were similar for all 25 entries. Sugar amounts were almost three times; higher in the Pima cultivars. Honeybee visits were negligible to all entries, even though 10 honeybee colonies per hectare were provided.

Wells, R. and W. R. Meredith, Jr. 1984. Comparative growth of obsolete and modern cotton cultivars. I. Vegetative dry matter partitioning. Crop Sci. 24: 858-862. Old cultivars (released before 1920) partitioned more dry matter into stems than modern cultivars. Old cultivars tended to have higher leaf area indexes and light interception values than many of the modern cultivars. Net assimilation rates were not higher in newer cultivars.

Wells, R. and W. R. Meredith, Jr. 1984. Comparative growth of obsolete and modern cotton cultivars. II. Reproductive dry matter partitioning. Crop Sci. 24: 863-868. Modern cultivars produced a greater proportion of their squares and flowers earlier than obsolete cultivars. Modern cultivars appear to produce a larger lint yield by two major processes. The first is greater partitioning of dry matter to reproductive organs. The second is an increased amount of reproductive development occurring when maximal leaf mass and area are present.

Wells, R. and W. R. Meredith, Jr. 1984. Comparative growth of obsolete and modern cotton cultivars. III. Relationships of yield to observed growth characteristics. Crop Sci. 24: 868- 872. The largest contribution to yield variation was the number of bolls produced. Modern cultivars produced a greater proportion of their total lint and boll number before 135 days after planting than did obsolete cultivars. Earlier production of modern cultivars is associated with smaller vegetative plant canopies and an earlier transition to reproductive growth. Modern cultivars exhibited smaller boll weights and a greater lint percentage than obsolete cultivars. Fiber quality, with the exception of increased micronaire, showed little improvement due to plant breeding.

Wells, R. and W. R. Meredith, Jr. 1986. Heterosis in upland cotton. I. Growth and leaf area partitioning. Crop Sci. 26: 1119-1123. Four established upland cotton cultivars and their six F_1 hybrids were monitored in three environments. Total biomass was greater in hybrids than their parents in all environments. Growth analysis showed that heterosis greatly affected early development of the hybrids. Similar leaf area partitioning occurred in the parents and F_1's. Hybrids produced greater leaf area index resulting from greater net assimilation rates in early crop development.

Wells, R. and W. R. Meredith, Jr. 1986. Normal vs. okra-leaf yield interactions in cotton. II. Analysis of vegetative and reproductive growth. Crop Sci. 26: 223-228. Four paired near-isogenic okra-leaf and normal leaf lines were planted in replicated trials on two planting dates in 1983 at Stoneville, MS. Two strains had superior lint yield by the normal leaf sib, while two others had superior lint yield by the okra-leaf sib. 'Stoneville 213' normal leaf was superior in yield to its BC_5 okra-leaf near-isoline. Except for plant height, the parameters of vegetative and reproductive growth showed no significant leaf type x strain, or leaf type x strain x harvest date (maturity) interactions. Okra leaf produced leaf area that was 26 and 49 percent smaller than those produced by normal leaf line for the April and May planting dates, respectively. This disparity was partially offset by the production of more leaves by the okra entries in the earlier but not later planting. The maximum potential of cottons with okra leaves remain unclear, because of the large leaf type x environmental interactions.

Wells, R., W. R. Meredith, Jr., and J. R. Williford. 1986. Canopy photosynthesis and its relationship to plant productivity in near-isogenic cotton lines differing in leaf morphology. Plant Physiol. 82: 635-640. Near-isogenic lines of MD65-11 of normal, sub-okra, okra, and super okra were compared in a 2-year study at Stoneville, MS. The F_1 and F_2 populations of normal x okra leaf were also grown in these studies. Integrated canopy photosynthesis (ICAP) was significantly associated with light interception with averages of 36.3, 38.9, 32.7, 23.9, 38.5, and 36.5 ICAP relative units for normal, sub-okra, okra, super okra, F_1 and F_2 lines, respectively. Lint production was positively related to ICAP ($R^2 = 0.53$).

Wells, R., W. R. Meredith, Jr., and J. R. Williford. 1988. Heterosis in upland Cotton. II. Relationship of leaf area to plant photosynthesis. Crop Sci. 28: 522-525. Three established cultivars and their three F_1 hybrids were examined in two field environments. Hybrid progeny had significantly greater leaf area index and canopy photosynthesis rates in both environments during the earlier plant growth stages. Hybrids and their parents showed no differences in single leaf apparent photosynthesis (AP). Total dry weight was significantly correlated with leaf area index ($r = 0.85^{**}$). Early AP per plant was significantly associated with leaf area per plant. Later in development, this association weakened. The data indicate that hybrids produced generally bigger plants that intercepted more light than their parents, and have had increased photosynthesis rates on a per-plant basis. Factors that affect early plant growth can result in associated changes in AP per plant and accentuate the need for prudent crop management during early development.

Wendel, J. F., C. L. Brubaker, and A. E. Percival. 1992. Genetic diversity in *Gossypium hirsutum* and the origin of Upland cotton. Amer. J. Bot. 79(11): 1291-1310. This study was conducted to assess levels and patterns of genetic variation in the species and to elucidate the origin of upland cotton. Five hundred and thirty eight accessions representing the full spectrum of morphological and geographical diversity were analyzed for

allozyme variation at 50 loci.

Wendel, J. F., P. D. Olson, and J. McD. Stewart. 1989. Genetic diversity, introgression, and independent domestication of old world cultivated cottons. Amer. J. Bot. 76: 1797-1808. One hundred three accessions of *G. arboreum* and 31 accessions of *G. herbaceum* were examined for allelic variation at 40 allozyme loci. *G arboreum* possesses greater diversity than *G. herbaceum*, although both have low allozyme variation. Contrary to expectations, the two species are highly differentiated with respect to allozyme composition. The authors suggest that a significant portion of the allelic diversity in both species results from historical, bidirectional interspecific introgression. Because the genetic identity\y estimate (0.74) is markedly lower than for documented progenitor-derivative and crop-ancestor species pair, and because of other cytogenetic and genetic data, the cultivated *G. arboreum* and *G. herbaceum* appear to be independently domesticated from divergent ancestors.

Wendel, J. F. and A. E. Percival. 1990. Molecular divergence in the Galapagos Islands - Baja California species pair, *Gossupium klotzschianum* and *G. davidsonii*. Pl. Syst. Evol. 171, 99-115. Molecular divergence between *Gossupium davidsonii* Andress., and *G. klotzschianum* Kell. was studied. Genetic and taxonomic data suggests that these two species are related as progenitor and derivative respectively.

Wendel, J. F. and R. G. Percy. 1990. Allozyme diversity and introgression in the Galapagos Islands endemic *Gossypium darwinii* and its relationship to continental *G. barbadense*. Biochemical Systematics and Ecology 18: 517-528. Allozyme analysis was performed on 58 accessions collected on six islands of the Galapagos archipelago to determine the diversity and species status of *G. darwinii*. Levels of variation were high for an island endemic, and may have resulted from interspecific gene flow from introduced *G. barbadense*. Levels of introgression corresponded with levels of human habitation and activity on the six islands. It is suggested that the specific rank for *G. darwiniiis* warranted.

Wendell, J. F., J. McD. Stewart, and J. H. Rettig. 1990. Molecular evidence for the origin of *Gossypium bickii* via homoploid reticulation. Evolution 45: 694-711. Cladistic analysis of maternally inherited cpDNA restriction site mutations unite *G. bickii* with *G. sturtianum*, even though these two are in different taxanomic sections. Phylogenetic analysis of allozyme markers and restriction site mutations in nuclear ribosomal DNA indicate that *G. bickii* shares a more common ancestor with *G. australe* and *G. nelsonii* than it does with *G. sturtianum*. The discrepancy between independent molecular phylogenies indicates a biphyletic ancestry of *G. bickii*. This example, and others in *Gossypium*, attests to the evolutionary possibility of interspecific cytoplasmic transfer, and perhaps the origin of diploid species via reticulate speciation. This is an example of natural cytoplasmic introgression without long-term survival of nuclear genes from the maternal progenitor.

Wharton, T. F., J. N. Jenkins, J. C. McCarty, Jr., and W. L. Parrott. Productivity and tobacco budworm resistance of cotton developed between 1890 and 1986. Crop Sci. 31: 29-32. 1991. Describes results of field evaluation for tobacco budworm resistance of selected cultivars developed between 1895 and 1986. For every kilogram of lint yield increase due to breeding during the 96-year period, there was a corresponding lint yield increase under high infestations of tobacco budworm of only 0.69 kg of lint.

White, W. H., Jenkins, J. N., Parrott, W. L., McCarty, J. C., Jr., Collum, D. H. and Hedin, P. A. 1982. Generation mean analyses of various allelochemics in cottons. Crop Sci. 22:1046-1049. This research determined the inheritance of putative allelochemicals for resistance to tobacco budworm. The high degree of additive gene action for condensed tannins, a flavonoid-anthocyanin mixture, gossypol as measured by the CHEA test, and total phenolics indicate that it should be possible to fix and select for increased levels of these compounds.

White, W. H., Jenkins, J. N., Parrott, W. L., McCarty, J. C., Jr., Collum, D. H. and Hedin, P. A. 1982. Strain and within-season variability of various allelochemics within a diverse group of cottons. Crop Sci. 22: 1235-1238. Genetic and environmental interactions were studied for putative allelochemicals conferring resistance to tobacco budworm. Those in the study were total phenolics, gossypol and its analogs, a flavonoid-anthocyanin mixture, and condensed tannins as measured by three methods. The results suggest that differences in levels of these allelochemicals are inherited and that genetic effects among cotton strains should be manageable in breeding programs.

Williford, J. R., S. T. Rayburn, and W. R. Meredith, Jr. 1986. Evaluation of a 76-cm row for cotton production. Transactions of the ASAE. 29(6): 1544-1548. Field studies in 1982, 1983, and 1984 were conducted to study the effects of year, soil type, irrigation, variety, and row spacing. In 1982, five cultivars produced more lint on 76-cm rows than in 102-cm rows, when all were irrigated. Without irrigation, all eight varieties produced more lint on 102-cm rows.

Wilson, F. D. 1980. Cotton cultivars resistant to the pink bollworm. p. 46-51 *in* Graham, H. M. (ed.) Pink bollworm control in the western United States. USDA-ARS-ARM-W-16. List of the cotton cultivars that showed reduced seed damage caused by pink bollworm when grown in insecticide-free plots at Phoenix and Tempe, Arizona.

Wilson, F. D. 1982. Present state of the art and science of cotton breeding for insect resistance in the West. Proc. Beltwide Cotton Prod. Res. Conf. p. 111-117. Future cotton cultivars for irrigated areas of the West may be quite different from the full- season cultivars favored by growers for many years. Cottons that combine a high level of insect resistance with acceptable fiber yield and quality will be of great value to western growers.

Wilson, F. D. 1983. The taxonomic status of *Hibiscus berberidifolius* A. Rich. (Malvaceae). Brittonia 35: 175-179. *Hibiscus berberidifolius* is the right name to be applied to this perennial species that occurs in the mountains associated with the Great Rift Valley of eastern Africa.

Wilson, F. D. 1985. A genetic study of the number of involucral bract teeth in cotton. Crop Sci. 25: 32-34. A primitive race stock of cotton, Texas 207, had many more bract teeth than did the cultivar Stoneville 7A. Genetic studies suggested that those two parents differed by at least three pairs of genes that acted additively in concert. Narrow-sense heritability was 46 percent.

Wilson, F. D. 1986. Inheritance of ephemeral leaf mutant in upland cotton. Crop Sci. 26: 498- 500. The gene *ep*, inherited as a monofactorial recessive, conditions a developmental mutant that results in misshapen leaves from about stem nodes 6 to 18. The *ep* gene is not allelic to, nor closely linked to veins-fused (*vf*) or to strap (*s*).

Wilson, F. D. 1986. Pink bollworm resistance, lint yield, and lint yield components of okra-leaf cotton in different genetic backgrounds. Crop Sci. 26: 1164-1167. Okra-leaf in seven different cultivar backgrounds were compared with their normal-leaf counterparts. Okra-leaf in some genetic backgrounds showed a modest level of resistance to pink bollworm and yielded as much lint as their normal-leaf cultivars. However, the inconsistent response of some okra-leaf lines emphasizes the importance of comparing them with their normal-leaf cultivars over a range of environments.

Wilson, F. D. 1986. Registration of seven cotton germplasm lines. Crop Sci. 26: 206-207. Seven lines, carrying nectariless, smoothleaf, and okra leaf and their normal counterparts in all possible combinations, were transferred into AET-5 background.

Wilson, F. D. 1987. Inheritance of pink filament in cotton. J. Hered. 78: 223-224. Pink filament is conditioned by two incompletely dominant gene pairs, designated, Pf_1 and Pf_2. Pink filament is expressed only when petal spot, conditioned by R_2, is present.

Wilson, F. D. 1987. Pink bollworm resistance, lint yield, and earliness of cotton isolines in a resistant genetic background. Crop Sci. 27: 957-960. The pink-bollworm resistant line AET-5 had significantly less pink bollworm damage than the control cultivar, Deltapine 61. AET-5N (nectariless), AET-5L (okra leaf), AET-5NL, and AET-5NSL (S =Smoothleaf) isolines all had less damage than did AET-5 itself. However, AET-5S, AET-5NS, and AET-5SL did not have less damage than AET-5. Also, AET-5NL unexpectedly did not have less damage than AET-5N or AET-5L. All lines carrying S yielded less lint, and were later maturing than those that did not carry S. Thus, nectariless and okra leaf were valuable pink-bollworm resistant traits, while Smoothleaf was not.

Wilson, F. D. 1987. Projections on the prospects of host-plant resistance in fiber crops. p. 523- 525 *in*

Magallona, E. D. (ed.) Proc. 11th Intern. Congr. Plant Prot., 5-9 Oct. 1987, Manila, Philippines. A review of the present state of host-plant resistance research on fiber crops, significant research accomplishments and breakthroughs, and the actions needed to take advantage of those accomplishments and breakthroughs, particularly by scientists with limited resources.

Wilson, F. D. 1987. Registration of three cotton germplasm lines. Crop Sci. 27: 820-821. WC-10NL, WC-11NSSL, and WC-12NL are cotton germplasm lines that combine the pink-bollworm-resistant traits nectariless (N) and okra leaf (L) in improved agronomic backgrounds.

Wilson, F. D. 1989. Inheritance of undulate leaf mutant of upland cotton. J. Hered. 80: 482- 483. The undulate leaf mutant is so named because leaves have undulate margins. They also have a light-green color as a result of reduced chlorophyll content. The mutant expression is conditioned by a recessive gene, designated *ul*. This gene is not allelic to 10 other leaf shape genes.

Wilson, F. D. 1989. Yield, earliness, and fiber properties of cotton carrying combined traits for pink bollworm resistance. Crop Sci. 29: 7-12. A series of germplasm lines carrying various combinations of nectariless (N), semi-smoothleaf (SS), and okra leaf (L), were compared with nectaried, normal-leaf cultivars. All N, NL, NSS, and NSSL lines sustained less seed damage caused by pink bollworm and most were equal in lint yield and earliness. Some were equal and some were deficient in fiber properties.

Wilson, F. D. 1990. Relative resistance of cotton lines to pink bollworm. Crop Sci. 30: 500-504. In a series of diallel and generation-mean experiments, the amount of seed damage caused by pink bollworm to 13 cotton lines and several series of F_1 hybrids was compared with damage done to the resistant control line AET-5. Only Stoneville 7A okra leaf equalled the level of resistance shown by AET-5, and T39C-1-L was inconsistent over two seasons. No F_1 hybrid had lower seed damage than that of the lowest parent.

Wilson, F. D. 1991. Combining ability for yield, yield components, and earliness of cotton with resistance to pink bollworm. Crop Sci. 31: 922-925. Only T39C-1-L, a pink-bollworm resistant germplasm line (among four lines that were evaluated), equalled the control cultivar, Stoneville 825, in yield but it was later in maturity. Both T39C-1-L and Stoneville 825 showed significant general combining ability for high lint yield and bolls per plant. Stoneville 825 achieved its high yield by producing many relatively small bolls while T39C-1-L produced fewer but larger bolls. The T39C-1-L × Stoneville 825 F_1 showed specific combining ability effects for high yield, seeds per boll, and earliness.

Wilson, F. D. 1991. Twenty years of HPR -- progress, problems, prognostications. p. 42-544 *in* D. J. Herber and D. Richter (eds.) Proc. Beltwide Cotton Res. Conf. 8-12 Jan. 1991, San Antonio, TX. National Cotton Counc., Memphis, TN. A review of the 20-year history of host-plant resistance research at the Western Cotton Research Laboratory, Phoenix, Arizona. Progress: the best germplasm line required 41 percent less insecticide to control pink bollworm (PBW), yielded 12 percent more lint, and was significantly earlier than the control cultivar. Problems: personnel decisions led to different plant breeder/entomologist relations; the best arrangement was when both partners made joint decisions concerning the direction of the research. Prognostications: new, highly resistant germplasm developed by private industry using genetic engineering methods, and improved technologies in other areas of biological control of PBW suggest that the HPR research can focus more on other insects and less on PBW.

Wilson, F. D. 1992. Registration of eight cotton germplasm lines with pink bollworm resistance. Crop Sci. 32: 288-289. Eight germplasm lines were registered which carry various combinations of nectariless, semi-smoothleaf, and okra leaf in improved agronomic backgrounds.

Wilson, F. D. and J. K. Brown. 1991. Inheritance of resistance to cotton leaf crumple virus in cotton. J. Hered. 82: 508-509. Deltapine 90, highly susceptible to cotton leaf crumple virus, was crossed with Cedix, highly resistant. Seedlings of parents, F_1, F_2, and backcross hybrids were exposed to viruliferous whiteflies in a greenhouse, then transplanted to the field and scored for virus symptoms. Factors controlling symptom expression were inherited as duplicate factors. The severe symptom phenotype (genotype $c_1c_1\ c_2c_2$) was recessive to the asymptomatic phenotype (genotypes $C_1\_C_2\_$).

Wilson, F. D., J. K. Brown, and G. D. Butler, Jr. 1989. Reaction of cotton cultivars and lines to cotton leaf crumple virus. J. Ariz.-Nev. Acad. Sci. 23: 7-10. The widely grown cultivars Deltapine 61 and Deltapine 90 are highly susceptible to infection by the cotton leaf crumple virus, vectored by the sweetpotato whitefly. A cultivar from El Salvador, Cedix, is highly resistant. Nineteen lines from a resistance breeding project in Nicaragua showed highly variable responses.

Wilson, F. D., H. M. Flint, L. A. Bariola, and C. C. Chu. 1991. Reduction in insecticide use associated with cotton resistant to pink bollworm. Crop Sci. 31: 363-366. At two locations over three seasons, the mean number of insecticide applications for pink bollworm control was 41 percent lower for the nectariless, okra-leaf, early-maturing WC-12NL than for the nectaried, normal-leaf, full-season Deltapine 61. First and last insecticide application dates averaged 21 days later and 10 days earlier for WC-12NL. WC-12NL had less pink bollworm damage, yielded more lint, was earlier, but had inferior fiber properties when compared with Deltapine 61.

Wilson, F. D., H. M. Flint, W. R. Deaton, D. A. Fischhoff, F. J. Perlak, T. A. Armstrong, R. L. Fuchs, S. A. Berberich, N. J. Parks, and B. R. Stapp. 1992. Resistance of cotton lines containing a *Bacillus thuringiensis* toxin to pink bollworm Lepidoptera:Gelechiidae) and other insects. J. Econ. Entomol. 85: 1516-1521. In a field experiment at Maricopa, AZ, three transgenic cotton lines containing the *Bt* toxin gene, had 95 percent fewer rosetted blooms, 99 percent fewer pink bollworm per boll, and 97 percent lower seed damage than did the Coker 312 control cultivar. Cotton leafperforator damage was apparently absent on leaves of the transgenic lines, whereas the control cultivar sustained heavy damage. Leaf feeding damage of saltmarsh caterpillar and beet armyworm was minimal on the transgenic leaves, but leaves of the control cultivar were virtually destroyed. The transgenic lines showed no resistance to nonlepidopterous pest species, an expected result.

Wilson, F. D. and B. W. George. 1980. Combining ability for agronomic and fiber properties in cotton stocks resistant to pink bollworm. Crop Sci. 20: 563-566. Two cultivars, Deltapine 61 and Stoneville 256, and four pink-bollworm-resistant breeding stocks were evaluated in a diallel cross experiment for 12 agronomic and fiber-property traits. Results suggested that it would be easy to combine the pink-bollworm resistance of Texas 167 with the desirable agronomic and fiber-property traits of the cultivars, but it would probably be more difficult for AET-5, Texas 31, and Texas 55.

Wilson, F. D. and B. W. George. 1981. Breeding cotton for resistance to pink bollworm. Proc. Beltwide Res. Conf. p. 63-65. Breeding should be easy to combine morphological characters (nectariless, smoothleaf, and okra leaf) and early maturity, each of which imparts some resistance to pink bollworms. Breeding to transfer antixenosis and antibiosis, however, will be more difficult because their detection requires bioassays. [Authors' note: Additional research showed that smoothleaf is not a reliable resistance trait.]

Wilson, F. D. and B. W. George. 1981. Breeding potentials of noncultivated cottons. V. Productivity of cultivars, race stocks, and F_1 among them in long- and short-day environments. Crop Sci. 21: 410-414. Twelve primitive race stocks, four upland cultivars, and 24 race stock × cultivar F_1 hybrids were grown in the summer at Phoenix, AZ, and in the winter at Isabela, Puerto Rico. Genetic variability among the hybrids was caused by the race stocks, because the cultivars were very similar. Positive heterosis for F_1 vs. cultivar comparisons was shown by 26 percent of all hybrid/agronomic trait combinations in Puerto Rico and by 9 percent in Arizona.

Wilson, F. D. and B. W. George. 1981. Lint yield and resistance to pink bollworm in early maturing cotton. Crop Sci. 21: 213-216. Moderately early-maturing cultivars and breeding stocks of upland cotton sustained less pink-bollworm damage and yielded slightly less to substantially more lint by mid-September than full-season cultivars did by mid-October. Very early-maturing cottons sustained the lowest amount of seed damage but had lower yield potentials than the moderately early and full-season cottons.

Wilson, F. D. and B. W. George. 1982. Effects of okra-leaf, frego-bract, and smoothleaf mutants on pink bollworm damage and agronomic properties of cotton. Crop Sci. 22: 798-801. Seed damage by pink bollworm and 11 agronomic traits were studied in eight isolines of upland cotton, carrying all possible combinations of okra leaf, frego bract, and smoothleaf vs. their normal-leaf and bract equivalents. Okra leaf appears to have value as a pink-bollworm resistant trait, frego bract does not, and smoothleaf must be reevaluated.

Wilson, F. D. and B. W. George. 1983. Effect of pink bollworm on agronomic properties of resistant and susceptible cotton. Crop Sci. 23: 695-698. The major effect of pink bollworms on a susceptible upland cultivar, Deltapine 61, a resistant upland breeding stock, AET-5, and a susceptible Pima cultivar, Pima S-5, was to damage rather than to destroy seed. Also, most bolls stayed on the plant rather than abscising. Agronomic properties were much less affected in untreated, as compared to insecticide treated plants of the resistant AET-5 than of the two susceptible cultivars.

Wilson, F. D. and B. W. George. 1983. A genetic and breeding study of pink bollworm resistance and agronomic properties in cotton. Crop Sci. 23: 1-4. Pink bollworm resistance and high lint percentage of the upland breeding stock, AET-5, when crossed with a nectariless advanced breeding stock, 24-8 ne, showed high narrow-sense heritabilities; gene action was primarily additive.

Wilson, F. D. and B. W. George. 1984. Pink bollworm (Lepidoptera:Gelechiidae): Selecting for antibiosis in artificially and naturally infested cotton plants. J. Econ. Entomol. 77: 720-724. Seven primitive race stocks, a susceptible cultivar, and a resistant upland breeding stock, were infested artificially with pink bollworm eggs, and also allowed to become infested naturally. Texas 39 was variable in its resistance and was separated into susceptible and resistant lines. T39C-1-L, a resistant line, had significantly less seed damage than T39C-1-H, a susceptible line, and also less than the susceptible cultivar Deltapine 61 in both artificially and naturally infested plots.

Wilson, F. D. and B. W. George. 1985. Innovations in the x-ray technique of evaluating cotton germplasm for resistance to pink bollworm. USDA-ARS-40. The innovations reduced the amount of time required to process seed samples for x-raying by 57 percent (5.6 vs. 12.9 minutes per sample).

Wilson, F. D. and B. W. George. 1986. Smoothleaf and hirsute cottons: response to insect pests and yield in Arizona. J. Econ. Entomol. 79: 229-232. Smoothleaf ($T^{sm}_1 = Sm_2$) isolines did not differ significantly than hirsute isolines in susceptibility to pink bollworm or cotton leafperforator. They were, however, more susceptible to *Lygus hesperus* and tended to yield less seedcotton. The semi-smoothleaf 'Deltapine 16' ($T_3 = Sm_3$) did not differ in pink bollworm damage, but had less lygus damage and more cotton leafperforator damage than did its smoothleaf isoline.

Wilson, F. D., B. W. George, and H. M. Flint. 1985. Progress in transferring resistance to pink bollworm into nectariless cotton. Proc. Beltwide Cotton Prod. Res. Conf. p. 386-388. Eight of 14 nectariless backcross progenies, with several cotton cultivars as recurrent parents and the resistant AET-5 as the donor parent, had no more seed damage than AET-5 and compared favorably in lint yield and other agronomic properties with the cultivars.

Wilson, F. D., B. W. George, K. E. Fry, J. L. Szaro, T. J. Henneberry, and T. E. Clayton. 1986. Pink bollworm (Lepidoptera:Gelechiidae): Egg hatch, larval success, pupal, and adult survival on okra-leaf and normal-leaf cotton. J. Econ. Entomol. 79: 1671-1675. Pink bollworm oviposition was no different, but fewer larvae penetrated the bolls of Stoneville 7A okra leaf than of the normal-leaf Stoneville 7A cultivar. Boll temperatures were higher on the okra-leaf line, but not enough higher to account for the reduced larval penetration. In other experiments, higher boll or soil- surface temperatures did not result in higher insect mortality.

Wilson, F. D., B. W. George, and Jayne L. Szaro. 1984. Pink bollworm (Lepidoptera:Gelechiidae): Oviposition and larval success on resistant and susceptible cotton plants. J. Econ. Entomol. 77: 709-714. The resistance of AET-5 to pink bollworms was caused mainly by lower oviposition but also by lower penetration of the larvae into the bolls of this cotton than into those of the susceptible cultivar, Deltapine 61.

Wilson, F. D., B. W. George, and R. L. Wilson. 1981. Screening cotton for resistance to pink bollworm. USDA-ARS-ARM-W-22. A list of cotton (*G. hirsutum* and *G. barbadense*) cultivars, breeding stocks, and primitive race stocks that showed resistance to pink bollworms in diet bioassays, and in greenhouse and field trials in Arizona and Puerto Rico.

Wilson, F. D. and R. L. Shepherd. 1987. Plant pubescence, genetic background, and seasonal effects on agronomic and fiber properties of upland cotton. Crop Sci. 27: 865-868. 1981 and 1982 results showed that no agronomic or fiber-property deficiencies were associated consistently with the smoothleaf trait, in comparisons of eight smoothleaf lines and their hirsute cultivars. In 1983, however, the two smoothleaf lines selected from the earlier experiments yielded significantly less lint than their hirsute counterparts, because of fewer bolls per plant and less lint per seed.

Wilson, F. D. and C. R. Smith, Jr. 1992. Behavior and survival of pink bollworm (Lepidoptera:Gelechiidae) on bolls of resistant and susceptible cotton lines. J. Agric. Entomol. 9: 165-173. Neonate larvae of pink bollworm (PBW) were placed on bolls of T39C-1-L, a resistant line; T39C-1-H, a susceptible sibling line; and Deltapine 90, a control cultivar. T39C-1-L had fewer PBW entrance holes and shorter internal carpel-wall mines than did T39C-1-H, but both had more than did Deltapine 90. Larval response to bolls of different ages (12 to 30 days) was similar in all three entries. After neonate larvae had been placed on artificial diet, moth emergence was lowest on T39C-1-L carpel-wall diet, but also lower on carpel-wall diet of T39C-1-H than on control, seed, or lint diets of the two lines. After T39C-1-L carpels had been extracted sequentially with methylene chloride and ethanol, moth emergence was lower on diets to which the extracts had been added than on the control diet.

Wilson, F. D. and B. R. Stapp. 1984. Crossing success in cotton in Arizona as affected by irrigation, time of emasculation, and number of flowers pollinated. Agron. J. 76: 457-460. Retention of crossed bolls is low when cotton plants are exposed to the high temperatures and water deficits encountered commonly in irrigated desert regions. In this study: (1) crosses made the first week of a biweekly irrigation cycle yielded almost as much hybrid seed as those made for the entire two weeks; (2) flowers emasculated even as early as 0200 on the day of pollination led to some self-contamination; and (3) seed yield loss would not have been severe even if a shortage of pollen forced us to pollinate as many as 30 pistillate flowers with one staminate flower.

Wilson, F. D. and B. R. Stapp. 1985. Emasculation and pollination studies on upland cotton flowers. J. Ariz.-Nev. Acad. Sci. 20: 107-109. Boll set from severely emasculated flowers of upland cotton (calyx, corolla, and staminal column removed) was 84 percent, not significantly different than that from minimally emasculated flowers (corolla slit, anthers removed; 75 percent), from selfed flowers (81 percent), or open-pollinated flowers (84 percent). Boll set decreased to 6 percent when the ovary was damaged. Treating severely emasculated flowers with 30 percent ethanol reduced self contamination from 26 percent to 1 percent, but reduced boll set only from 78 percent to 71 percent, when flowers were emasculated and pollinated the same morning.

Wilson,F.D. and J.L. Szaro. 1984. Comparison of two methods of infesting cotton bolls with pink bollworm eggs. J. Econ. Entomol. 77: 277-280. Pink bollworm eggs were suspended in a solution of xanthan gum and pipetted onto cotton bolls using an automatic repeating pipette. This method was as effective as a method of placing 1-cm² egg papers on bolls, and was also more efficient.

Wilson, F. D. and J. L. Szaro. 1988. A rapid field technique for infesting cotton plants with pink bollworm eggs. J. Econ. Entomol. 81: 959-962. Pink bollworm eggs were suspended in a 0.05% solution of gum xanthan in distilled water. This suspension was sprayed on cotton plants in the field with the use of a spray apparatus that maintained a constant air pressure through the use of an oxygen tank. This new method required 2.5 seconds per boll per person, compared to 21.3 seconds with the use of an automatic repeating pipette. In a replicated field experiment, this method was used to detect 19 of 99 lines that had less pink bollworm damage than the resistant control, AET-5.

Wilson, F. D. and J. L. Szaro. 1989. Behavior of cotton leafperforator (Lepidoptera:Lyonetiidae) on wild and cultivated cotton. J. Ariz.-Nev. Acad. Sci. 23: 45-48. The behavior of cotton leafperforator larvae was studied on the upland cultivar, Deltapine 70, and on Arizona wild cotton, *G. thurberi*. Under the most natural conditions of our experiments, i. e., free-choice oviposition on intact plants growing in a full-sun environment, the distribution of "horseshoes" (larval resting stage) and later-stage larval feeding holes was virtually the same on Deltapine 70 leaves (81 and 79 percent, respectively, on the lower surface), necessitating practically no migration of post-horseshoe larvae. On Arizona wild cotton, however, 81 percent of the horseshoes, but only 32 percent of the fifth-instar larvae were found on the lower leaf surface, necessitating considerable larval migration.

Wilson, F. D., J. L. Szaro, and B. A. Hefner. 1992. Behavior of pink bollworm larvae (Lepidoptera:Gelechiidae) on bolls of normal-leaf and okra-leaf cotton isolines under laboratory conditions. J. Agric. Entomol. 9: 55-63. Neonate larvae were placed on bolls of Stoneville 7A, Stoneville 7A okra leaf, Stoneville 213, and Stoneville 213 okra leaf, and behavior was observed for 70 minutes. Fewer larvae penetrated the bolls of Stoneville 7A than of Stoneville 213, and fewer penetrated the bolls of Stoneville 7A okra leaf than of Stoneville 7A. This difference in penetration was not caused by differences in compression strength required to puncture bolls (not different for the four entries) nor by the differences in carpel wall thickness (thinner for Stoneville 7A okra leaf than for Stoneville 7A).

Wilson, F. D., R. L. Wilson, and B. W. George. 1980. Resistance to pink bollworm in breeding stocks of upland cotton. J. Econ. Entomol. 73: 502-505. An advanced breeding stock of upland cotton, designated AET-5, consistently showed less seed damage caused by pink bollworm than did control cultivars in Arizona and Puerto Rico.

Wilson, F. D., R. L. Wilson, and B. W. George. 1981. Agronomic and fiber properties of primitive race stocks and hybrids of cotton. USDA-ARS-ARM-W-21. Eleven agronomic and fiber properties measured for 63 primitive race and six agronomic properties for 233 race stocks showed that genes were available to improve every trait in upland cotton except lint percentage and fiber length. Cultivar × race stock F_1 hybrids showed favorable heterosis in 13 percent of the combinations in Arizona, and in 33 percent of the combinations in Puerto Rico.

This bulletin from Regional Project S-77 included researchers from Alabama, Arizona, Arkansas, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, and Texas. It is being electronically published with the approval of the Directors of the Southern Agricultural Experiment Stations. Under the procedure of cooperative publications, it becomes in effect, a separate publication for each of the cooperating stations listed.