Report on the Status of *Arachis* Germplasm in the United States

Peanut Crop Germplasm Committee

Peanut Crop Germplasm Committee - 2003

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Executive Summary

A. Pest and Disease Resistance

1. Develop more efficient strategies to evaluate pest resistance
2. Identify and evaluate novel gene for resistance.
3. Conduct a comprehensive evaluation of elite and exotic germplasm collection for new pest resistance genes.
4. Improve durability of pest resistance.
5. Identify the molecular bases of host-pathogen interactions.

B. Seed Composition

1. Characterize the molecular basis for changes in seed composition.
2. Identify and quantify the impact of altered composition on agronomic performance.
3. Determine the value of altered genotypes.

C. Yield Potential

1. Identify and sequence yield genes.
2. Determine yield genes.
3. Identify genomic locations of yield genes.
4. Determine possible parental sources of positive alleles for yield.

D. Germplasm collection

1. Develop strategies for exchange of germplasm with China.
2. Develop exchange strategies for germplasm in South America.
3. Improve evaluation and documentation of peanut collection.

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1 The Genus *Arachis*

1.1 Introduction

Peanut (*Arachis hypogaea* L.) is an ancient crop of the New World that was widely grown in Mexico, Central America and South America in pre-Colombian times. The domesticated species had already evolved into subspecies and varietal groups before seeds were distributed to the Old World by early Spanish and Portuguese explorers. The first successful introductions to North America were small seeded peanuts with a runner growth habit (Higgins, 1951). These introductions were probably from northern Brazil or the West Indies, and loaded as food supplies onto ships carrying slaves from Africa to the New World.

Peanut is cultivated around the world in tropical, subtropical and warm temperate climates. Peanuts are one of the principal oilseeds in the world. According to USDA estimates for the crop year 1999/2000 (FAS, 2000), from a world total oilseeds production of 286.7 million metric tons, peanuts' share was approximately 10 percent, behind soybeans (53 percent), rapeseed (15 percent), and cottonseed (12 percent). Until the mid-1980s, peanuts ranked third in terms of production among oilseeds; however, changes in consumer preferences in industrial countries due to growing health concerns fostered the production of rapeseed and sunflower seed. Peanut production can be found on all the continents, although four of them (Africa, Asia, North and South America) account for the majority of production (99 percent). Furthermore, according to USDA data (ERS, 2001), on average for the 1972-2000 period, 90 percent of the world production occurred in developing countries. Developed countries' share in total world production of peanuts has steadily decreased from approximately 12 percent during the 1970s to about 6 percent during the 1990s.

In the U.S., acreage has fallen from 0.82 million ha in 1991 to 0.59 million ha in 1996, with a corresponding 0.7 million tons fewer peanuts harvested (Lamb and Blankenship, 1996). Further, the average yield per acre in the U.S. has dropped more than 9% since the 1970s, probably because of increased disease pressure, whereas yields in China and Argentina have increased more than 75%, with the introduction of improved cultivars and management practices (Carley and Fletcher, 1995).

The peanut seed has from 36 to 54% oil (Knauft and Ozias-Akins, 1995) and more than half of the global crop is grown as an oilseed. Because prices on the international commodity market favor the sale of peanuts as edible seeds, most of the crop in the U.S. and South America is sold for consumption as food. In most other counties the primary use of peanut is for the oil market. However, as major producers become self-sufficient for oil production, a larger percentage of the peanut seed crop is consumed directly by humans. In addition to seeds, the foliage is an important fodder in regions where animals are used extensively on the farm, and the meal remaining after oil extraction is also an important source of animal feed.

1.1.1 World Production

The world in-shell peanut production averaged 29,108 thousand metric tons during the 1996-2000 period, growing between 1972 to 2000 at an annual rate of 2.5%. The production increase was due both to an increase in the harvested area and in peanut yields. However, the latter played a more fundamental role in the production growth. During the period 1972-2000 yields steadily grew from 0.8 to 1.37 metric tons per hectare (i.e., 1.9% increase per year). During the same period, the area harvested remained approximately stable, with an annual growth of 0.1%, averaging 18.9 million hectares. Furthermore, most of the growth in harvested area occurred during the 1990s. In fact, the annual growth rate during the period 1972 to 1990 was only 0.1%, while between 1991 and 2000 the annual growth rate was 1.2%.

1.1.2 Production

U. S. production of peanuts in 2003 totaled 4.14 billion pounds, up 25% from last year's crop. Planted area for the U.S., at 1.34 million acres, was down 1% from 2002. Harvested area totaled 1.31 million acres, up 1% from 2002. The yield per harvested acre averaged a record high 3,159 pounds, up 598 pounds from 2002.

1.1.3 Policy changes related to the International Trade

The direction that the previous analyzed trends will take in the future will depend on how the countries respond to changes in the international and the domestic economic environment. The policy commitments agreed to by the countries under the Uruguay Round Agreement would certainly affect the amount of peanuts imported and exported. For instance, as summarized by Skinner (1999), Switzerland agreed to eliminate the duty on peanuts for human consumption over a period of 6 years beginning in 1995. Poland also will eliminate the 15 percent duty on shelled peanuts over a period of 6 years. Korea reduced the in-quota tariff on shelled peanuts from 40 to 24 percent. On July 1 [1995], Korea also liberalized imports of roasted peanuts. Thailand agreed to halve the tariff on peanut butter to 30% or 2.5 baht per kilogram. Norway agreed to cut its tariff on peanut butter from 30% to 6%. Finland agreed to bind its tariff for roasted peanuts at duty free and reduce its tariff for peanut butter from 4.3% to duty free.

The United States, one of the main markets for peanut products, has substantively modified its border policy with respect to peanuts. According to Skinner (1999), as a result of the Uruguay Round Agreement, the United States replaced its import quotas for peanuts with an ad-valorem tariff equivalent to 155% for shelled peanuts and 192.7% for in-shell peanuts in 1995 (the in-quota tariff rates are 9.35 cents per kilogram for peanuts in shell and 6.6 cents per kilo-gram for shelled peanuts). From these values, the over-quota tariffs rates have been reduced by 15% to 131.8 % for shelled peanuts and 163.85 for in-shell peanuts. Furthermore, the import tariff rate quota for peanuts set at 33,770 metric tons in 1995 has reached the committed 56,821 metric tons. The tariff rate quota includes four categories of peanuts: in shell, shelled, blanched, and others. For peanut butter, the quota was set at 19,150 metric tons in 1995 and reached 20,000 tons over 6 years. The in-quota rate set at 2 cents per kilogram in 1995 was eliminated in 1998. The over-quota for peanut butter is the same as for shelled peanuts.

It is important to note that a reduction of the border protection will imply a reduction in the domestic protection, too. This is important since, as mentioned in Changping et al. (1997), one of the major differences of peanuts and Chinese peanuts (major competitor at the world peanut market) is the cost associated with renting the peanut quota.

With respect to the international peanut market, China has just acceded to the World Trade Organization. Although China is already granted trade concessions of the Most Favored Nation status (MFN), it will probably negotiate for a share of the U.S. tariff rate quota in the upcoming WTO Trade meetings. According to FAS data, in year 2000, China was the third exporter of peanuts to the United States (behind Argentina and Mexico) with 4.9 thousand metric tons.

Argentina, another important competitor of peanuts and main exporter to the market, will probably be part of the Free Trade Area of the Americas (FTAA), under which Argentina would face an accelerated tariff reduction schedule and similar status that current NAFTA countries have. Furthermore, the recent severe devaluation of the Argentine currency (Peso) will give Argentina extra competitiveness in the export markets. However, it is important to note that the government is taxing peanut exports with a rate of 10 percent, reducing the Argentine competitiveness.

Another source of competition in the domestic market will be the presence of exports from NAFTA countries, particularly peanuts from Mexico, which under the agreement will export to the United States in 2008 without tariffs. In 2000, Argentina exported 44.4 thousand metric tons of peanuts to the United States, while Mexico exported 5.6 thousand metric tons.

In addition to these events, it is important to add the recent emergence/reemergence of a number of peanut exporters such as Brazil, South Africa and Australia, which are challenging exports in traditional markets such as the European Union.

1.2 History and origin of the genus

The origins of the *Arachis* genus are not totally clear, but little doubt remains that the genus was formed in the southwestern part of Mato Grosso do Sul, Brazil or northeast Paraguay because the most ancient species of the genus, *A. guaranitica* Chodat. & Hassl. and *A. tuberosa* Bong. ex Benth., are still growing in that area.

The genus has evolved into species that fit into nine taxonomic sections (Krapovickas and Gregory, 1994) which include the most ancient section *Trierectoides* with its two species with three leaflets, *A. tuberosa* and *A. guaranitica*. From these ancient progenitors developed the sections *Erectoides*, *Extranervosae*, *Triseminatae*, and *Heteranthae*. The species of these four sections have varying affinities to the primitive section, as reported by Gregory and Gregory (1979) and Krapovickas and Gregory (1994) (Simpson, unpubl. data). The more advanced sections include the *Caulorrhizae*, *Procumbentes*, and *Rhizomatosae*. The affinities of these latter species groups are varied as well, but with very limited successes reported in crossing with species of the most advanced section, *Arachis* (Gregory and Gregory, 1979; Krapovickas and Gregory, 1994). The distribution of the *Arachis* section has overlapped that of the other sections in many areas. It is not unexpected that the most advanced species would be more adaptable to many environments and able to rapidly move to areas where the more ancient species have been adapted for many millennia.

1.3 Origin and history of *Arachis hypogaea*

The cultigen cannot survive for many years in nature without the aid of man (or other animals) to harvest seeds each year. The most convincing data to date, indicating that *A. hypogaea* originated in the gardens of primitive 'hunter/gather/cultivators', come from digs on the coast of Peru two sites near Casma and another near Bermejo. In these locations, peanut shells which closely resemble the shells of *A. magna* Krapov., W.C. Gregory and C.E. Simpson, *A. ipaensis* Krapov. and W.C. Gregory, and/or *A. monticola* Krapov. and Rigoni were excavated from a layer where there was no indication of the presence of corn. These shells were dated at 1800 to 1500 B.C. In a dig nearby, shells were found that closely resemble *A. duranensis* Krapov. and W.C. Gregory dated at about the same time period. Archeological evidence similar to that found in Peru has been discovered in northwest Argentina, indicating that the hunter/gatherers possessed, and possibly grew, wild peanut fruits in the high Andes of Argentina as well, although the sample sizes of excavated shells was much smaller. This Argentine site could possibly supply some data in the future to support a two event origin of *A. hypogaea*, but additional data will be required to fully support such a theory.

The natural distribution of the wild Arachis appears to have been made well before man arrived in South America, but man has obviously played an important role in distributing some of the cultivated species, including *A. villosulicarpa*, *A. stenosperma*, and the man selected species, *A. hypogaea*.

1.4 Market classes of peanut

Peanut production and marketing has resulted in designation four U.S. market classes which generally correspond to subspecific and varietal groups as follows: runner (subsp. *hypogaea* var. *hypogaea*), Virginia (subsp. *hypogaea* var. *hypogaea*), spanish (subsp. *fastigiata* var. *vulgaris*), and valencia (subsp. *fastigiata* var. *fastigiata*).

Runner type cultivars have medium sized pods and seeds which range from 550 to 650 mg/seed. They have a relatively long growing season, with 120 or more days needed for maturity, and are highly indeterminate. Runners have become the dominant peanut type grown due to the introduction in the early 1970’s of a new cultivar, the Florunner, which was responsible for a spectacular increase in peanut yields. Runners have rapidly gained wide acceptance because of their attractive kernel size range; a high proportion of runners are used for peanut butter. Runners, grown mainly in Georgia, Alabama, Florida, Texas and Oklahoma, account for 80% of total production.

Virginia type peanuts have large pods and seeds. A premium is paid for large seeded peanuts in the U.S., which makes this market type desirable at the farmer level.

However, they are generally long season plants and require more calcium for seed development than smaller seeded peanuts. Virginias have the largest kernels and account for most of the peanuts roasted and eaten as in shells. When shelled, the larger kernels are sold as salted peanuts. Virginias are grown mainly in southeastern Virginia, northeastern North Carolina and West Texas. Virginia-type peanuts account for about 15% of total U.S. production. Spanish types are widely grown around the world, especially where mechanization is not available. Seeds are similar in size to runner types (550 to 650 mg/seed), but yields are generally lower. The primary advantages of spanish types are their short growing season and bunch-type growth habit. Spanish type peanuts have smaller kernels covered with a reddish-brown skin. They are used predominantly in peanut candy, with significant quantities used for salted nuts and peanut butter. They have higher oil content than the other types of peanuts which is advantageous when crushing for oil. They are primarily grown in Oklahoma and Texas. Spanish-type peanuts account for 4% of production. The valencia market type grown in west Texas and eastern New Mexico and accounts for less than 1% of the market. Valencias usually have three or more small kernels to a pod. They are very sweet peanuts and are usually roasted and sold in the shell; they are excellent for fresh use as boiled peanuts. This is the only market for red seeded peanuts in the U.S.

1.5 Peanut diseases

Pathogens attack all plant parts of peanut and restrict plant development throughout the growing season as well as reducing seed quality in post harvest storage (Porter et al., 1982). Significant crop losses occur in most production areas. Cultural practices, such as the elimination of alternate host plant species from field edges, crop rotation, chemical control and use of resistant cultivars have lessened or eliminated several disease problems, but neither cultural control nor genetic resistance has been found for several others. On a global scale, the leaf spots [caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton] and rust (caused by *Puccinia arachidis* Speg.) are the most destructive pathogens of peanut. Together they can cause up to 70% yield losses (Subrahmanyam et al., 1984), and even when fungicides are applied significant yield reductions can occur. Rust currently is not a serious problem in the U.S.A,., but almost all U.S. producers expend significant effort on control of leaf spots. Further, shifts have occurred from one leaf spot to the other as cultivars are released with different tolerance levels. As a result, multiple disease resistance factors may be needed to solve the most important disease problems of peanut.

1.6 Peanut insects

In addition to directly lowering yields, insects serve as vectors for viruses and damage pods and seeds, making them undesirable for commerce. Both pre- and post-harvest insect pests cause significant economic losses in peanut. On a global scale, the most important insects include aphids, thrips, jassids, and *Spodoptera* (Isleib et al., 1994). However, insect populations vary greatly among production regions and even from year to year within the same area. In Asia, white grubs, termites, millipedes and ants are problem pests. In the U.S., the lesser cornstalk borer and southern corn rootworm cause the greatest damage to pods. Thrips are the most important insect because they vector the tomato spotted wilt virus.

1.7 Weeds

Because the peanut plant produces pegs that grow into the soil from branches, weed control through tillage is more difficult in peanut than for many other crop species. Yields may be suppressed when fields with a partial cover of peanut plants are cultivated (Buchanan et al., 1982). Two or more months are necessary for peanut plants to completely cover the soil surface, and weeds can easily become established during this time. Further, canopy depth for runner types is relatively shallow, which does not help to suppress competitive plant species. Weed control costs are estimated at $132/ha in Texas to $391 /ha in Florida (Wilcut et al., 1995). Weeds generally cause greater yield reductions when at high population levels early in the growing season (Wilcut et al., 1995), but relatively little research has been done to establish economic threholds for weed populations. Thus, cultivars which initially grow quickly and cover the soil are highly desirable.

2. Genetic vulnerability in peanuts

2.1 Genetic Vulnerability of the Standing US Peanut Crop in 2004

The genetic vulnerability of the standing peanut (*Arachis hypogaea* L.) crop is a function of its degree of genetic uniformity. Uniformity or diversity can be viewed simplistically as the array of cultivars being grown. The array of peanuts being grown in 2004 can be ascertained with a reasonable degree of accuracy from the records of seed production the previous year (Appendix: Table 1). The array varies across the three main peanut production regions within the USA - the Southeast region (Georgia, Florida, Alabama, and South Carolina) where the runner market-type predominates; the Southwest region, (Texas, Oklahoma, and New Mexico) where runner, virginia, spanish, and valencia market types are all grown; and the Virginia-North Carolina (VC) region where only the virginia market type is grown. The Southeast has a history of monoculture with the dominant cultivar changing periodically. The current dominant cultivar is Georgia Green which rose to prominence because of its field resistance to tomato spotted wilt virus. Because the runner market type occupies approximately 79% of the total peanut acreage in the USA and the Southeast is the largest production region, Georgia Green is currently the most widely grown peanut cultivar in the country, occupying approximately half the peanut acreage in the USA as a whole and 80% of the acreage in the Southeast. The second most common cultivar in the USA is Flavor Runner 458, a cultivar with elevated oleic fatty acid content in the seed oil derived by mutation of the Florunner cultivar. Flavor Runner 458 is the most common runner cultivar grown in the Southwest, occupying over one third of the acreage in that region but only about 8% of the acreage nationally. The VC region is more diverse with five cultivars occupying 15 to 20% of the acreage.

The array of cultivars in a region does not wholly describe the level of genetic uniformity as the cultivars can be related to a greater or lesser degree. There are several measures of genetic uniformity of a group of cultivars, including ones based upon the frequencies of alleles or markers covering the majority of the species' genome. Peanut, an amphidiploid species ($2n$=$4x$=40) ostensibly originating from a relatively recent natural hybridization between two diploid ($2n$=$2x$=20) progenitors, exhibits very little polymorphism at the molecular level in spite of the high levels of morphological and physiological variation observed within the species. Because an estimate of uniformity based on markers would necessarily be very high, the older method of estimating uniformity based on genetic coancestry, *i.e.*, the probability that two cultivars are carrying alleles identical by descent (Malècot, 1948), was used.

For each cultivar for which seed was produced in 2003, the parentage was traced back to ancestors for whom no further information could be found. Pedigree information was gathered from published registration articles, release notices, internal documents of the North Carolina and Florida breeding projects, and by personal communication with breeders in other states. Each cultivar was assigned to a breeding cycle based on the number of cycles of crossing and selection it was removed from the founding ancestors. In this system, ancestors were assigned to Cycle 0, selections from Cycle 0 ancestors or progeny from crosses between Cycle 0 lines were assigned to Cycle 1, and so on. Each line was assigned to a cycle one higher than the higher of its parents. Coefficients of coancestry of each cultivar with each of the others were then calculated.

The coancestry between lines X and Y, θ_{XY}, is the probability that a gene randomly sampled from line X is identical by descent to a gene randomly sampled from Y, *i.e.*, the two genes are meiotic/mitotic copies of a gene inherited by each line from a common ancestor. The rules for calculation of coancestry are well known (Malécot, 1948; Kempthorne, 1969). If A and B are the parents of X, and C and D the parents of Y, then $\theta_{XY} = (\theta_{XC} + \theta_{XD})/2 = (\theta_{AY} + \theta_{BY})/2 = (\theta_{AC} + \theta_{AD} + \theta_{BC} + \theta_{BD})/4$. The expressions are expanded back until they intersect at a common ancestor, W, at which point they include a term θ_{WW}, the coancestry of a line with itself which is $\theta_{WW} = (1+F_W)/2$ where F_W is the coefficient of inbreeding or the probability that the two genes carried by W are identical by descent. For purposes of this study, all lines were assumed to be completely inbred (F=1). These rules were developed for outcrossing species, but they can be adapted for use in self-pollinated species. If one assumes that the probability of fixation under self-pollination of the gene derived from either parent of a cross is one half (St. Martin, 1982), then the computational rules for self-pollinators are identical to those for cross-pollinators. Additional rules are required to determine the coancestry of lines derived by self-fertilization from the same cross (Cockerham, 1983). For lines derived by selection within an existing line, either with or without mutagenesis, it was assumed that the coancestry between the parent and selected line was 0.99.

To estimate the coancestry of plants chosen at random from a particular peanut-producing region, weighted averages of coancestries were calculated using the 2003 certified acreage (Association of Official Seed Certifying Agencies, 2003) expressed as a proportion of the total acreage for the region as the weighting variable. Weighted averages were calculated for the USA as a whole and for the three main production regions. Weighted averages also were calculated for the four market types of peanuts grown in the USA: runner, virginia, spanish, and valencia.

The coancestry of two peanut plants randomly chosen from the USA as a whole in 2004 is expected to be 0.415, 0.716 in the Southeast where the single cultivar Georgia Green occupies approximately 80% of the acreage, 0.396 in the Southwest, and 0.412 in the VC region. Within the runner market type in the USA as a whole the coancestry between two randomly chosen plants is expected to be 0.597; within the virginia market type 0.375, within the spanish market type 0.722, and within the valencia market type 0.346. Clearly, the region with the greatest genetic vulnerability is the Southeast due to the dominance of Georgia Green while the market type with the greatest genetic vulnerability is the spanish type whose production is confined entirely to the Southwestern region and which occupies only about 2% of peanut acreage in the USA. There was substantially greater average coancestry within production regions than between regions (Appendix: Table 2) due to the differences among regions in the market types and specific cultivars within market types grown in the regions.

Cultivars from different market types are much less related to each other than they are to other cultivars within the market type (Appendix: Table 3), particularly when the comparison is between a market type derived primarily from ancestry of subsp. *hypogaea* var. *hypogaea* and a market type derived from ancestry of subsp. *fastigiata* Waldron var. *fastigiata* (the valencia market type) or subsp. *fastigiata* var. *vulgaris* Harz (the spanish market type. Although there has been substantial introgression of subsp. *fastigiata* genes, particularly from spanish ancestors, into the runner and virginia market types (Isleib, 2001), the specific ancestors are different from those that figure in the ancestry of current spanish and valencia type cultivars.

2.2 High impact diseases

The peanut plant is subject to attack by many pathogens. The pathogens causing diseases and economic losses on peanut are endemic to the peanut growing areas of the United States. Most of the pathogens that attack peanut are of fungal origin. Also, viruses, bacteria, nematodes, and phytoplasmas attack peanut in the USA, causing economic damage. See Appendix: Table 4 for possible high impact pathogens on peanut.

2.3 High impact insects

The peanut plant is also subject to attack by many insects. Insects causing damage and economic losses on peanut are endemic to the peanut growing areas. See Appendix: Table 5 for possible high impact insects on peanuts.

2.4 Use of Plant Introductions in Peanut Cultivar Development

The genetic base of peanut in the USA has at times been extremely narrow, particularly in specific production areas where a single cultivar may be grown in near monoculture. Because peanut is not a native North American species, all cultivars necessarily trace their ancestry to plant introductions (PIs). Most of the genetic base of current cultivars rests on selections from farmer stock peanuts of obscure origin. Over the past 20 yr, there have been concerted efforts to incorporate additional germplasm into U.S. breeding populations, usually with the purpose of improving resistance to diseases or pests, but also with the objective of broadening the genetic base. These efforts have had a significant economic impact on peanut farmers, the largest from the development of cultivars with resistance to Sclerotinia blight (*Sclerotinia minor* Dagger), rootknot nematodes (*Meloidogyne* spp), and tomato spotted wilt virus. Use of these resistant cultivars has an economic impact of more than $200 million annually for peanut producers.

As of July 2004, 79 peanut cultivars have been released in the U.S.(Appendix: Table 6) through the Journal of Crop Science, 53 released prior to 1961 when the Crop Science Society of America (CSSA) began to register crop cultivars and 121 germplasm releases (Appendix: Table 7) and eight genetic stocks (Appendix: Table 8). Material can be obtained from the National Plant Germplasm System web site at www.ars-grin.gov/npgs). Seventy four cultivars have been registered for protection under Plant Variety Protection (Appendix: Table 9). Several have expired, been abandoned or withdrawn from the process. Forty three have certificates issued and thirteen are pending.

In spite of the large number of cultivars available to growers, the peanut crop has been characterized as being genetically vulnerable to diseases and insect pests (Hammon, 1972, 1976; Knauft and Gorbet, 1989).

One of the ways that plant breeders can increase the genetic diversity of a crop is to incorporate diverse germplasm into the breeding populations from which cultivars derive. The first peanut introduction of the modern era was PI 4253, collected by B. Lathrop and D.G. Fairchild in 1899 and identified as the prize winning peanut from the 1898 exposition of the Khedival Agricultural Society of Cairo, Egypt (USDA, 1900, 1901). There have been thousands of accessions introduced and numbered by the USDA since that time. Many were donated by diplomats, missionaries, and travelers in foreign countries. Others were provided by foreign governments and agricultural research institutions as part of germplasm exchanges with U.S. institutions. Still others were collected as part of a coordinated effort by the USDA and international agencies to collect and preserve natural genetic diversity before it erodes through the displacement of farmer held seed stocks by improved cultivars.

2.5 Use of genetic resources in cultivar development

Because peanuts as a crop were introduced to what is now the USA, all peanut cultivars necessarily trace back to plant introductions. However, much of the genetic base of current cultivars traces back to ancestors that were developed by mass selection from farmer stock peanuts in the various production areas (Isleib and Wynne, 1992). Much of the base of improved runner and virginia cultivars rests on four ancestors used as parents in the early years of peanut improvement, including var. *hypogaea* lines Dixie Giant and Basse and var. *vulgaris* Harz lines Small White Spanish and Spanish 18-38. Of these, only Basse is known to have been introduced in the modern era of plant collection. Most current runner and virginia type cultivars trace their ancestry back to these two crosses through Florispan and its close siblings, derived from a cross between GA 207-1 and F230-118-2-2, and their immediate descendants Florunner and Florigiant.

In addition to the four primary ancestors of runner-type cultivars, the early virginia market type cultivars had additional infusion of ancestry from farmer stock selection Jenkins Jumbo, a large seeded selection from farmer stock used as a parent in the Florida program, a group of five lines (NC 4, NC Bunch, White's Runner, Improved Spanish 2B, and PI 121067) among seven used by W.C. Gregory to initiate the breeding program at N. C. State Univ., and Atkins Runner, an ancestor used by the USDA breeding program in Virginia. Of these additional early ancestors of the virginia market type, only PI 121067 is a modern plant introduction. A different set of introductions including PI 121070, PI 161317, PI 268661, and *A. monticola* Krapov. & Rigoni were used as parents in theTexas and Oklahoma breeding programs. The remaining five introductions that appear in the pedigrees of runner-type cultivars (PI 121067, PI 121070, PI 616317, PI 259785, and PI 221057) do so through crosses of runner type parents with virginia type and spanish type parents. Only three plant introductions appear in the pedigrees of improved virginia type cultivars: Basse, PI 121067,and PI 337396.

Most runner and virginia type cultivars are characterized as having had some introgression of genes from subsp. *fastigiata* Waldron, mostly from var. *vulgaris* but to some extent from var. *fastigiata*. Spanish type cultivars are more varietally pure than other market types for the most part.

2.6 Economic impact of genetic resources

The genetic variability contributed to breeding populations by the introgression of genes from introductions has no doubt contributed to genetic gain in the development of cultivars that possess no salient disease resistance or other introduction derived trait. However, the economic impact of such introgression is difficult if not impossible to measure. Genetic resources have been particularly useful in adding disease resistance to peanut cultivars. This has had significant economic impact on peanut farmers, the largest from the development of cultivars with resistance to Sclerotinia blight, rootknot nematode, and tomato spotted wilt virus.

Use of Sclerotinia resistant cultivars increases yield and reduces fungicide costs. The estimated impact from the use of these resistant cultivars is $5 million annually.

COAN, a nematode-resistant runner type cultivar, was developed by introgressing resistance from wild diploid peanut species. A nematode-resistant cultivar would save southwestern peanut growers an estimated $6.5 million annually in increased yields and reduced nematicide costs.

In the Southeastern USA, TSWV was detected in peanut in 1987, and its incidence has increased substantially in the ensuing years (Culbreath et al., 1992). PI 203396 was an ancestor to many breeding populations in the Southeast due to its resistance to late leaf spot. Fortunately, PI 203396 also has resistance to TSWV that was transmitted to resistant runner type cultivars Southern Runner, Georgia Green, Florida MDR 98, and C-99R. Under severe TSWV pressure, the additional economic return from growing these cultivars in comparison to previous susceptible cultivars is in excess of $500 per acre. Assuming that half of the peanut acreage in the Southeast has severe TSWV pressure, the economic impact of this resistance is more than $200 million annually.

2.7 Use of wild *Arachis* Species/Introgression of genes

The desire to transfer genes from wild Arachis species into cultivated peanut has burned brightly since the 1940s when both W.C. Gregory and A. Krapovickas first attempted to cross wild peanuts.

The first peanut cultivars released from interspecific hybridization were by Hammons (1970) and Simpson and Smith (1975). Hammons released cv. Spancross in 1970 from the cross *A. hypogaea* x *A. monticola* Krapov. & Rigoni, which was also the same source of cv. Tamnut 74 released by Simpson and Smith. Neither of these cultivars had phenotypic characters that could be identified as derived from the wild species. In 1999, Simpson and Starr (2001) released the first rootknot nematode resistant peanut cultivar, COAN. This new cultivar contains a gene for the pest resistance which was transferred from *A. cardenasii* Krapov. & W.C. Gregory in an intensive backcrossing program (Simpson, 1991).

Several programs have released lines which have been derived from interspecific hybridization, including Simpson et al. (1993) and Stalker and Beute (1993).

2.8 Transformation methods applicable to the production of transgenic peanut

Although some evidence for Agrobacterium-mediated transformation was published in the early 1990s (Eapen and George, 1994 and McKently et al., 1995), the first thoroughly documented Agrobacterium mediated transformation of peanut was reported in a series of publications using the cultivar, New Mexico Valencia A (Cheng et al., 1997; Cheng et al., 1996; and Li et al., 1997). Li et al. (1997) unequivocally demonstrated foreign gene integration in multiple transgenic events derived from this cultivar.

Stable transformation of peanut has been accomplished by microprojectile bombardment of embryogenic cultures and selection on hygromycin (Ozias-Akins et al., 1993) or bombardment of apical and lateral meristems on the embryo axis followed by screening for reporter gene activity (Brar et al., 1994). Bombardment of embryogenic cultures and selection on hygromycin appears to be the most widely applicable technology since it has been used by at least three different groups to transform multiple cultivars including runner, virginia, and spanish market types (Livingstone and Birch, 1999; Magbanua et al., 2000; Ozias-Akins et al., 1993; Singsit et al., 1997; Wang et al., 1998; and Yang et al., 1998).

2.9 Enhancing beneficial traits in peanut through genetic engineering

In addition to the selectable marker and reporter genes described above, genes for insect and virus resistance have been introduced into peanut (Brar et al., 1994; Li et al., 1997; Magbanua et al., 2000; Sharma and Anjaiah, 2000; Singsit et al., 1997; Yang et al., 1998). Introduction of the nucleocapsid protein gene from the tomato spotted wilt virus into peanut (Brar et al., 1994; Li et al., 1997; Magbanua et al., 2000; Yang et al., 1998) may eventually allow the recovery of highly resistant genotypes; however, durable and high levels of resistance have not been achieved to date (Li et al., 1997; Magbanua et al., 2000).

Finally, there are numerous traits that potentially could be manipulated with single or few gene introductions to produce more pest resistant, healthier, higher quality peanuts. These include oil quality such as a high oleic acid (Jung et al., 2000), reduced allergenicity by down regulation of highly allergenic peanut proteins (Burks et al., 1998), herbicide tolerance (Kishore et al., 1992), insect resistance using genes other than Bt (Hilder and Boulter, 1999), fungal resistance (Bent and Yu, 1999; Melchers and Stuiver, 2000), nematode resistance (Vrain,1999), and nutrient composition (Hirschberg, 1999). Such traits collectively would benefit growers, manufacturers, and consumers thus resulting in increased marketability of peanuts as a commodity and wholesome, healthy food.

2.10 Molecular markers of *Arachis* and marker assisted selection

The theory behind this method is that plant breeders could observe easy to score phenotypes to select difficult to score or low heritability traits that are linked to them (Tanksley, 1983). A good marker should (a) allow the separation of homozygotes from heterozygotes, thus allowing more genetic gain per generation than is possible without using the marker; (b) have early expression in the plant, thus saving time waiting for the desired phenotypeto develop; and (c) not have interactions with other markers (Arus and Moreno Gonzalez, 1993).

With the development of molecular markers there has been great potential for increasing breeding efficiency because many of the marker systems have large numbers of polmorphisms; alternate alleles rarely have deleterious effects at the molecular or whole plant level; they are often codominant, allowing all genotypes to be distinguished in each generation; and they rarely segregate in epistatic ratios. Isozymes have been associated with agronomic traits in several crops but, in peanut, isozymes do not generate enough polymorphisms in most species to be useful for crop improvement (Weeden, 1989).

2.10.1 Restriction fragment length polymorphisms (RFLPs)

In A. hypogaea, little molecular variation has been detected by using RFLP technologies (Kochert et al., 1991) or exotic germplasm lines (Halward et al., 1992). Kochert et al. (1996) also reported that no variation was found between *A. hypogaea* and *A. monticola* Krapov. & Rigoni. However, significant amounts of variation have been observed among *Arachis* species (Kochert et al., 1991; Paik-Ro et al., 1992).

2.10.2 Amplified fragment length polymorphisms (AFLPs)

He and Prakash (1997) were the first investigators to report applications of AFLP technologies in peanut. They used 28 primer pairs to generate 111 AFLP markers in *A. hypogaea*. Their results indicated that about 3% of the primers used for DNA amplification were polymorphic.

2.10.3 Simple sequence repeats (SSR) markers

Hopkins et al. (1999) reported six polymorphic SSRs in *A. hypogaea* with the number of fragments amplified per SSR ranging from two to 14, and differentiated 15 of 19 accessions of cultivated peanut. He et al. (2003 reported 19 polymorphic markers among the genotypes tested. The average number of alleles per locus was 4.25 with up to 14 alleles found at one locus. Ferguson et al. (2004) added 110 new polymorphic markers. Ferguson found two to 5.7 alleles per locus. Recent work on SSR markers have brought the total number of markers to 135.

3. National Plant Germplasm System *Arachis*

3.1 Genetic resources of *Arachis*

The USDA maintains an extensive collection of *Arachis* germplasm. The working collection is maintained by the Plant Genetic Resource Conservation Unit (PGRCU) in Griffin, GA. Much of this collection is maintained also under long-term seed storage condition at the National Center for Genetic Resources Preservation (formerly known as the National Seed Storage Laboratory) in Ft. Collins, CO. The working collection consists of 9,142 accessions of *A. hypogaea* L. (Appendix: Table 10) and 611 accessions of *Arachis* species (Appendix: Table 11). Large *Arachis* species collections in the USA are also maintained at Texas A&M Univ. and North Carolina State Univ. (Stalker and Simpson, 1995).

About half of the accessions are unimproved landraces collected from expeditions made to South America, which contains the centers of origin and diversity for peanut. These expeditions were sponsored by the USDA and the Int. Board of Plant Genetic Resources (IBRGR) in cooperation with state experiment stations in the U.S., and by several other countries as described by Isleib et al. (1994) and Stalker and Simpson (1995) (Appendix: Table 12). About one-third of the accessions in the collection originated from Africa. Much of this germplasm was introduced into the U.S. by J. Smartt during the 1960s (Wynne and Gregory, 1981).

In many cases, collected Arachis germplasm has been deposited in both the USDA germplasm system and in the Genetic Resource Unit of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Andhra Pradesh, India. The extent of duplication between the USDA and ICRISAT collections is not known, but has been estimated to be between one-third and one-half of the ICRISAT collection (Knauft and Ozias-Akins, 1995).

As pointed out by Knauft and Ozias-Akins (1995), additional important germplasm resources in the USA exist in the peanut breeding programs of Texas A&M Univ., North Carolina State Univ., Univ. of Georgia, Univ. of Florida, USDA, Oklahoma State Univ., Virginia Tech, and New Mexico State Univ. Many unique breeding lines developed to have tolerance to various biotic and abiotic stresses are maintained and preserved in these programs.

3.2 Germplasm Maintenance, Preservation, and Distribution

Maintenance of accessions is generally straightforward. Seed regeneration is based on the total number of seed available for distribution and the number of requests made by the user community. Both the USDA peanut curator and plant breeders from private industry, universities, and the USDA have cooperated in the regeneration of material to assure adequate seed reproduction. After drying to 5-7% moisture, seed are stored under controlled environmental conditions following the recommendation of Sanders et al. (1982) who concluded that the sum of temperature (F) plus relative humidity (RH) should be less than 100 to have optimal seed storage. Peanut seed for the working collection are stored at 4 C and 25% RH. Material which is infrequently requested is stored at -18 C.

Preservation of wild *Arachis* species is much more difficult than for *A. hypogaea*, particularly for accessions that produce few, if any, seed. Approximately 28% of the species accessions produce very few seed, especially the section *Rhizomatosae*, which are maintained as vegetative materials in the greenhouse (Stalker and Simpson, 1995). Most perennial *Arachis* species can be maintained for many years as original plants or cuttings in greenhouse pots. However, they must be frequently observed and maintained to prevent contamination. An international cooperative effort is underway to insure that these vegetatively propagated species are maintained in multiple environments so that they can be suitably conserved while minimizing the danger of loss (Singh and Simpson, 1994). This effort involves the cooperation of the USDA, North Carolina State Univ., Texas A&M Univ., ICRISAT, the Brazilian Corporation for Agricultural Research Botanical Institute (EMBRAPA), the Brazilian National Center for Genetic Resources and Biotechnology (CENARGEN), the Argentina National Institute of Agriccultural Technology (INTA), and the Argentina Botanical Institute of the Northeast (IBONE).

3.3 Descriptor Data

Without adequate characterization data plant breeders cannot know which accessions may be useful parents for cultivar development. Standards for characterizing *A. hypogaea* accessions have been published by IBPGR and ICRISAT (1992) and the USDA (Pittman, 1995). This involves the characterization of a range of attributes called descriptors. Simpson et al. (1992) applied 53 of the IBPGR and ICRISAT descriptors to 2000 accessions collected from 1977 to 1986 in South America and observed a large amount of variation in pod and seed characteristics. Holbrook and Anderson (1993) applied the USDA descriptors to accessions in the core collection. However, due to the limited resources that have been devoted to germplasm evaluation, little to no evaluation data are available for many accessions. Without these data the potential value of this material will remain unknown.

Development of the Germplasm Resource Information Network (GRIN) "http://www.ars-grin.gov", a database of descriptor information for each plant introduction in the USDA system, has made it much more efficient to access information regarding the collection. This information can be easily accessed, and plant introductions containing desired characteristics can be ordered for use in research or cultivar development. A pcGRIN version is available also on disk for use when internet access is not available (USDA, 1992).

3.4 Development of a Core Collection

Utilization of germplasm collections can be enhanced by the development of more efficient evaluation techniques. The core collection can serve as a working collection that could be extensively examined, and the accessions excluded from the core collection would be retained as the reserve collection (Frankel, 1984). This proposal was further developed by Frankel and Brown (1984) and Brown (1988, 1989) who described methods to select a core collection using information on the origin and characteristics of the accessions.

The germplasm collection was the first major germplasm collection to have a working core collection (Holbrook et al., 1993).

3.4.1 Utilization of the Peanut Core Collection

The efficiency gained by screening the peanut core collection has greatly increased the use of the peanut germplasm collection. In the USA, peanut is a regional crop with relatively few individuals involved in breeding and genetic research. Evaluation of core accessions for 24 characteristics (Appendix: Table 13) has resulted in the identification of numerous sources of resistance to several economically significant pathogens. Data generated from research with the core collection have been used to identify the geographical distribution of resistance to five important diseases of peanut (Holbrook and Isleib, 2001). By screening germplasm more intensely from these countries peanut breeders can utilize more efficiently the genes for disease resistance that are available in the germplasm collection.

3.5 Future Collection Efforts

Williams (2001) discussed emerging technologies using the geographical information system (GIS) to more effectively study, locate, and conserve *Arachis* genetic resources. He examined existing germplasm collections and the geographical distribution of genetic diversity and concluded that additional collection of wild *Arachis* species is warranted in eastern Bolivia and northwestern Paraguay. Several areas of primary and secondary centers of diversity that warrant further collection of the cultivated species were listed also. Stalker and Simpson (1995) also discussed collection needs, and stated that there is an immediate need for collecting more *A. hypogaea* subsp. *hypogaea* var. *hirsuta* accessions because they are poorly represented in both the USDA and ICRISAT collections. Future collection efforts also were discussed by Singh and Simpson (1994). In addition, these authors stressed the need to accelerate efforts on characterization and evaluation of germplasm so that it can be used effectively and with confidence by breeders.

Since the Convention on Biological Diversity (CBD) in 1993, many countries containing high levels of diversity of *Arachis* have implemented laws regulating access to their genetic resources. Currently, all countries in South America except Paraguay have regulations restricting access to their germplasm. Williams and Williams (2001) discussed innovative, mutually beneficial arrangements which have been developed and used to collect *Arachis* germplasm under CBD regulations. A memorandum of understanding also has been signed by the USDA and ICRISAT to facilitate germplasm exchange between these institutes in light of the CBD regulations (Shands and Bertram, 2000). Both institutions have agreed to forego claims of ownership and intellectual property rights on exchanged germplasm. The same policy applies to germplasm forwarded to state or private institutions when it is passed through the USDA (Williams and Williams, 2001).

3.6 Economic Benefits of Genetic Resources

Reducing input costs associated with pest management is becoming increasingly important in the USA due to changes in the federal peanut support program (Jordan et al., 1999). Peanut cultivars with disease resistance will allow producers to decrease costs of production and become more competitive with world market prices. Wynne et al. (1991) summarized progress in breeding peanut for disease resistance. They concluded that, although several breeding programs had been initiated for developing resistance to diseases during the 1980s, few cultivars had been released by the early 1990s due to the short duration of the programs. However, these efforts had resulted in the identification of many sources of disease resistance in peanut germplasm collections, and they predicted that resistant cultivars would be forthcoming. This prediction is currently being realized. Isleib et al. (2001) summarized the use of genetic resources in peanut cultivar development and concluded that there have been significant economic impacts for the peanut farmer. The largest impact has been through the development of cultivars with resistance to Sclerotinia blight, rootknot nematodes, and tomato spotted wilt virus. Use of cultivars with these resistances have had an economic impact of more than $200 million annually for peanut producers.

3.7 Geographical Distribution of Genetic Diversity in *Arachis hypogaea*

Countries of origin that are valuable sources of resistance to important diseases of peanut are presented in the Appendix: Table 14. Peanut breeders or pathologists who are interested in sources of resistance to the peanut root-knot nematode should focus their efforts on accessions from China or Japan. Bolivia is an important region for sources of resistance to both leaf spot pathogens. India, Nigeria, and Sudan were also important countries for resistance to early leaf spot, whereas Ecuador was the only other country where resistance to late leaf spot was more prevalent than expected. Peru appears to be the most valuable country for resistance to CBR. Resistance to TSWV was more prevalent than expected in accessions from India, Israel, and Sudan. Researchers who are interested in parents with multiple disease resistance should consider accessions from India, Mozambique, and Senegal. These observations should enable peanut breeders to more efficiently utilize genetic resources for disease resistance that are available in accessions present in the U.S. germplasm collection.

3.8 New Directions for Collecting and Conserving Peanut Genetic Diversity

3.8.1 New Constraints

In addition to the scarcity of money, trained personnel, and institutional support that have long been limiting factors for peanut genetic resources exploration and conservation, researchers must now also comply with an entirely new set of legal regulations before further international collaborations involving access and exchange can be implemented. In an effort to promote the conservation, sustainable use, and equitable sharing of benefits derived from genetic resources, the Convention on Biological Diversity (CBD), adopted internationally in 1994, recognized national sovereignty over genetic resources and prescribed national regulation of access to those resources. Consequentially, cumbersome regulations governing access and exchange of genetic resources recently have been put into effect in many countries. New legislation in several countries already has placed a significant constraint on international exchange and conservation of peanut genetic resources. One of the immediately tangible effects of the recent access legislation has been an abrupt decrease in internationally supported peanut explorations, as the formal mechanisms for complying with the new requirements are still in the process of being worked out in many countries. Ironically, these new obstacles to international collaboration are especially pronounced in the Latin American countries where the peanut's greatest diversity occurs, yet where, in many cases, the national capacity to conserve and use these genetic resources is still lacking.

3.8.2 New Opportunities

The capacity of the Geographic Information System (GIS) to integrate, analyze, and correlate huge amounts of relevant data makes it an invaluable new tool for planning effective peanut collecting and conservation activities. Furthermore, the host country's commitment to share the responsibilities associated with the conservation and use of their sovereign genetic resources becomes explicit within the context of their new legislation. This recognition of responsibility by the countries themselves will serve to strengthen their national commitment and capacity to conserve and use their own genetic resources, and to engage in effective partnerships with other countries. Moreover, the legal access agreements between cooperating countries will help formalize and promote international partnerships on Arachis conservation. Such partnerships are indispensable for achieving effective long term conservation, both *ex situ* and *in situ*, and will broaden the overall benefits derived from the use of peanut genetic resources.

3.8.3 New Tools and Approaches

The present availability of digitized data on *Arachis* diversity, distribution, taxonomy, characterization, and evaluation, together with other information on relevant human and physical, biotic, and abiotic variables, makes it possible for researchers to use GIS technology to more effectively study, locate, and conserve Arachis genetic resources (Guarino et al., 2001). Because of its ability to integrate different kinds of georeferenced data, GIS technology enables researchers not only to precisely map the distribution of different taxa but also to analyze the distribution of *Arachis* diversity and to correlate that diversity with other variables such as climate, topography, and soils, as well as relevant socioeconomic information such as demographic growth agricultural activity, urban expansion, market access development projects, ethnic diversity, etc. In the case of wild *Arachis* species, GIS applications such as FloraMap (Jones and Gladkov, 1999) can predict effectively the potential distribution of poorly known specie based on climate.

One of the main advantages of a complementary conservation strategy is that the different conservation methods act as a sort of security backup for one another, although the germplasm conserved *in situ* continues to evolve and/or erode in response to its environment while the sample stored *ex situ* remains comparatively static.

3.8.4 Political Issues Affecting International Exchange of *Arachis* Genetic Resources

While a considerable amount of *Arachis* germplasm has been conserved in international collections, additional wild and cultivated materials are needed to cover the full spectrum of genetic diversity in the genus (Simpson, 1991; Williams, 2001). The additional materials can be obtained only through exchange with foreign genebanks and research institutions or by conducting new plant explorations. Most of the existing accessions in the National Plant Germplasm System (NPGS) and other *Arachis* germplasm collections were obtained when genetic resources were considered the common heritage of humankind and available without restrictions. Since the Convention on Biological Diversity (CBD) entered into force, the free and open access to genetic resources from other countries has largely become a thing of the past.

3.8.5 USDA Plant Explorations Under the New Regulations

In this constantly changing environment of regulation of access to genetic resources, the Plant Exchange Office (PEO) of USDA-ARS, in collaboration with the International Plant Genetic Resources Institute (IPGRI), is working to develop models that will facilitate continued foreign access to germplasm, particularly access associated with plant explorations supported by the USDA (Williams, 1998). A proactive approach is being taken to establish favorable precedents that demonstrate the mutual benefits of collaborative germplasm conservation effortsand show how these can be achieved within the framework of the new legal regime.

Many germplasm donor countries believe that there has been an inequitable distribution of benefits derived from plant genetic resources obtained from their countries. Monetary benefits, such as payment of royalties, are often at the center of discussions on benefit sharing, while important non-monetary in-kind benefits go unrecognized or under appreciated (Secretariat of the Convention on Biological Diversity, 1998). Past USDA plant explorations have included non-monetary benefits to the host country such as paying the travel and equipment costs of the exploration, sharing half of the collected germplasm, preparation of herbarium specimens, and joint publication of research results. Today, additional nonmonetary benefits maybe necessary to obtain access to germplasm.

The approach taken by USDA and IPGRI to benefit sharing is that the additional support contributes to conservation of plant genetic resources in the host country, preferably by strengthening the capacity of the national plant genetic resources program.

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6 Appendix

Table 1. Distribution of Certified seed acreage of peanuts in the USA in 2003.

	Production area											
	USA			Southeast (GA, Fl, Al, SC)			Southwest (TX, OK, NM)			Virginia-North Carolina		
Cultivar	Certified seed area*	As part of marker type	As part of production area	Certified seed area	As part of marker type	As part of production area	Certified seed area	As part of marker type	As part of production area	Certified seed area	As part of marker type	As part of production area
	acres	%	%	acres	%	%	acres	%	%	acres	%	%
Runner market type	**126914**	**100.0**	**78.8**	**99075**	**100.0**	**98.9**	**27839**	**100.0**	**74.0**	**0.0**		**0.0**
Georgia Green	79384	62.5	49.3	79384	80.1	79.2	0.0	0.0	0.0			
Flavor Runner 458	13542	10.7	8.4				13542	48.6	36.0			
C-99R	8691	6.8	5.4	8691	8.8	8.7						
Tamrun 96	6424	5.1	4.0				6424	23.1	17.1			
Tamrun OL 01	5045	4.0	3.1				5045	18.1	13.4			
ANorden	2932	2.3	1.8	2932	3.0	2.9	0.0	0.0	0.0			
Georgia-02C	2788	2.2	1.7	2788	2.8	2.8						
Virugard	2244	1.8	1.4	1634	1.6	1.6	610	2.2	1.6			
AgraTech AT 201	1209	1.0	0.8	1209	1.2	1.2						
DP1	1151	0.9	0.7	1151	1.2	1.1						
AgraTech AT 1-1	1029	0.8	0.6	0.0	0.0	0.0	1029	3.7	2.7			
Okrun	710	0.6	0.4				710	2.6	1.9			
AgraTech AT 108	479	0.4	0.3	0.0	0.0	0.0	479	1.7	1.3			
Carver	477	0.4	0.3	477	0.5	0.5						
ANDRU II	450	0.4	0.3	450	0.5	0.4						
SunOleic 97R	145	0.1	0.1	145	0.1	0.1						
Southern Runner	90	0.1	0.1	90	0.1	0.1						
Hull	80	0.1	0.0	80	0.1	0.1						
AP-3	44	0.0	0.0	44	0.0	0.0						
Florunner	0.0	0.0	0.0				0.0	0.0	0.0			
Georgia Hi-O/L	0.0	0.0	0.0	0.0	0.0	0.0						
Georgia 01R	0.0	0.0	0.0	0.0	0.0	0.0						
GP-1	0.0	0.0	0.0				0.0	0.0	0.0			

NemaTam	0.0	0.0	0.0				0.0	0.0	0.0			
Tamrun OL 02	0.0	0.0	0.0				0.0	0.0	0.0			
Virginia market type	**28925**	**100.0**	**18.0**	**1130**	**100.0**	**1.1**	**4620**	**100.0**	**12.3**	**23175**	**100.0**	**100.0**
NC-V 11	5710	19.7	3.5	898	79.5	0.9				4812	20.8	20.8
Perry	5031	17.4	3.1	232	20.5	0.2				4799	20.7	20.7
Gregory	4493	15.5	2.8							4493	19.4	19.4
NC 12C	4011	13.9	2.5							4011	17.3	17.3
VA 98R	3671	12.7	2.3							3671	15.8	15.8
NC 7	2588	8.9	1.6				2588	56.0	6.9	0H	0.0	0.0
AgraTech VC-2	1347	4.7	0.8	0H	0.0	0.0	1183	25.6	3.1	164	0.7	0.7
Wilson	859	3.0	0.5							859	3.7	3.7
Jupiter	849	2.9	0.5				849	18.4	2.3			
Spanish market type	**3696**	**100.0**	**2.3**	**0**		**0.0**	**3696**	**100.0**	**9.8**	**0**		**0.0**
Tamspan 90	2327	63.0	1.4				2327	63.0	6.2			
OLin	824	22.3	0.5				824	22.3	2.2			
Spanco	545	14.7	0.3				545	14.7	1.4			
Valencia market type	1478	100.0	0.9	19	100.0	0.0	1459	100.0	3.9	0		0.0
New Mexico Valencia A	644	43.6	0.4				644	44.1	1.7			
Proprietary	524	35.5	0.3				524	35.9	1.4			
New Mexico Valencia C	171	11.6	0.1				171	11.7	0.5			
Valencia	60	4.1	0.0				60	4.1	0.2			
Valencia 102	60	4.1	0.0				60	4.1	0.2			
Georgia Valencia	19	1.3	0.0	19	100.0	0.0						
Total	**161013**		**100.0**	**100224**		**62.2**	**37614**		**23.4**	**23175**		**14.4**

* Acreage data from Association of Official Seed Certifying Agencies (AOSCA), 2003.

Table 2. Weighted average coancestries among and within production regions.

	Production region		
	Southeast	Southwest	Virginia-Carolina
Southeast	0.716	0.276	0.110
Southwest	–	0.396	0.120
Virginia-Carolina	–	–	0.412

Table 3. Weighted average coancestries among and within market types.

	Market type			
	Runner	Virginia	Spanish	Valencia
Runner	0.597	0.111	0.010	0.001
Virginia	–	0.375	0.005	0.001
Spanish	–	–	0.722	0.172
Valencia	–	–	–	0.346

Table 4. Possible high impact pathogens on peanuts.

Fungal Pathogens	**Code**	**U.S.**
Alternaria arachidis (Alternaria Leaf Spot)	1	N
Colletotrichum arachidis (Anthracnose)	1	
Aspergillus niger (Aspergillus Crown Rot)	2	
Thielaviopsis basicola (Black Hull)	2	
Botrytis cinerea (Botrytis Blight)	1	
Macrophomina phaseolina (Charcoal Rot)	1	
Choanephora sp. (Choanephora Leaf Spot)	1	N
Cylindrocladium crotalariae (Cylindrocladium Black Rot)	3	
Diplodia gossypina (Diplodia Collar Rot)	1	
Cercospora arachidicola (Early Leaf Spot)	3	
Cercosporidium personatum (Late Leaf Spot)	3	
Fusarium sp. (Fusarium Diseases)	2	
Stemphylium botryosum (Melanosis)	1	
Myrothecium roridum (Myrothecium Leaf Blight)	1	N
Neocosmospora vasinfecta (Neocosmospora Foot Rot)	1	N
Olpidium brassicae (Olpidium Root Discoloration)	1	
Pythium myriotylum, *Rhizoctonia solani*, *Fusarium solani* (Peanut Pod Rot Complex)	3	
Leptosphaerulina crassiasca (Pepper Spot and Leaf Scorch)	2	
Pestalotiopsis arachidis (Pestalotiopsis Leaf Spot)	1	N
Phanerochaete omnivore	1	
Phomopsis sojae (Phomopsis Blight)	1	
Phyllosticta arachidis-hypogaea (Phyllosticta Leaf Spot)	1	
Phymatotrichum omnivorum (Phymatotrichum Root Rot)	1	
Oidium arachidis (Powdery Mildew)	1	N
Pythium sp. (Pythium Diseases)	3	
Rhizoctonia sp. (Rhizoctonia Disease)	3	
Puccinia arachidis (Rust)	2	
Sphaceloma arachidis (Scab)	1	N
Sclerotinia minor (Sclerotinia Blight)	3	
Sclerotium rolfsii (Southern Blight or Stem Rot)	3	
Mucor pusillus, *Humiscola lanuginosa*, *Talaromyces dupontii*, *Thermoascus aurantiacus*, *Malbranchea pulchella*, *Aspergillus fumigatus*, *Thielavia albomyces*, *Sporotrichum* sp., and *Chaetomium* sp. (Thermophilic Fungi)	1	
Verticillium dahliae (Verticillium Wilt)	2	
Phoma arachidicola (Web Blotch)	3	
Aspergillus flavus, *A. parasiticus* (Yellow Mold and Aflatoxin)	3	
Cristulariella moricola (Zonate Leaf Spot)	1	

Bacterial Pathogens

Pseudomonas sp. (Bacterial Leaf Spot)	1	N
Pseudomonas solanacearum (Bacterial Wilt)	1	
Nematodes		
Meloidogyne sp. (Root-Knot Nematodes)	3	
Pratylenchus brachyurus (Root-Lesion Nematodes)	2	
Belonolaimus gracilis (Sting Nematodes)	2	
Criconemella ornate (Ring Nematodes)	1	
Ditylenchus africanus (Peanut Pod Nematodes)	1	N
Viral Pathogens		
Tomato Spotted Wilt	3	
Peanut Clump	2	N
Indian Peanut Clump	2	N
Groundnut Rosette	3	
Peanut Mottle	1	
Peanut Stripe	1	
Peanut Stunt	1	
Cowpea Mild Mottle	2	N
Cucumber Mosaic	3	N
Peanut Chlorotic Streak	1	N
Phytoplasmas		
Witches'-Broom	1	N

Table 5. Possible high impact insects on peanuts.

Common name	Life form	Scientific name	Primary host	Plant part affected	Entry potential	Establishment potential	Spread potential	Economic impact	Risk
Khapra beetle	Btle	*Trogoderma granarium*	Stored products	Seed, dried products	Medium	Medium	Medium	Medium	Medium
Tobacco thrips	Thri	*Frankliniella fusca*		Foliage & Flowers	Medium	Medium	Medium	Low	Low
Giant African snail	Snail	*Achatina achatina*		Whole	Medium	Medium	Medium	Low	Low
Giant East African snail	Snail	*Achatina fulica*		Whole	Medium	Medium	Medium	Low	Low
Knotgrass moth	Moth	*Acronicta rumicis*		Above ground	Medium	Medium	Medium	Low	Low
Otidid fly	Diptera	*Acrosticta apicalis*	peanut, cotton, aubergine, sweet potato.	Whole	Medium	Medium	Medium	Low	Low
Leaf-curling moth, apple	Moth	*Adoxophyes privatana*		Foliar	Medium	Medium	Medium	Low	Low
Striped wireworm	Btle	*Agriotes lineatus*		Cotyledons (seed; leaves, root and	Medium	Medium	Medium	Low	Low
Wheat wireworm	Btle	*Agriotes mancus*		Cotyledons (seed; leaves, root and	Medium	Medium	Medium	Low	Low
Cutworm	Moth	*Agrotis repleta*		Seedlings	Medium	Medium	Medium	Low	Low
Turnip moth	Moth	*Agrotis segetum*		Above ground	Medium	Medium	Medium	Low	Low

Indian cotton jassid	Bug	*Amrasca biguttula biguttula*		Above ground	Medium	Medium	Medium	Low	Low
Hairy caterpillar	Moth	*Amsacta albistriga*		Above ground	Medium	Medium	Medium	Low	Low
Red tiger moth	Moth	*Amsacta lactinea*		Above ground	Medium	Medium	Medium	Low	Low
Tiger moth	Moth	*Amsacta moorei*		Above ground	Medium	Medium	Medium	Low	Low
Gelechiid moth	Moth	*Anarsia ephippias*		Above ground	Medium	Medium	Medium	Low	Low
Oriental beetle	Btle	*Anomala cuprea*		Above ground	Medium	Medium	Medium	Low	Low
Soybean beetle	Btle	*Anomala rufocuprea*		Above ground	Medium	Medium	Medium	Low	Low
Cockhafer of the plains	Btle	*Anomala varians*		Above ground	Medium	Medium	Medium	Low	Low
Giant coreid bug	Bug	*Anoplocnemis curvipes*		Above ground	Medium	Medium	Medium	Low	Low
Coreid bug	Bug	*Anoplocnemis phasiana*		Above ground	Medium	Medium	Medium	Low	Low
Soybean or Velvet bean caterpillar	Moth	*Anticarsia gemmatalis*	cowpea, soybean, pigeon pea, peanut, beans.	Foliage	Medium	Medium	Medium	Low	Low
Peanut leafminer	Moth	*Aproaerema modicella*	peanut, soybean.	Foliage	Medium	Medium	Medium	Medium	Medium
Soybean leafroller	Moth	*Archips micaceanus*	coffee, soyabean, breadfruit, peanut.	Foliage	Medium	Medium	Medium	Low	Low

Leafroller	Moth	*Archips tabescens*	peanut, jackfruit.	Foliage	Medium	Medium	Medium	Low	Low
Arionid slug	Slug	*Arion circumscriptus*		Whole	Medium	Medium	Medium	Low	Low
Arionid slug	Slug	*Arion distinctus*		Whole	Medium	Medium	Medium	Low	Low
Arionid slug	Slug	*Arion fasciatus*		Whole	Medium	Medium	Medium	Low	Low
Arionid slug	Slug	*Arion lusitanicus*		Whole	Medium	Medium	Medium	Low	Low
Arionid slug	Slug	*Arion subfuscus*		Whole	Medium	Medium	Medium	Low	Low
Peanut leafminer	Moth	*Biloba subsecivella*	peanut, soybean.	Foliage	Medium	Medium	Medium	Medium	Medium
Boettgerillid slug	Slug	*Boettgerilla patens*		Whole	Medium	Medium	Medium	Low	Low
Garden springtail	Springt	*Bourletiella hortensis*		Seedlings	Medium	Medium	Medium	Low	Low
Bush snail	Snail	*Bradybaena ravida*		Whole	Medium	Medium	Medium	Low	Low
Onion thrips	Thri	*Caliothrips indicus*	onions, garlic, leek, etc., peanut, legumes,	Foliage, fLowers	Medium	Medium	Medium	Low	Low
Seed-beetle (Bruchid)	Btle	*Calobruchus analis*	peanut, chickpea, faba, field pea, lentil	Pods & seed	Medium	Medium	Medium	Low	Low
Peanut bruchid	Btle	*Caryedon serratus*	peanut, Stored products (dried stored products).	Pods & seed	Medium	Medium	Medium	Low	Low
Cicadellid	Bug	*Chlorotettix fraterculus*	peanut, yam, grasses.	Foliage	Medium	Medium	Medium	Low	Low

Gulf wireworm	Btle	*Conoderus amplicollis*		Seedlings	Medium	Medium	Medium	Low	Low
Wireworm	Btle	*Conoderus vespertinus*		Seedlings	Medium	Medium	Medium	Low	Low
Curculionid	Btle	*Corigetus sieversi*	peanut, mora, soyabean.	Whole plant	Medium	Medium	Medium	Low	Low
Cotton lacebug	Bug	*Corythuca gossypii*	Annona, Araceae, peanut, pigeon pea, bell pepper, papaw, okra, cassava, banana, beans, castor bean, sugarcane, aubergine.	Foliage	Medium	Medium	Medium	Low	Low
Mirid	Bug	*Creontiades pallidifer*	*peanut, black gram.*	Foliage	Medium	Medium	Medium	Low	Low
Tea flush worm		*Cricula trifenestrata*		Foliage	Medium	Medium	Medium	Medium	Medium
Limacid slug	Slug	*Deroceras laeve*		Whole	Medium	Medium	Medium	Low	Low
Southern corn rootworm	Btle	*Diabrotica undecimpunctata*			Medium	Medium	Medium	Low	Low
Earwigs (World wide) Various species	Ewig	*Doru, Euborellia, Labidura & Nala spp.*		Seedlings	Medium	Medium	Medium	Low	Low
Oriental army ant	Ant	*Dorylus orientalis*		Whole plant	Medium	Medium	Medium	Low	Low
Sharp-headed leafhopper	Bug	*Draeculacephala clypeata*		Foliage	Medium	Medium	Medium	Low	Low

lesser corn stalk borer	Moth	*Elasmopalpus lignosellus*	maize, sugarcane, rice, Sorghum, peanut, pigeon pea, beans, yellow nutsedge, flax, cotton, kidney bean, soyabean, strawberry, turnip, cowpea, wheats.	Whole plant	Medium	Medium	Medium	Low	Low
Potato leafhopper	Bug	*Empoasca fabae*		Foliage	Medium	Medium	Medium	Low	Low
Cicadellid	Bug	*Empoasca kerri*	peanut, pigeon pea, soyabean, lablab, moth beans, mung bean, black gram, castor bean, sesame, Sorghum, cowpea.	Foliage	Medium	Medium	Medium	Low	Low
Blister beetle	Btle	*Epicauta maklini*	peanut	Foliage	Medium	Medium	Medium	Low	Low
FLower thrips	Thri	*Frankliniella intonsa*		FLowers	Medium	Medium	Medium	Low	Low
Southern false wireworm	Btle	*Gonocephalum macleayi*	peanut, sorghum, sunfLower, chickpea, soyabean & other legumes, wheats	Above ground	Medium	Medium	Medium	Low	Low
Tomato budworm	Moth	*Helicoverpa viriscens*		Above ground	Low	high	high	Medium	Low
American cotton bollworm	Moth	*Helicoverpa zea*	peanut, maize, cotton, Sorghum, tomato, sunflower, soybean, pigeon pea etc	Flowers, pods	Medium	Medium	Medium	Medium	Medium

French escargot	Snail	*Helix pomatia*		Whole	Medium	Medium	Medium	Low	Low
Harvester termite	Termi	*Hodotermes mossambicus*		Seedling	Medium	Medium	Medium	Low	Low
White grub	Btle	*Holotrichia consanguinea*		Seedling	Medium	Medium	Medium	Low	Low
White grub	Btle	*Holotrichia morosa*		Seedling	Medium	Medium	Medium	Low	Low
White grub	Btle	*Holotrichia oblita*		Seedling	Medium	Medium	Medium	Low	Low
White grub	Btle	*Holotrichia serrata*		Seedling	Medium	Medium	Medium	Low	Low
Tortricid	Moth	*Homona nubiferana*	peanut, Cajanus, Citrus, Crotalaria, Tephrosia,	Foliage	Medium	Medium	Medium	Low	Low
Common green sugarcane leafhopper	Bug	*Hortensia similis*	peanut, pigeon pea, cucurbits, yam, soyabean, rice, beans, sugarcane, maize, grasses,tomato.	Above ground	Medium	Medium	Medium	Low	Low
Areca white grub	Btle	*Leucopholis lepidophora*		Seedling	Medium	Medium	Medium	Low	Low
Achatinid snail	Snail	*Limacolaria martensiana*		Whole	Medium	Medium	Medium	Low	Low
Limacid slug	Slug	*Limacus pseudoflavus*		Whole	Medium	Medium	Medium	Low	Low

Vegetable leaf miner	Fly	*Liriomyza sativae*	tomato, cruciferous crops, celery, aubergine, lucerne, beans, Solanaceae, Fabaceae, bell pepper, cucurbits, lettuce, kidney bean, potato, maize, ornamental gourd, okra, pea, kale, turnip, tobacco, cotton, radish, spinach, watermelon, sugarbeet, peppers, clovers, onions, garlic, leek, etc., peanut, pigeon pea, carrot, pea, cowpea, Cucurbita, melon, cucumber, giant pumpkin, sweet pea, basil.	Foliage	Medium	Medium	Medium	Low	Low
American serpentine leafminer	Fly	*Liriomyza trifolii*	beans	Foliage	Medium	Medium	Medium	Medium	Medium
Nicaraguan grain beetle	Btle	*Lophocateres pusillus*	peanut, rice, cassava, Stored products (dried stored products).	Dried seed & pods	Low	Medium	Medium	Low	Low
Beet webworm	Moth	*Loxostege sticticalis*		Foliage	Low	Medium	Medium	Low	Low
Smaller velvet chafer	Btle	*Maladera orientalis*	maize, wheats, tobacco, peanut, beans.	Foliage	Low	Medium	Medium	Low	Low
Kalotermitid	Termi	*Microtermes obesi*	wheats, jutes, sugarcane, coconut, peanut.	Whole plant	Low	Medium	Medium	Low	Low

Noctuid	Moth	*Mocis undata*	Gloriosa, Derris, peanut, velvetbeans, soyabean, hoang pea.	Foliage	Low	Medium	Medium	Low	Low
Chrysomelid	Btle	*Monolepta signata*	tobacco, peanut, beans, potato.	Foliage	Low	Medium	Medium	Low	Low
Yellow-banded blister beetle	Btle	*Mylabris phalerata*	peanut, hemp, pigeon pea.	Foliage	Low	Medium	Medium	Low	Low
Scarabaeid	Btle	*Neodontocnemis formosana*	peanut	Seedling	Medium	Medium	Medium	Medium	Medium
Tetranychid	Mite	*Oligonychus biharensis*	*peanut, coconut, Eucalyptus, Leucaena, cassava, banana, kidney bean, cowpea, okra, roses.*	Foliage	Low	Medium	Medium	Low	Low
Soybean webworm	Moth	*Omiodes indicata*		Foliage	Low	Medium	Medium	Low	Low
Tussock moth	Moth	*Orgyia turbata*		Foliage	Low	Medium	Medium	Low	Low
Pyralid	Moth	*Ostrinia scapulalis*	peanut, maize.	Pods, Flowers	Medium	Medium	Medium	Medium	Medium
Spanish edible snail	Snail	*Otala lactea*		Whole	Low	Medium	Medium	Low	Low
White grubs	Btle	*Phyllophaga*		Seedling	Low	Medium	Medium	Low	Low
White grub (Scarabaeid)	Btle	*Polyphylla laticollis*	peanut	Seedling	Low	Medium	Medium	Low	Low
Black vine thrips	Thri	*Retithrips syriacus*		Above ground	Low	Medium	Medium	Low	Low

Lesser grain borer	Btle	*Rhizopertha dominica*	Stored grain, flour	Stored grain	Low	Medium	Medium	Low	Low
Bean slug	Slug	*Sarasinula plebeia*		Whole	Low	Medium	Medium	Low	Low
Pea leaf weevil (Britain)	Btle	*Sitona lineatus*	Lucerne, pea, broad bean, black medic, kidney beans, winter peas	Foliage	Medium	Medium	Medium	Low	Low
Spotted bean weevil	Btle	*Sitona macularius*	Chickpea, lentil, pea, vetch & broad bean	Pods	Low	Medium	Medium	m	Low
Common hairy caterpillar	Moth	*Spilarctia obliqua*		Foliage	Low	Medium	Medium	m	Low
Costa Rican armyworm	Moth	*Spodoptera albula*	tomato, soyabean, maize, Sorghum, pea, cotton, onions, garlic, leek, etc., peanut, bell pepper, cruciferous crops, cucurbits, cassava, banana, tobacco, sweet potato, sugarbeet.	Seedlings	Medium	Medium	Medium	Low	Low
Southern armyworm	Moth	*Spodoptera eridania*		Seedlings	Medium	Medium	Medium	Low	Low
Fall armyworm	Moth	*Spodoptera frugiperda*		Seedlings	Medium	Medium	Medium	Low	Low
Cotton leafworm	Moth	*Spodoptera littoralis*		Seedlings	Medium	Medium	Medium	Low	Low
YelLow striped armyworm	Moth	*Spodoptera ornithogalli*		Seedlings	Medium	Medium	Medium	Low	Low
Peanut budworm	Moth	*Stegasta bosqueella*	peanut	Flowers / pods	Medium	Medium	Medium	Medium	Medium

Budapest slug	Slug	*Tandonia budapestensis*		Whole	Medium	Medium	Medium	Low	Low
Japanese ant	Ant	*Tetramorium bicarinatum*	*peanut, soyabean, aubergine, cowpea.*	Whole	Medium	Medium	Medium	Low	Low
Canadian spider mite	Mite	*Tetranychus canadensis*		Leaves	Medium	Medium	Medium	Low	Low
Pierce's spider mite	Mite	*Tetranychus piercei*	peanut, papaw, castor bean, kidney bean, banana, Polygala paniculata, Butterfly-pea, African oil palm, sweet potato, plants of the palm family, Ageratum.	Leaves	Medium	Medium	Medium	Low	Low
Truncate spider mite	Mite	*Tetranychus truncatus*	castor bean,cassava, maize, cotton, aubergine, peanut, mora, African oil palm, carrot, melon, beans.	Leaves	Low	Medium	Medium	Low	Low
Sweet cherry spider mite	Mite	*Tetranychus viennensis*	*peanut, cotton, apple, apricot, peach, oaks.*	Leaves	Low	Medium	Medium	Low	Low
Field thrips	Thri	*Thrips angusticeps*		Leaves	Low	Medium	Medium	Low	Low
Cabbage looper	Moth	*Trichoplusia ni*		Foliage	Medium	Medium	Medium	Low	Low
Tenebrionid	Btle	*Ulomoides dermestoides*	*peanut, rice, mung bean, sorghum, wheat, maize.*	Seedlings	Medium	Medium	Medium	Low	Low
Vaginulid slug	Slug	*Veronicella moreleti*		Whole	Medium	Medium	Medium	Low	Low

Life forms: Ant = Ants (Hymenoptera); Btle = Bettles (weevils etc.) (Coleoptera); Bug = Stink bugs, aphids, mealybugs, scale, whie flies and

Hoppers (Homoptera); Ewig = Earwigs (Dermaptera); Fly = Flies and Midges (Diptera); Mite = Mites e.g. speder and gall mites (Acari); Moth = (Lepidoptera); Slug = (Gastropoda); Snai = Snails (Gastropoda); Termi = Termite (Isoptera); Thri = Thrips (Thysanura)

Table 6. List of peanut cultivars registered with Crop Science.

Reg. No.	NameGRIN	Accession Id	Registration Date
CV-01	Florigiant	PI 565445	11/01/1969
CV-02	Florunner	PI 565448	11/01/1969
CV-03	Spancross	PI 565449	07/01/1970
CV-04	Tifspan	PI 565450	07/01/1970
CV-05	NC2	PI 565446	07/01/1970
CV-06	NC5	PI 565447	07/01/1970
CV-07	NC17	PI 565451	07/01/1970
CV-08	Virginia Bunch 67	PI 565438	07/01/1970
CV-09	Southeastern Runner 56-15	PI 565439	11/01/1970
CV-10	Virginia 56R	PI 565441	11/01/1970
CV-11	Virginia 61R	PI 565444	11/01/1970
CV-12	Georgia 119-20	PI 565440	03/01/1971
CV-13	Virginia 72R	PI 565454	01/01/1972
CV-14	New Mexico Valencia A	PI 565452	03/01/1972
CV-15	Spantex	PI 565442	05/01/1972
CV-16	Starr	PI 565443	05/01/1972
CV-17	NC-FLA 14	PI 565466	05/01/1974
CV-18	Altika	PI 565453	03/01/1974
CV-19	Tamnut 74	PI 564855	07/01/1975
CV-20	NC6	PI 565456	03/01/1977
CV-21	Early Bunch	PI 565458	09/01/1978
CV-22	NC 7	PI 565459	07/01/1979
CV-23	Toalson	PI 635015	09/01/1979
CV-24	New Mexico Valencia C	PI 565461	01/01/1980
CV-25	Virginia 81 Bunch	PI 565474	09/01/1982
CV-26	Sunbelt Runner	PI 565473	09/01/1982
CV-27	NC 8C	PI 565476	01/01/1983
CV-28	Pronto	PI 565475	01/01/1983
CV-29	Sunrunner	PI 565433	11/01/1985
CV-30	NC 9	PI 565484	01/01/1986
CV-31	Langley	PI 506237	07/01/1987
CV-32	Southern Runner	PI 506419	07/01/1987
CV-33	Georgia Red	PI 508278	09/01/1987
CV-34	Tamrun 88	PI 520600	01/01/1989
CV-35	Spanco	PI 531500	11/01/1989
CV-36	Okrun	PI 531499	11/01/1989
CV-37	ICGV 87128	PI 537112	07/01/1990

CV-38	ICGS 11	PI 478788	07/01/1990
CV-39	NC 10C	PI 540460	03/01/1991
CV-40	NC-V11	PI 540461	03/01/1991
CV-41	Georgia Runner	PI 542960	03/01/1991
CV-42	ICGV 87141	PI 546372	07/01/1991
CV-43	ICGS 1	PI 478780	09/01/1991
CV-44	Tamspan 90	PI 550721	11/01/1991
CV-45	ICGV 87187	PI 550930	01/01/1992
CV-46	Marc I	PI 552555	01/01/1992
CV-47	ICGV 87160	PI 478787	07/01/1992
CV-48	Sinkarzei	PI 561673	01/01/1993
CV-49	ICGV 86590	PI 562530	03/01/1993
CV-50	VA-C 92R	PI 561566	03/01/1994
CV-51	VA 93B	PI 561568	07/01/1994
CV-52	Georgia Browne	PI 574450	07/01/1994
CV-53	Andru 93	PI 566905	02/28/1995
CV-54	ICGV 86325	PI 590879	05/01/1996
CV-55	Georgia Green	PI 587093	05/01/1996
CV-56	SunOleic 95R	PI 578304	07/01/1997
CV-57	NC 12C	PI 596406	11/01/1997
CV-58	Southwest Runner	PI 599178	03/01/1998
CV-59	Tamrun 96	PI 601819	09/30/1998
CV-60	Georgia Bold	PI 601980	05/01/1998
CV-61	ALR 2	PI 599975	11/30/1998
CV-62	Gregory	PI 608666	09/01/1999
CV-63	Jeokwangtangkong	PI 607913	01/01/2000
CV-64	Tamrun 98	PI 608737	05/01/2000
CV-65	SunOleic 97R	PI 596800	07/01/2000
CV-66	VA 98R	PI 607566	07/01/2000
CV-67	Georgia Hi-O/L	PI 607836	11/01/2000
CV-68	Coan	PI 610452	05/05/2001
CV-69	Georgia Valencia	PI 617040	11/01/2001
CV-70	Georgia-01R	PI 629027	09/01/2002
CV-71	C-99R	PI 613135	11/01/2002
CV-72	Florida MDR 98	PI 607535	11/01/2002
CV-73	Perry	PI 613600	03/01/2003
CV-74	NemaTAM	PI 631175	07/01/2003
CV-75	OLin	PI 631176	02/28/2003
CV-76	Georgia-02C	PI 632380	02/28/2003
CV-77	Tamrun OL 01	PI 631177	03/31/2003

CV-78	Wilson	PI 631390	09/30/2003
CV-79	Georgia-03L	PI 634333	01/31/2004

Table 7. List of germplasm releases of peanuts registered with Crop Science.

Reg. No.	NameGRIN	Accession Id	Registration Date
GP-001	GP-NC343	PI 565465	07/01/1971
GP-002	Chico	PI 565455	01/01/1975
GP-003	Aspergillus Flavus Resistant Peanut	PI 544346	01/01/1975
GP-004	Rosado	PI 337409	01/01/1975
GP-005	NC 10247	PI 565434	09/01/1975
GP-006	NC 10272	PI 565435	09/01/1975
GP-007	NC 15729	PI 565436	09/01/1975
GP-008	NC 15745	PI 565437	09/01/1975
GP-009	ICG 5816	PI 565460	11/01/1976
GP-010	Mani	PI 109839	03/01/1980
GP-011	VGP 1	PI 565462	05/01/1980
GP-012	CBR-R1	PI 565470	11/01/1981
GP-013	CBR-R2	PI 565469	11/01/1981
GP-014	CBR-R3	PI 565468	11/01/1981
GP-015	CBR-R4	PI 565471	11/01/1981
GP-016	CBR-R5	PI 565467	11/01/1981
GP-017	CBR-R6	PI 565472	11/01/1981
GP-018	ICG 7881	PI 561676	03/01/1982
GP-019	ICG 7886	PI 561677	03/01/1982
GP-020	ICG 7887	PI 561678	03/01/1982
GP-021	ICG 7898	PI 561679	03/01/1982
GP-022	ICG 7894	PI 561680	03/01/1982
GP-023	ICG 7895	PI 561681	03/01/1982
GP-024	ICG 7896	PI 561682	03/01/1982
GP-025	ICG 7888	PI 561683	03/01/1982
GP-026	ICG 7889	PI 561684	03/01/1982
GP-027	ICG 7890	PI 561685	03/01/1982
GP-028	ICG 7893	PI 561686	03/01/1982
GP-029	ICG 7891	PI 561687	03/01/1982
GP-030	ICG 7883	PI 561688	05/01/1982
GP-031	ICG 7882	PI 561689	05/01/1982
GP-032	F334A-B-14	PI 565477	09/01/1983
GP-033	GFA-1	PI 565478	09/01/1983
GP-034	GFA-2	PI 565479	09/01/1983
GP-035	AR-1	PI 565480	09/01/1983
GP-036	AR-2	PI 565481	09/01/1983
GP-037	AR-3	PI 565482	09/01/1983

GP-038	AR-4	PI 565483	09/01/1983
GP-039	Tifton-8	PI 565463	01/01/1985
GP-040	TXAG-1	NSL 199440	03/01/1986
GP-041	TXAG-2	NSL 199441	03/01/1986
GP-042	VGP 2	PI 509536	11/01/1987
GP-043	VGP 3	PI 509537	11/01/1987
GP-044	VGP 4	PI 509538	11/01/1987
GP-045	VGP 5	PI 509539	11/01/1987
GP-046	VGP 6	PI 509540	11/01/1987
GP-047	VGP 7	PI 509541	11/01/1987
GP-048	TxAG-4	PI 535816	03/01/1990
GP-049	TXAG-5	PI 535817	03/01/1990
GP-050	ICGL1	PI 544348	05/01/1991
GP-051	ICGL2	PI 544349	05/01/1991
GP-052	ICGL3	PI 544350	05/01/1991
GP-053	ICGL4	PI 544351	05/01/1991
GP-054	ICGL5	PI 544352	05/01/1991
GP-055	Convergent Peanut Early-segregating	PI 542961	03/01/1991
GP-056	ICGV 87157	PI 556992	05/01/1992
GP-057	ICGV 87121	PI 478784	07/01/1992
GP-058	ICGV 86031	PI 561917	01/01/1993
GP-059	GP-NC WS1	PI 564844	09/01/1993
GP-060	GP-NC WS2	PI 564845	09/01/1993
GP-061	GP-NC WS3	PI 564846	09/01/1993
GP-062	GP-NC WS4	PI 564847	09/01/1993
GP-063	TXAG-6	PI 565287	11/01/1993
GP-064	TXAG-7	PI 565288	11/01/1993
GP-065	ICGV 86564	PI 573007	05/01/1994
GP-066	VGP 9	PI 561567	07/01/1994
GP-067	Jinpungtangkong	PI 577819	03/31/1994
GP-068	ICGV-SM 83708	PI 585000	11/01/1995
GP-069	ICGV 86252	PI 585001	11/01/1995
GP-070	ICGV 86393	PI 585002	11/01/1995
GP-071	ICGV 86455	PI 585003	11/01/1995
GP-072	ICGV 86462	PI 585004	11/01/1995
GP-073	ICGV 86015	PI 585005	11/01/1995
GP-074	ICGV 88145	PI 585006	11/01/1995
GP-075	ICGV 89104	PI 585007	11/01/1995
GP-076	ICGV 86699	PI 591815	05/01/1996
GP-077	ICGV 86388	PI 593239	09/01/1996

GP-078	ICGV 87165	PI 594923	05/01/1997
GP-079	ICGV 86155	PI 594969	05/01/1997
GP-080	ICGV 86156	PI 594970	05/01/1997
GP-081	ICGV 86158	PI 594971	05/01/1997
GP-082	ICGV 87378	PI 594972	05/01/1997
GP-083	ICGV 87921	PI 594973	05/01/1997
GP-084	ICGV 88438	PI 596514	11/01/1997
GP-085	ICGV 89214	PI 596515	11/01/1997
GP-086	ICGV 91098	PI 596516	11/01/1997
GP-087	ICGV 86143	PI 596359	11/01/1997
GP-088	VGP 10	PI 584772	03/01/1998
GP-089	ICGV-SM 86715	PI 598133	03/01/1998
GP-090	ICGV-SM 85048	PI 598134	03/01/1998
GP-091	ICGV-SM 83005	PI 598135	03/01/1998
GP-092	ICGV 92196	PI 599344	05/01/1998
GP-093	ICGV 92206	PI 599345	05/01/1998
GP-094	ICGV 92234	PI 599346	05/01/1998
GP-095	ICGV 92243	PI 599347	05/01/1998
GP-096	VGP 11	PI 584773	09/30/1998
GP-097	ICGV 87354	PI 568164	01/01/2001
GP-098	ICGV 91278	PI 614083	03/01/2001
GP-099	ICGV 91283	PI 614084	03/01/2001
GP-100	ICGV 91284	PI 614085	03/01/2001
GP-101	ICGV 94361	PI 614086	09/30/2000
GP-102	ICGV 93470	PI 614087	03/01/2001
GP-103	GP-NC WS 5	PI 619169	01/01/2002
GP-104	GP-NC WS 6	PI 619170	01/01/2002
GP-105	GP-NC WS 7	PI 619171	01/01/2002
GP-106	GP-NC WS 8	PI 619172	01/01/2002
GP-107	GP-NC WS 9	PI 619173	01/01/2002
GP-108	GP-NC WS 10	PI 619174	01/01/2002
GP-109	GP-NC WS 11	PI 619175	01/01/2002
GP-110	GP-NC WS 12	PI 619176	01/01/2002
GP-111	GP-NC WS 13	PI 619177	01/01/2002
GP-112	GP-NC WS 14	PI 619178	01/01/2002
GP-113	GP-NC WS 15	PI 619179	01/01/2002
GP-116	ICGV 92267	PI 630947	11/01/2002
GP-117	ICGV 93382	PI 630948	11/01/2002
GP-118	ICGV 99001	PI 631072	01/01/2003
GP-119	ICGV 99003	PI 631073	01/01/2003

GP-120	ICGV 99004	PI 631074	01/01/2003
GP-121	ICGV 99005	PI 631075	01/01/2003

Table 8. List of genetic stocks registered with Crop Science.

Reg. No.	NameGRIN	Accession Id	Registration Date
GS-1	ICGL 6	PI 561916	01/01/1993
GS-2	Variegated-leaf	PI 561736	03/01/1993
GS-3	Curly-leaf	PI 578012	07/31/1994
GS-4	VGS 1	PI 584770	11/01/1995
GS-5	VGS 2	PI 584771	11/01/1995
GS-6	Georgia Non-Nod	PI 595385	07/01/1997
GS-7	Rusty-Leaf	PI 608669	09/01/1999
GS-8	White-Spot Testa	PI 608670	09/01/1999

Table 9. List of peanut cultivars which have been Plant Variety Protected (PVP).

PVP No.	Variety/Name	Applicant	Status	Status	Date
7100035	Goldin I	Wilco Peanut Company	Certificate	Expired	03/05/1993
7100102	G.K. 9B	Gold Kist Inc.	Application	Abandoned	03/05/1994
7100103	G.K. 55B	Gold Kist Inc.	Application	Abandoned	03/05/1995
7100104	G.K. 17DS	Gold Kist Inc.	Application	Abandoned	03/05/1996
7100110	Avoca-11	R. J. Reynolds Tobacco Company	Certificate	Expired	03/05/1997
7300005	GK-19	AgraTech Seeds Inc.	Certificate	Expired	03/05/1998
7300006	G.K. 17IS	Gold Kist Inc.	Application	Withdrawn	03/05/1999
7300066	Valencia McRan	Borden Peanut Company Inc.	Certificate	Expired	07/19/1993
7300076	Shulamit	Keel Peanut Company Inc.	Ineligible		11/28/1975
7300093	G.K. 14R	Gold Kist Inc.	Application	Abandoned	06/05/1975
7300094	GK-3	AgraTech Seeds Inc.	Certificate	Expired	06/01/1993
7500062	Early Bunch	Florida Foundation Seed Production, Inc.	Certificate	Withdrawn	02/17/1998
7605011	NC 6	North Carolina Agricultural Research Service	Certificate	Expired	10/20/1994
7800063	Keel 76	James T. Keel	Application	Abandoned	07/02/1979
7900104	NC 7	North Carolina Agricultural Research Service	Certificate	Expired	10/16/1997
8000155	K-29	James T. Keel	Certificate	Expired	08/27/1999
8200141	GK-7	AgraTech Seeds Inc.	Certificate	Expired	02/27/2002
8500201	NC 9	North Carolina Agricultural Research Service	Certificate	Issued	07/31/1986
8600030	AD-1	J. Ashley Darden	Certificate	Expired	06/30/2004
8700093	Southern Runner	Florida Agricultural Experiment Station, University of Florida	Certificate	Issued	12/18/1987
8700094	KH20	Kenneth E. Hughes	Certificate	Issued	12/18/1987
8900116	NC 10C	North Carolina Agricultural Research Service	Certificate	Issued	06/28/1991
9000197	NC-V11	North Carolina Agricultural Research Service	Certificate	Issued	06/28/1991
9200014	VC-1	AgraTech Seeds Inc.	Certificate	Issued	03/29/1996
9200029	Georgia Runner	University of Georgia Research Foundation, Inc.	Certificate	Issued	05/31/1995
9200066	127	Golden Peanut Company, LLC	Certificate	Issued	06/28/1996

9200115	Marc I	Florida Agricultural Experiment Station	Certificate	Issued	09/30/1994
9200252	VA-C 92R	Virginia Agricultural Experiment Station	Certificate	Issued	09/30/1994
9300153	Andru 93	Florida Agricultural Experiment Station	Certificate	Issued	10/31/1994
9400043	Georgia Browne	University of Georgia Research Foundation, Inc.	Certificate	Issued	06/30/1997
9400123	Shosh	State of Israel/Ministry of Agriculture, Agricultural Research Organization, The Volcani Center	Certificate	Issued	02/28/1995
9400148	SunOleic 95R	Florida Agricultural Experiment Station, University of Florida	Certificate	Issued	09/30/1994
9500120	David	State of Israel/Ministry of Agriculture, Agricultural Research Organization, The Volcani Center	Certificate	Issued	06/28/1996
9500165	Georgia Green	University of Georgia Research Foundation, Inc.	Certificate	Issued	06/28/1996
9600242	458	James Sutton, Mycogen Corporation Gordon Patterson, Hershey Foods Corporation	Certificate	Issued	07/31/1997
9600322	AT 108	Golden Peanut Company, LLC	Certificate	Issued	06/30/1997
9700010	AT225 High Oleic	Golden Peanut Company, LLC	Certificate	Issued	10/31/1997
9700074	NC 12C	North Carolina Agricultural Research Service	Certificate	Issued	06/30/1997
9700182	SunOleic 97R	Univ. of Fla. Agric. Expt. Sta.	Certificate	Issued	07/31/1997
9700275	AT 120	Golden Peanut Company, LLC	Certificate	Issued	06/30/1997
9700336	H & W Valencia 102	H & W GENETEX L.C.	Certificate	Issued	02/05/2002
9700337	H & W Valencia 101	H & W GENETEX L.C.	Certificate	Issued	02/05/2002
9800019	GK-7 High Oleic	Golden Peanut Company, LLC	Certificate	Issued	02/05/2002
9800022	ViruGard	Golden Peanut Company, LLC	Certificate	Issued	06/10/2002
9800041	Georgia Bold	University of Georgia Research Foundation, Inc. (UGARF) and University of Florida Agricultural Experiment Station (UFAES)	Certificate	Issued	06/10/2002
9800338	TAMRUN 96	Texas Agricultural Experiment Station	Certificate	Issued	04/09/2002
9900189	Tamrun 98	Texas Agricultural Experiment Station	Certificate	Issued	04/18/2002
9900212	Florida MDR 98	University of Florida - Agric. Expt. Sta.	Certificate	Issued	06/10/2002

9900337	Gregory	North Carolina Agricultural Research Service Dr. Thomas G. Isleib (breeder)	Certificate Issued	04/18/2002
9900338	Coan	Texas Agricultural Experiment Station	Certificate Issued	04/18/2002
9900419	VA 98R	Virginia Tech Intellectual Properties, Inc.	Certificate Issued	11/15/2002
200000134	AgraTech 1-1	Golden Peanut Company, LLC	Certificate Issued	11/15/2002
200000135	AgraTech 201	Golden Peanut Company, LLC	Certificate Issued	11/15/2002
200000136	AgraTech VC-2	Golden Peanut Company, LLC	Certificate Issued	11/15/2002
200000182	C-99R	Florida Agricultural Experiment Station	Certificate Issued	11/15/2002
200000203	Hughes Runner	Kenneth E. Hughes	Certificate Issued	11/15/2002
200000225	Perry	North Carolina Agricultural Research Service Dr. Thomas G. Isleib (breeder)	Certificate Issued	01/30/2003
200000255	Georgia Hi-0/L	University of Georgia Research Foundation, Inc.	Certificate Issued	11/15/2002
200100132	Georgia Valencia	University of Georgia Research Foundation, Inc.	Certificate Issued	03/10/2003
200200148	NemaTAM	Texas Agricultural Experiment Station	Certificate Issued	09/16/2003
200200149	OLin	Texas Agricultural Experiment Station	Certificate Issued	03/03/2004
200200150	Tamrun OL 01	Texas Agricultural Experiment Station	Application Pending	07/02/2004
200200171	Georgia-01R	University of Georgia Research Foundation, Inc.	Application Pending	07/02/2004
200200200	Wilson	Virginia Tech Intellectual Properties, Inc.	Application Pending	07/02/2004
200300050	Georgia-02C	University of Georgia Research Foundation, Inc.	Application Pending	07/02/2004
200300170	Tamrun OL 02	Texas Agricultural Experiment Station	Application Pending	07/02/2004
200300179	Andru II	Florida Agricultural Experiment Station	Application Pending	07/02/2004
200300204	Carver	Florida Agricultural Experiment Station	Application Pending	07/02/2004
200300205	ANorden	Florida Agricultural Experiment Station	Application Pending	07/02/2004
200300206	DP-1	Florida Agricultural Experiment Station	Application Pending	07/02/2004
200300207	Hull	Florida Agricultural Experiment Station	Application Pending	07/02/2004
200300320	AP-3	Florida Agricultural Experiment Station University of Florida, IFAS	Application Pending	07/02/2004
200300321	GP-1	Florida Agricultural Experiment Station	Application Pending	07/02/2004

200400089	Georgia-03L	University of Georgia Research Foundation, Inc.	Application Pending

Table 10. List of cultivated peanuts in National Plant Germplasm System.

Taxon	No. Accessions
Arachis hypogaea	6804
Arachis hypogaea fastigiata	361
Arachis hypogaea fastigiata var. *aequatoriana*	62
Arachis hypogaea fastigiata var. *fastigiata*	1149
Arachis hypogaea fastigiata var. *peruviana*	24
Arachis hypogaea fastigiata var. *vulgaris*	128
Arachis hypogaea hypogaea	141
Arachis hypogaea hypogaea var. *hirsuta*	29
Arachis hypogaea hypogaea var. *hypogaea*	527
Total number of accessions	9225

Table 11. List of wild peanut species in National Plant Germplasm System.

Taxon	No. of accessions
Arachis appressipila Krapov. & W. C. Greg.	5
Arachis archeri Krapov. & W. C. Greg.	4
Arachis batizocoi Krapov. & W. C. Greg.	15
Arachis benensis Krapov. et al.	4
Arachis benthamii Handro	4
Arachis brevipetiolata Krapov. & W. C. Greg.	0
Arachis burchellii Krapov. & W. C. Greg.	10
Arachis burkartii Handro	3
Arachis cardenasii Krapov. & W. C. Greg.	15
Arachis chiquitana Krapov. et al.	2
Arachis correntina (Burkart) Krapov. & W. C. Greg.	7
Arachis cruziana Krapov. et al.	2
Arachis cryptopotamica Krapov. & W. C. Greg.	8
Arachis dardanoi Krapov. & W. C. Greg.	7
Arachis decora Krapov. et al.	3
Arachis diogoi Hoehne	15
Arachis douradiana Krapov. & W. C. Greg.	0
Arachis duranensis Krapov. & W. C. Greg.	41
Arachis giacomettii Krapov. et al.	1
Arachis glabrata Benth.	71
Arachis glabrata var. *glabrata*	36
Arachis glabrata var. *hagenbeckii* (Harms) F. J. Herm.	19
Arachis glandulifera Stalker	5
Arachis gracilis Krapov. & W. C. Greg.	0
Arachis guaranitica Chodat & Hassl.	1
Arachis hatschbachii Krapov. & W. C. Greg.	1
Arachis helodes Mart. ex Krapov. & Rigoni	6
Arachis hermannii Krapov. & W. C. Greg.	4
Arachis herzogii Krapov. et al.	0
Arachis hoehnei Krapov. & W. C. Greg.	5
Arachis ipaensis Krapov. & W. C. Greg.	2
Arachis kempff-mercadoi Krapov. et al.	6
Arachis kretschmeri Krapov. & W. C. Greg.	4
Arachis kuhlmannii Krapov. & W. C. Greg.	15
Arachis lignosa (Chodat & Hassl.) Krapov. & W. C. Greg.	1
Arachis lutescens Krapov. & Rigoni	0
Arachis macedoi Krapov. & W. C. Greg.	4

Arachis magna Krapov. et al.	5
Arachis major Krapov. & W. C. Greg.	11
Arachis marginata Gardner	0
Arachis martii Handro	0
Arachis matiensis Krapov. et al.	15
Arachis microsperma Krapov. et al.	0
Arachis monticola Krapov. & Rigoni	7
Arachis oteroi Krapov. & W. C. Greg.	3
Arachis palustris Krapov. et al.	1
Arachis paraguariensis Chodat & Hassl.	13
Arachis paraguariensis subsp. *capibarensis* Krapov. & W. C. Greg.	2
Arachis paraguariensis subsp. *paraguariensis*	11
Arachis pietrarellii Krapov. & W. C. Greg.	3
Arachis pintoi Krapov. & W. C. Greg.	37
Arachis praecox Krapov. et al.	1
Arachis prostrata Benth.	3
Arachis pseudovillosa (Chodat & Hassl.) Krapov. & W. C. Greg.	5
Arachis pusilla Benth.	10
Arachis repens Handro	4
Arachis retusa Krapov. et al.	1
Arachis rigonii Krapov. & W. C. Greg.	2
Arachis setinervosa Krapov. & W. C. Greg.	0
Arachis simpsonii Krapov. & W. C. Greg.	9
Arachis sp.	84
Arachis stenophylla Krapov. & W. C. Greg.	2
Arachis stenosperma Krapov. & W. C. Greg.	18
Arachis subcoriacea Krapov. & W. C. Greg.	3
Arachis sylvestris (A. Chev.) A. Chev.	32
Arachis trinitensis Krapov. & W. C. Greg.	1
Arachis triseminata Krapov. & W. C. Greg.	1
Arachis tuberosa Benth.	1
Arachis valida Krapov. & W. C. Greg.	4
Arachis vallsii Krapov. & W. C. Greg.	0
Arachis villosa Benth.	13
Arachis villosulicarpa Hoehne	12
Arachis williamsii Krapov. & W. C. Greg.	1
Total	641

Table 12. Peanut germplasm collections made since 1932.

Year	-Year	Collectors	Location
1932	1933	O	Brazil
1936	1937	Ar	Argentina, Brazil, Paraguay, Uruguay
1939		O	Brazil
1947		BaRi	Argentina
1947	1948	StHt	Argentina, Brazil, Paraguay, Uruguay
1950		BaRiK	Argentina
1953		K	Argentina
1953		RiKP	Argentina
1958		K	Bolivia
1959		GKP	Argentina, Bolivia, Brazil, Paraguay
1961		GKP	Brazil, Paraguay
1967		GK	Brazil
1968		HLPK	Argentina, Brazil, Uruguay
1971		KMoF	Bolivia
1976		GKAOk	Brazil
1977		GKBSPSc	Argentina, Bolivia
1977		BPZ	Bolivia
1977		GKSSc	Bolivia
1977		GKPSc	Paraguay, Brazil
1978		S	Argentina
1979		GKSPScGb	Bolivia
1980		KSBScCo	Argentina, Bolivia
1980		BZC	Bolivia
1980		KSSc	Bolivia
1980		BZCJk	Bolivia
1980		SPAi	PERU
1981		PZi	Bolivia
1981		VSGr	Brazil
1981		VVeSv	Brazil
1981		SPZ	PERU
1982		ScVn	Argentina
1982		VKRSv	Brazil
1982		VSW	Brazil
1983		SKBPZScCrGVSvGeM	Argentina, Bolivia, & Brazil
1983		KSScCr	Bolivia, Argentina
1983		VKSvVe	Brazil
1983		VSMSvGe	Brazil
1983		BPZ	Ecuador
1984		SGSaVGdW	Brazil
1984		VRGeSv	Brazil

1984		VSGdSaW	Brazil
1985		VKSSv	Brazil
1985		VPoBi	Brazil
1985		VPoPeJAj	Brazil
1985		VVeSv	Brazil
1985		B	Peru
1986		SKGVSv	Brazil
1986		VPoJSv	Brazil
1986		VSW	Brazil
1987		VRSv	Brazil.
1988		Wi	Bolivia
1988		VQFdSv	Brazil
1989		Wi	Bolivia
1989	1990	Wi	Bolivia, Argentina
1989		VK	Brazil
1990		Wi	Bolivia
1990		VGaRoSv	Brazil
1991		VFaPzSv	Brazil
1991		VPmSv	Brazil
1992		Wi	Bolivia
1992		VPzVaW	Brazil
1992		VSPmPzRs	Brazil
1992		VSPmWiSv	Brazil
1992		WiD	Mexico
1993		WiAs	Mexico
1994		WiSVr	Bolivia
1995		VSPmSv	Brazil
1995		WiWmT	Ecuador
1996		WmSTMe	Ecuador
1997		WiWmAz	Guatemala
1999		TaEMn	Ecuador
1999		WiWmAzAy	Guatemala
2002		SWiQJaVg	Paraguay
2002		WlPmPzCb	Paraguay
2003		WlPmPzCbRb	Paraguay

Initials of Collectors

Initial	Collectors
A	A.C.Allem, CENARGEN, Brazilia, Brazil.
Ai	O.Arriola, INIA, Cuzco, Peru.
Aj	M. Araujo
Ar	W.A. Archer, USDA
As	L.M. Arias-Reyes, CINVESTAV, Merida, Mexico.
Ay	H. Ayala, Universidad de San Carlos de Guatemala, Guatemala City, Guatemala.
Az	C. Azurdia, Universidad de San Carlos de Guatemala, Guatemala City, Guatemala.
B	D.J. Banks, USDA
Ba	J.R.Baez, EEA. Manfredi, Cordoba, Argentina.
Bi	L.B.Bianchetti, CENARGEN, Brazilia, Brazil.
Bm	B. Maass, CIAT, Cali, Colombia.
Bs	C.T. Bastidas, DENAREF, Quito, Ecuador
C	C.L. Cristobal, IBONE, Corrientes, Argentina.
Cb	P.J. Caballero, Instituto Agronomico Nacional, Caacupe, Paraguay
Co	L. Coradin, CENARGEN, Brazilia, Brazil.
Cr	M. Corro, Univ. J.M. Saracho, Tarija, Bolivia.
D	S. Dominguez, Universidad Autonoma Chapingo, Chapingo, Mexico
E	J. Estrella, DENAREF/INIAP, Santa Catalina, Ecuador.
F	A.F ernandez, IBONE, Corrientes, Argentina.
Fa	L. Faraco de Freitas, CENARGEN, Brazilia, Brazil.
Fd	M. Soter Franca Dantas, CPAC, EMBRAPA, Planaltina, DF, Brazil.
G	W.C. Gregory, North Carolina State University, Raleigh, NC, USA.
Ga	M.L. Galgaro, UNESP, Botucatu, SP, Brazil.
Gb	R.W. Gibbons, ICRISAT, India.
Gd	I.J. de Godoy, IAC, SP, Brazil.
Ge	M.A.N. Gerin, IAC, SP, Brazil.
Gr	A. Gripp, CENARGEN, Brazilia, Brazil.
H	R.O. Hammons, USDA
He	V. Hemsy, Facultad de Agronomia, Tucuman, Argentina.
Ht	W. Hartley, SCIRO, Australia.
J	L. Jank, CNPGC, EMBRAPA, Campo Grande, MS, Brazil.
Ja	A. Jarvis, IPGRI, Cali, Colombia.
Jk	L. Janicki, PRODES, La Paz, Bolivia.
K	A. Krapovickas, IBONE, Corrientes, Argentina.
L	W.R. Langford, USDA
M	J.P. Moss, ICRISAT, India.
Me	E. Mendoza, INIAP, EE Portoviego, Santa Ana, Ecuador
Mn	A. Monteros, DENAREF/INIAP, Santa Catalina, Ecuador.
Mo	L.A. Mroginski, IBONE, Corrientes, Argentina.
Mr	A.R. Miranda, CENARGEN, Brazilia, Brazil.

O	J. Ramos de Otero, S. Agrostologia, M. Agric., Rio de Janeiro, Brazil
Oj	H.R. Ojeda, Fac. de Ciencias Agrarias, Corrientes, Argentina.
Ok	K. Okada, CIAT, Cali, Colombia.
or	anaranjado.
Ov	J.C. Oliveira, EMBRAPA, CNPO, Bage RS, Brazil.
P	J.R. Pietrarelli, EEA, Manfredi, Cordoba, Argentina.
Pe	M.I. Penteado
Pm	R.N. Pittman, USDA, Griffin, Georgia, U.S.A.
Po	A. Pott, EMBRAPA, Corumba, MS, Brazil.
Pz	E.A. Pizarro, CIAT/CPAC-EMBRAPA, Planaltina, DF, Brazil.
Q	C.L. Quarin, IBONE, Corrientes, Argentina.
Qu	M. Quintana, Museo Nacional de Historia Natural del Paraguay, San Lorenzo, Paraguay.
R	V.R. Rao, ICRISAT, India.
Rb	L.E. Robledo, Direccion de Investigacion Agricola, Asuncion, Paraguay
Ri	V.A. Rigoni, EEA Manfredi, Argentina.
Ro	D.M.S. Rocha, CENARGEN, Brazilia, Brazil.
Rs	Roseane C. dos Santos, CNPA, Campina Grande, Paraiba, Brazil.
S	C.E. Simpson, Texas A&M University, Stephenville, Texas, USA.
Sa	H.T. Stalker, North Carolina State University, Raleigh, NC, USA.
Sc	A. Schinini, IBONE, Corrientes, Argentina. Sg, A.K. Singh, ICRISAT, India.
St	J.L. Stephens, USDA
Sv	G.P. Silva, EMBRAPA, Brazilia, Brazil.
Ta	C. Tapia, DENAREF/INIAP, Santa Catalina, Ecuador.
V	J.F.M. Valls, CENARGEN, Brazilia, Brazil.
Va	S.E.S. Valente, UNESP, Botucatu, SP, Brazil.
Ve	R.F. de Arruda Veiga, IAC, SP, Brazil.
Vn	R.O.Vanni, IBONE, Corrientes, Argentina.
Vr	I. Vargas, Fundacion Amigos de la Naturaleza (FAN), Santa Cruz, Bolivia.
W	W.L.Werneck, CENARGEN, Brazilia, Brazil.
Wi	D.E. Williams, USDA.
Wl	M.J. Williams, USDA, ARS, Brooksville, Fl., U.S.A.
Wm	K.A. Williams, USDA-ARS, Beltsville, MD.
y	amarillo.
Z	O. Zurita, Estacion Exp. Agricola, Saavedra, S. Cruz, Bolivia.
Zi	R.H. Zanini, INTA, Manfredi, Argentina.
Zn	C.N. Zanin, IBONE, Corrientes, Argentina.

Table 13. Germplasm evaluations using the peanut core collection.

Character	Reference
Cylindrocladium black rot	Isleib et at., 1995
Early leaf spot	Isleib et at., 1995
Fatty acid composition	Hammon et at., 1997
Meloidogyne arenaria	Holbrook et al., 2000a,b
Minimum descriptors	Holbrook, 1997
Percent oil	Holbrook et al., 1998
Preharvest aflatoxin contamination	Holbrook et at., 1997
Rhizoctonia limb rot	Franke et al., 1999
Tomato spotted wilt virus	Anderson et al., 1996

Table 14. Valuable origins for disease resistance in the peanut germplasm collection.

Country of origin	Disease resistance
Bolivia	Early and late leaf spot
China	Peanut rootknot nematode
Ecuador	Late leaf spot
India	Tomato spotted wilt Tospovirus, early leaf spot and multiple disease resistances
Israel	Tomato spotted wilt Tospovirus
Japan	Peanut rootknot nematode
Mozambique	Multiple disease resistances
Nigeria	Early leaf spot
Peru	Cylindrocladium black rot
Senegal	Multiple disease resistances
Sudan	Tomato spotted wilt Tospovirus and early leaf spot