Delta and Pine Land Company's Efforts with Transgenic Cotton

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Delta and Pine Land Company was founded in 1911 in the heart of the Mississippi Delta. Its purpose was to provide the British mills with an additional source of cotton fiber. At one time, Delta and Pine Land Company owned and operated the largest cotton plantation in the world. The company occupied about 15,000 hectares of land.

In 1915, the company hired its first cotton plant breeder. Historically, this was one of the first modern, scientific efforts at cotton plant breeding.

Today the company is privately owned by American investors. Delta and Pine Land Company is solely a seed company. Deltapine varieties are grown on about 54% of the cotton acreage in the US. Deltapine 50 is the number one variety in the US. It is grown on more acreage than the total acreage planted to Deltapine's nearest competitor.

In recent years, Deltapine has placed a big emphasis on international markets. Deltapine varieties are being sold, grown and evaluated in more than 24 countries.

Quality control is seen as a key ingredient in the success of Deltapine seeds. The company has an extensive program to insure that only top quality seed is placed in a Deltapine bag.

The program begins when a Deltapine cotton breeder releases a variety to the Foundation Seed Department for increase. The variety is increased on a small acreage and rogued to insure physical and varietal purity. A portion of this original breeder seed increase is placed in cold storage. This seed will be used for future seed increases. This process helps to insure the variety is maintained true to the characteristics for which it was selected.

Cotton seed stocks are often produced under the auspices of various state seed improvement associations in the US. Seed certification regulations are strictly adhered to. These regulations often require one variety farms and gins. This insures the highest possible level of varietal and physical purity.

Deltapine originator seed is generally produced from foundation level seed stocks. Specific lots are assigned to Deltapine seed growers and fields are inspected throughout the growing season. All planting, harvesting, and ginning equipment is inspected and approved before use.

Once the seed is ginned, Deltapine's extensive laboratory testing begins. Seeds are tested for physical purity, temperature, moisture content, free fatty acid content, mechanical damage, standard germination and the Texas Cool Test. Fuzzy seed that meets Deltapine's quality standards are accepted and placed in bulk storage warehouses. Bulk seed in the warehouses are sampled and again tested through the rigorous Quality Assurance Laboratory before being released for delinting.

Delta and Pine Land Company currently owns four acid delinting plants. Deltapine has the capacity to condition more cotton seed for planting than any other company in the world. The delinting and conditioning process is also monitored by quality control personnel. Each finished lot of cottonseed is again subjected to a battery of tests to insure the final product meets or exceeds the Deltapine standards and our customers' expectations.

Deltapine has six cotton breeding programs. Five of these are in the US and one is in Australia. Deltapine plant breeders are involved throughout the world in cotton testing and evaluation. The six main research stations allow plant breeding work to be done in unique, distinct climates. At these various stations Deltapine is breeding for a wide range of environments. Some locations have rain grown cotton and others are one hundred percent irrigated. Deltapine is breeding cottons for different soil types. Deltapine is breeding in relatively low yielding environments and in environments with the highest yields in the world. Deltapine plant breeders are also breeding for resistance to a host of insect and disease pests.

Yield is the main selection criterion. Farmers around the world are paid for the amount of lint or seed cotton they produce. In addition to yield, tremendous importance is placed on breeding for improved fiber characteristics.

Delta and Pine Land Company has its own HVI laboratory. The Deltapine plant breeders send samples of fibers to this lab for analysis. The samples are analyzed and the data sent back to the researcher. This information is used as a selection criterion in the development of new cotton varieties.

The Deltapine HVI lab evaluates between fifty and sixty thousand samples per year.

Deltapine has very close contact with cotton spinning mills and textile people. Many mills in the US contract directly with growers and specify Deltapine varieties. Deltapine is trying to stay current with new spinning technology. The goal is to develop new varieties that will be in demand by the mills.

Several agronomic characteristics are of importance in Deltapine's conventional breeding program. Most of the Deltapine cotton varieties are smooth leaf. This is important in mechanically picked cotton. The smooth leaf characteristic results in higher grades of lint because the leaf trash from smooth leaf varieties does not adhere as much to the lint as much as it does on hairy leafed varieties.

Early maturity is a major consideration in many places where cotton is produced. In many areas, early maturity is necessary to escape plant pests, to reduce the number of irrigations and/or to avoid inclement weather at harvest.

Deltapine's conventional programs are breeding for resistance to several diseases. Deltapine is actively selecting new experimental lines that are resistant to Verticillium wilt. This selection work is going on in several parts of the world. All the Deltapine varieties have some level of tolerance to Verticillium wilt. Deltapine Acala 90 has excellent tolerance. Additionally, Deltapine is breeding varieties that are tolerant to Fusarium wilt and root knot nematodes. Deltapine's plant breeders in Australia are incorporating resistance to bacterial blight (*Xanthomonas campestris*) into current and future Deltapine varieties.

Artificial cross pollination is used to create genetic diversity. A large pool of genetic material is maintained and available to the Deltapine plant breeders.

Delta and Pine Land Company is very involved in biotechnology. Biotechnology can be defined as the introduction of a foreign gene (from a non-related organism) into the genetic material of a crop plant using sophisticated laboratory techniques. Deltapine is collaborating with several major companies that specialize in biotechnology.

Delta and Pine Land Company is working in cooperation with Monsanto on cottons containing the "Bt" gene. Bt is an abbreviation for the delta-endotoxin proteins derived from the common soil microbe *Bacillus thuringiensis* var. *kurstaki*. The genes from this microbe were isolated, modified and inserted into cotton plants by Monsanto.

Plants containing this gene produce small quantities of the endotoxin protein that is highly effective in controlling some lepidopteran caterpillar insects. These proteins initially inhibit insect feeding and subsequently lead to the death of the insect pest.

There are many potential benefits of Bt cotton. Many researchers feel that Bt is the world's safest insecticide. The Bt protein makes up less than 1% of the total plant protein. It is biodegradable and breaks down in exactly the same fashion as any other protein in the environment. Bt is very specific in its toxicity to lepidopteran insects. Bt is non-toxic to humans, animals, fish, avian species, and other insects.

The insect pests targeted for control by the Bt gene are very serious pests of cotton. Included in this group are *Heliothis*, *Heliocoverpa*, and *Pectino-*

phora gossypiella. Commercial cotton production requires extensive use of chemical insecticides to control these pests. It is hoped that Bt cotton will substantially reduce the amount of topically applied chemical insecticides needed in commercial cotton production.

Deltapine has been working with Bt cottons for several years. We are currently backcrossing the gene into varieties that are on the market today. In addition, we are incorporating the gene into potential new varieties. Deltapine has an extensive program working with Bt in cotton. Transgenic material is being grown in the greenhouse, a winter nursery is being utilized to advance the material, and field evaluations are being conducted.

Another area of work with transgenic cotton involves plants resistant to Roundup (Glyphosate). Glyphosate is a broad spectrum, non-selective, post emergence herbicide. It is very effective in controlling many annual and biennial weeds. It is effective against grasses and broadleaf weeds. Glyphosate has the added benefit of being very "environmentally friendly." It has no soil residual and minimal leaching.

The insertion of this gene into Deltapine cottons will allow farmers to spray Roundup over the top of the cotton with no deleterious effect on the cotton crop. Monsanto's goal is to have at least a "3X" safety margin. In other words, three times the highest recommended application rate can be sprayed on the cotton with no reduction in yield.

Roundup resistant cottons are being evaluated in the field this year. Incorporation of the gene for tolerance is proceeding as quickly as possible.

Delta and Pine Land Company is collaborating with DuPont Chemical Company on the incorporation of sulfonylurea (SU) resistance in cotton. There are several SU herbicides on the market in the US and around the world. These are primarily labelled for use on small grains and oil seed crops. Sulfonylureas are a family of chemicals that require very low dosages and are environmentally friendly. Herbicides with this chemistry have some residual activity and can be applied preplant incorporated, preemergence or postemergence.

The gene for SU tolerance has been incorporated into the current commercial Deltapine varieties. This genetic material is being grown in field tests

this year in the US. New cotton varieties could be ready for release within two years.

Many other areas are being investigated through biotechnology. There are possible ways, through biotechnology, to modify fiber characteristics in ways that can not be done through conventional plant breeding. It is possible that the nutritional value of the seed will be improved through biotechnology. Additionally, there are some potential new ways to create hybrid seed through biotechnology. Salt and drought tolerance are two other avenues through which biotechnology may improve cotton production. These and many other areas are being investigated by various companies involved in biotechnology. Deltapine is trying to stay at the forefront of these new technologies.