

The Chemist and the Cottonseed Industry

Condensed from an address to the 59th Annual Meeting of the Tennessee Academy of Science

IN SEPTEMBER the fields of Dixie, stretching from the Carolinas far across Texas, are white with open cotton bolls. For 1949 the crop was 15 million bales. A bale weighs 500 pounds, and for every bale of the cotton fiber there is half a ton of seed left over. What will happen to this 7 million tons of seed?

Cotton growing is at least as old as history. There are references to it in Hindu literature before 1500 B.C. Herodotus wrote of the wool trees of India, as did one of the officers of Alexander the Great. In the middle ages some Europeans who had survived the hazardous round trip to the Orient told, among their other amazing stories, about the Vegetable Lamb which was attached to the ground by a stem. It was said to eat all the plants within reach and yielded a wool-like fleece.

In America the Spanish explorers found a wild cotton in Louisiana and Texas. But the cotton we know was introduced in the sixteenth century to Virginia and Carolina by the Spaniards. For many years it was less profitable to raise than tobacco; hours of hand labor were required to tear the seed from a few pounds of the fiber. Then in 1793 Eli Whitney invented the cotton gin which could do the work of a thousand hands. With cheaper cotton the world suddenly discovered that it was hungry for cloth. Cotton growing spread across the South. Each year saw new land brought under the plow until the kingdom of cotton finally embraced parts of New Mexico and California. This area of the South has exported as much as 10 million bales of cotton in a year to feed the roaring looms of most of the world.

Around the gin houses the cottonseed piled up, two pounds for every pound of cotton. The seed did not burn well, and the local cattle could eat only a small part of the great piles. When dumped into streams, they rotted with a foul odor and poisoned the water so that states passed laws prohibiting such disposal. The cotton country had a forty million-ton by-product on its hands which speedily became an evil smelling nuisance.

The cottonseed, gossypium hirsutum, is about the size of a small peanut. After the long fiber has been ginned off, it is still covered with short fiber growing out of its hard black skin or hull. It looks like a tiny sheep without legs or head. Inside is the egg shaped kernel which is a bit more than half the seed's weight. This kernel is rich, being about one-third oil and one-third protein. Many centuries ago the Orientals pressed the cottonseed for oil to use as medicine, cosmetics, and illuminating fuel. The residue, called press cake, was fed to cattle. Americans followed their lead.

The early history of our oil mill industry is vague. Some say it began when Captain Waring charged cottonseed in his sesame and flaxseed mill in Columbia, South Carolina, in 1801. It is generally agreed that by 1834 a successful cottonseed mill was operating in Natchez. The steady growth of the industry was checked by the Civil War, but by 1870 there were 20 mills and by the turn of the century the number exceeded 300. No longer did the cottonseed build up into obnoxious piles beside the gin house. This waste material has been converted into products worth a third of a billion dollars yearly, primarily because ways were found to make it edible. The oil was made palatable for human food; the protein, fed to cattle, was transmuted into beef. Cattle also find the hulls as satisfying as hay. And from the fuzz or linters, by-product of a by-product, come scores of materials from gun cotton to movie film.

The chemist was not responsible for the beginning of the cottonseed industry. It got off to a good start without him. But he hopped on the caboose and worked his way up to the throttle. Since then it has been full speed ahead so that today, while there is a chronic surplus of cotton, there is never enough cottonseed.

The crushing of cottonseed is essentially a simple process and, until recently, has not changed basically from a century ago. Most of the cotton crop is picked and ginned in the three fall months. This means that in about 90 days the mill receives its entire spring's supply of raw material. Because the seed are perishable and subject to spontaneous heating, they must be stored carefully. This is done in specially designed houses and tanks holding several thousand tons and equipped so that air can be drawn through the seed to cool them. Thermometers are inserted throughout the pile so that the first rise of temperature can be detected.

After the seed is cleaned, most of the lint is removed in
That in turn produced the mayonnaise industry. The most out-
hulls; cake or meal; and crude oil.
hot oil flows down the sides of the presses and into the settling
tanks. This is the crude oil which is ready for the refinery.
The slabs, cakes, are removed from the presses and ground
into meal. The oil mill has four products: linters of two kinds;
hulls; cake or meal; and crude oil.
First cut linters go into mattresses and upholstery. Cattle
eat the hulls and meal without any further treatment. It was
in the utilization first of the oil and later of the second cut lint
that the chemists did their work.
In 1879 the industry consisted of 45 crude mills and four
refineries when the N. K. Fairbanks Company hired W. B.
Albright, the first cottonseed chemist. At that time all proc-
esses were inefficient and wasteful. The dark crude oil was
refined by men who relied on taste and smell to determine how
much caustic, heat, and stirring to use. The refined oil was
mixed with hard animal fat and was sold as "lard-eon~pound."
Judged by today's standards it was a low quality product.
By 1900 Albright and the pioneering chemists who followed
him, Boyce, Wesson, and Eckstein, had made cottonseed oil a
more palatable product. Dr. Wesson perfected steam and vac-
uum deodorization and gave us the modern bland salad oil.
Hydrogenation was applied to edible oil, especially cottonseed
oil. The oil is heated and, in the presence of nickel as a cat-
alyst, hydrogen is bubbled through it. The "unsaturated" oil
molecules take on atoms of hydrogen. This raises the melting
point so that the oil becomes a fat. Hydrogenation plus im-
provements in refining, bleaching, and deodorization produced
an essential part of the American diet as salad oil, shortening,
and margarine. The nineteenth century "compound" was looked
down upon as a poor and cheap substitute for lard. In contrast
the present day all-vegetable shortening ranks supreme in the
housewife's esteem. The technologists can now produce custom-
made shortenings to meet the widely varying qualities required
for cake, bread, and cracker making and for deep frying of
doughnuts and potato chips.
In the early days of cottonseed milling only enough lint
was removed to facilitate the separation of the meats from the
hulls. The short fuzz of the second cut linters had a limited
use in cheap mattresses and in such things as horse-collar stuff-
ing and shotgun shell wadding. Then came World War I with
the tremendous artillery and rifle fire of trench warfare. Cord-
ite and smokeless powder are made from guncotton, and gun-
cotton is best made from second cut lint. Cottonseed supplied
much of the power of destruction which was expended on the
Western Front.
At the end of the war there were stocks of linters in all
stages of chemical processing up to the finished smokeless pow-
der. As the country beat its swords into plowshares, the chem-
ists converted guncotton into automobile lacquer and linters
into rayon, cellophane, photographic film, and plastics. A new
important industry developed based on the cellulose in second
cut lint.
In World War II cottonseed again played its role by sup-
plying the raw material for most of the smokeless powder
required. The transparent noses and machine gun blisters on
our B-17's and B-29's were formed from cellulose plastic. Cot-
toseed hulls were found to be an excellent source of furfural,
an ingredient of synthetic rubber which Pearl Harbor suddenly
made essential.

It was in 1909 that the few chemists who then worked in
the cottonseed industry met together and formed the Society
of Cotton Products Analysts. They cooperated to develop pro-
cedures of analysis for the seed and its products so that guess-
work was eliminated and manufacturing efficiency could be
improved. Their standardized analytical methods made it pos-
sible for the industry to buy and sell millions of dollars worth
of products with the settlement price determined by chemical
analysis.
This small group of analysts has grown to be the American
Oil Chemists' Society with a membership of about 2,000 rep-
resenting most of the countries of the world. It is the pre-

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