Oilseeds

Cottonseed: the “golden goose”

Producing fibre, food and feed, cottonseed is a versatile crop and demand for its oil has boomed since New York banned trans fats from restaurants in 2006. Charlotte Niemiec looks at its strengths and weaknesses in a health-conscious world.

The history of the cotton plant – a member of the mallow family – is long and varied. Before the crop was realised as a source of oil, cotton was used primarily in the manufacture of fabrics for clothes and home furnishings. Between the 17th and mid-19th centuries, cotton production expanded but, aside from the minority of seeds that were replanted, no use could be found for the remaining seeds, which were piled up in heaps.

The mid-19th century saw the first US entrepreneurs attempt to extract oil from the seeds, as demand for oils and fats rose in Europe while supply fell drastically during the Industrial Revolution. Cottonseed put up a fight; the seed hull was extremely difficult to crush, and most of these ventures failed.

In 1857, William Fee invented a huller, which separated the tough hulls from the meats of cottonseed. The oil was used for lamps, and later – illegally – used to fortify animal fats and lards. By 1859, the petroleum industry emerged and cottonseed oil was sidelined once again.

It was Procter & Gamble (P&G) that changed the fortune of cottonseed oil (CSO). It chose CSO to replace expensive animal fats in food production. It found an edible use for it and, through patented technology, it was able to hydrogenate it and develop a substance that closely resembled lard. After an aggressive marketing campaign, the vegetable brand shortening, Crisco, went on to be a huge success in the USA, and a product of this name is still used today. By the 1950s, however, demand for palm oil surged and CSO was temporarily ousted.

Then, when New York City announced in 2006 that it would ban trans fats from restaurants (see OFI Vol 24, No 8, November 2008, p29), the cottonseed market in the USA boomed.

A healthier oil alternative

The National Cottonseed Products Association (NCPA) – established since 1898 – is an organisation of firms and individuals in the USA engaged in the processing of cottonseed and the marketing of cottonseed and cottonseed products. These include oil mills, refiners, product dealers and product brokers. It states that CSO is one of the few oils considered acceptable for reducing saturated fat intake, as it is among the most unsaturated oils.

Other oils in this category include safflower, corn, soybean, canola and sunflower oils. CSO has a 2:1 ratio of polyunsaturated to saturated fatty acids. Its fatty acid profile generally consists of 70% unsaturated fatty acids, including 18% monounsaturated (oleic) and 52% polyunsaturated (linoleic) and 26% saturated (primarily palmitic and stearic). It is rich in tocopherols, which are natural antioxidants with varying degrees of vitamin E activity, which contribute to the oil’s stability and give products that contain it a longer shelf life.

The oil has a mild, nutty taste, according to the NCPA. It is generally clear, with a light golden colour but, like most oils, the degree of colour depends on the amount of refining.

It is used primarily in salad oil, mayonnaise, sauces and marinades. When used as a cooking oil, it is ideal for frying in both commercial and domestic cooking. As a basis for shortening or margarine, it is used for baked goods and cake icings.

Global production and world market

According to Lynn A Jones and Jarrod H Kersey of the NCPA, cottonseed oil was the second most commonly produced oilseed in the world in the 1993/94 to 1997/98 period, averaging one-fourth that of soybeans in the same period, just slightly ahead of rapeseed/canola. World cottonseed production averaged about 33M tonnes/year in this decade. Cottonseed oil falls to about fifth or sixth in world production of oils, however, due to the relatively low amount of oil in the seed (about 18%) and to the great amount of cottonseed which is fed unprocessed to cattle, especially dairy cattle.

Two species of cotton are currently grown commercially in the USA: Gossypium barbadense, or Pima cotton. Upland cotton dominates US cultivation, and characterised 96.6% of all production in 2008. More than a third of this is grown in the state of Texas, as the crop thrives in climates with a long, sunny growing season and prefers well-drained, loose soils.

According to Commodity Online, recent global cottonseed output has been estimated at around 35M tonnes. It ranks third in volume behind soybean and corn oil, respectively, representing about five to six percent of the USA’s domestic fat and oil supply.

The world’s major producers of CSO are Brazil, China, India, Pakistan and the USA; major exporters are Australia, Mexico and the USA; and major importers are Europe and Japan.

The NCPA states that demand for healthier oils “has greatly impacted the cotton processing industry. For the first time in more than 10 years, more cottonseed will be crushed for oil than will be fed as whole cottonseed to dairy cattle.”

Historically, more cottonseed has gone into the dairy market, as cows are able to consume cottonseed without being affected by the toxin gossypol. But today, the most lucrative market for cottonseed processors is CSO, with prices reaching 80-
OILSEEDS

Oilseed prices have recently settled at 50-60c/lb, more than double the five-year average. Prices have recently settled at 50-60c/lb, more than double the five-year average. The NCPA states that, despite an anticipated 28% reduction in cotton production this year, cottonseed crush will remain relatively stable. This year’s estimated 4.71M tonnes of cottonseed has combined with ballooning stocks to set the stage for a crush of 2.7M tonnes, compared to last year’s slightly higher 2.76M tonnes.

Nevertheless, Bloomberg reported on 10 July that Oil World warned that cottonseed production may drop to a three-year low on smaller plantings. The report states that global cottonseed output may be 4.3M tonnes, or 600,000 tonnes less than estimated in June, and 2.9M tonnes lower than the previous season. Cotton futures, it claims, are down 37% from a year ago, and lower prices are encouraging farmers in North and South America, Africa and Asia to cut plantings in favour of other crops. In the USA, acreage has fallen 14%.

Oil World adds: “Smaller supplies are expected to enforce a … [limit of] world cottonseed crushings in the vicinity of 2.5M tonnes in October-September 2012-13. This will reduce production in cottonseed oil and meal correspondingly, aggravating the supply shortage stemming from the likely decline of global soyabean crushings anticipated for the remainder of 2012.”

The production of CSO is limited by the supply of cottonseed, which is primarily planted for fibre production. Cottonseed is under heavy competition from other crops such as corn and soyabeans, which have been replacing cotton acreage in recent years in response to higher demand for biofuel production.

Nevertheless, the industry is increasingly viewing CSO as less of a by-product of cotton fibre production, and more of a viable revenue stream in its own right.

According to the Central Institute for Cotton Research (CICR), based in Nagpur, India, cotton is one of the most important crops and single largest source of fibre in India. It plays a dominant role in the country’s agrarian and industrial economy as the backbone of the textile industry, which consumes 70% of the country’s total fibre production, accounts for 38% of the country’s export and fetches over Rs.42,000 crores (US$71.3M) a year to the exchequer.

However, cotton is not just used in the textile industry. The CICR states that the plant produces more food for man and feed for animals than fibre and, as such, has earned the title of the ‘Golden Goose’. It produces linters, kernels and hulls used in various consumer products; human food and animal feed; and, of course, oil (see Figure 1, below).

The toxic paradox

As more and more focus is placed on sustainable crops, cottonseed has one significant drawback that prevents its meal being fed to the majority of animals. It contains a toxin called gossypol, which is toxic to all non-ruminant animals. According to the CICR, the gossypol content is greater in the raw material than in cooked cottonseed.

Gossypol is the most important pigment present in cottonseed and presents enormous problems with seed processing and utilisation of cottonseed as a byproduct. It is located all over the plant and gives an undesirable colour to the oil.

Scientists have made several unsuccessful attempts to remove gossypol from cottonseed, which would enable its meal to be fed to animals and therefore increase its sustainability and universal use. Those in the biotech industry have also attempted to grow gossypol-free varieties, as there are considerable variations in gossypol content within the same species.

In the 1970s, studies of gossypol in China revealed it was effective as a male contraceptive in tablet form, and was subsequently used as such for over a decade.

However, disturbing effects began to appear in the men who had been taking the tablets. They began to suffer from hypokalemia – low blood potassium levels – which caused symptoms of fatigue, muscle weakness and, at its most extreme, paralysis. In 1998, the World Health Organization (WHO)’s Research Group of Methods for the Regulation of Male Fertility recommended the research be abandoned.

A May Inform article, written by Catherine Watkins and titled ‘The saga of ultra-low-gossypol cottonseed’, suggests that scientists may not be far away from creating low gossypol level cottonseed.

Tom Wedegaertner, of Cotton Incorporated, based in North Carolina, USA suggests the industry is as far as 10 years away from planting a million acres (more than 400,000ha) of ultra-low-gossypol cotton.

When low-gossypol cotton was trialled in the 1970s, the problem was soon made clear: the presence of gossypol kept away insects and pests; low-gossypol cottonseed became plagued.

Now, says Watkins, researchers at Texas A&M University have used RNAi technology to bioengineer cotton lines that exhibit ultra-low gossypol content in the seeds and normal levels elsewhere, bringing hope that the problem will soon be solved. Until then, cottonseed meal is not a viable feedstock for animals except cows.

Another problem, and one highlighted by environmentalists, is that cotton is primarily grown for its fibre, not for feed use. Because of this, states the Agriculture Society, ‘Cottonseed oil is absolutely loaded with pesticides and other harmful chemicals … to ensure the mass production of crops to keep up with demand.’

Before cottonseed meal can be used as a feedstock, the levels of pesticides used would need to be addressed.

Potential biofuel feedstock

The use of cottonseed as a feedstock for biofuels has been evaluated by many, including the CICR, which concluded that approximately 148.3M gallons (674.1M litres) of biodiesel could be produced from half the amount of cottonseed produced in 2003 (6.556M tonnes).

Cynthia F Murphy, who contributed her report on ‘Cottonseed Oil Biodiesel’ to the University of Texas’ ‘Analysis of Innovative Feedstock Sources and Production Technologies for Renewable Fuels’, assessed the potential of cottonseed as a biofuel feedstock.

Murphy considers it ‘likely problematic’, and concludes: “Growing cottonseed for fuel production is also land intensive. If all available land in the southern USA (approximately two-thirds of the total) was converted to growing cotton, less than 20% of the current demand for petroleum motor diesel could be met by cottonseed biodiesel. In addition, the amount of lint created by meeting cottonseed demand for biodiesel demand could unbalance the commercial cotton market.”

The production of biofuel from cottonseed does not, therefore, seem viable at the current time.

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### Table 1: Cottonseed Oil Production by Country in 000 Tonnes

<table>
<thead>
<tr>
<th>Country</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1,541</td>
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<tr>
<td>India</td>
<td>1,253</td>
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<tr>
<td>Pakistan</td>
<td>610</td>
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<tr>
<td>Brazil</td>
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<tr>
<td>USA</td>
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<td>Uzbekistan</td>
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<td>Turkey</td>
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<td>Australia</td>
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<tr>
<td>Tanzania</td>
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Source: Indexmundi.com

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![Figure 1: Cottonseed Products Yield/Ton of Seed Crushed](source: CICR (www.cicr.org.in))