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Chinese Tallow Trees a Potential Bioenergy Crop for Louisiana

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Chinese tallow trees (Photo by Gary A. Breitenbeck)

Newly matured seed is bright, white and waxy because of an outer coating of saturated fats. For centuries this wax has been used for making candles and soap. (Photo by Gary A. Breitenbeck)

The Chinese tallow tree is a familiar sight growing in yards and along fence rows throughout Louisiana, though some may not recognize this name. In southern Louisiana, it is commonly called "chicken" or "chicken-foot" tree, presumably because its seeds hang in clusters that offer some resemblance to a chicken's foot. Other common names include popcorn tree, candleberry tree, white wax berry and Florida aspen. In Cajun French, it's called boire, possibly because of its preference for wet soils. The U.S. Department of Agriculture prefers the scientific name *Triadica sebifera*, though an earlier classification, *Sapium sebiferum*, remains in frequent use.

"Sebifera" and "sebiferum" mean "wax-bearing" and refer to the thick layer of vegetable tallow that coats the seeds. Because of the prolific production of these vegetable-oil-bearing seeds, the tallow tree promises to become the second or third most productive source of vegetable oil for biodiesel, after oil palm and possibly algae. This tree can be grown on marginal land and therefore would not compete with food production for limited cropland. Currently, naturalized stands of the tallow tree occupy tens of thousands of acres throughout Loui siana. Converting these lands to commercial production of the tallow tree as a feedstock for biodiesel production offers many potential benefits.

Perhaps the greatest deterrent to commercialization of the tallow tree lies in its potential for invasiveness. The tallow tree has both strong supporters and detractors, and discussion of its possible use as a bioenergy crop can quickly lead to heated debate. For the past decade and more, it has been fashionable to vilify the tallow tree in both the popular and scientific literature with uncommon intensity. Supporters of the tallow tree argue this beautiful and useful tree has not received a fair hearing. While they admit some environmental concerns are valid, they contend that others are exaggerated and some are complete nonsense.

Without question, the tallow tree can rapidly colonize poorly managed pastures, fence rows, clear-cut forests and other areas that offer adequate sunlight. The principal natural habitat at risk appears to be coastal prairies in Texas and southwestern Louisiana, though these areas face a more formidable enemy in rising sea levels. Because of its short stature and limited tolerance of shade, the tallow tree is less able to dominate in established woodlands where it generally remains a secondary tree in the understory. Claims that the tallow tree is allelopathic – that is, it exudes

chemicals that inhibit growth of other plant species – appear to be without foundation.

While the occasional landowner becomes enraged when these trees rapidly take over idle land, many homeowners value their beautiful tallow trees, and some cattle producers view them as a source of quick shade for their animals. The animals do not graze the leaves and immature fruit in the summer because they contain a mildly toxic latex. When the sap descends in autumn, this toxicity apparently disappears, and seed are foraged by many animals. A host of songbirds rely on this seed during winter months. The tallow tree is an excellent honey plant that results in a good quality honey with a slight tang prized by some and discounted by others. Rumors persist that beekeepers have played a principal role in spreading the tallow tree in eastern Texas and western Louisiana As a source of vegetable oil for the production of high-quality biodiesel, the tallow tree has few peers.

Biodiesel, an alternative for petroleum diesel, is derived from natural fats and oils. This alternative fuel can be used directly in tractors, pumps and other equipment with diesel engines. Biodiesel often is produced in large refineries, but its production is sufficiently simple and safe to allow on-farm production using commercially available processors. Farmers are well-aware that in the past few years the price of diesel has risen more rapidly than that of gasoline, and this increase is a major contributor to rising crop production and food costs. In 2006, Louisiana farmers used 57.1 million gallons of diesel. Nationwide, 3.62 billion gallons were used to produce our crops. The principal limitation for on-farm production of biodiesel lies in the availability of suitable fat and oil feedstocks.

In many respects, the tallow tree offers the ideal energy crop for biodiesel production along the gulf coast. It thrives in wet areas that cannot be farmed profitably with conventional crops. It has few insect pests and diseases and is tolerant of salt, prolonged flooding and occasional freezing temperatures. It has low nutrient and other management requirements. These characteristics as well as the tallow tree’s exceptional ability to produce high-quality vegetable oil underscore its commercial potential as a low-input, high-return biodiesel crop for Louisiana.

Cultivation of the tallow tree is not new. It has been grown in China for at least 1,500 years, partly for its vegetable wax used for soap and candles and partly for coloring silk with a black dye produced by boiling its leaves in alum. In 1772, Benjamin Franklin sent a few seeds to Dr. Noble Wimberly Jones of the Georgia colony with the brief comment, "Tis a most useful plant." Since Franklin’s time, the tallow tree has been repeatedly introduced as an ornamental, an oil crop for making soap and lighting oil, and for erosion control along stream banks. At one time the tallow tree was widely distributed commercially as a landscape plant for yards and along highways because of its brilliant fall foliage and the novel appearance of its blooms and seeds. It is now naturalized along the Eastern Seaboard from North Carolina to Florida and extends west into eastern Texas and northwestern Arkansas. Because of its invasive nature, commercial distribution is now discouraged, though planting remains legal in most

During the summer the seed develops within a three-lobed fruit capsule, which turns brown in the fall. (Photo by Gary A. Breitenbeck)

The size of the oval-shaped seeds varies among trees. The waxy outer layer coats a hard, woody endocarp protecting the actual seed. (Photo by Gary A. Breitenbeck)

Wax recovered from the outer layer of tallow seed is used not only in soap and candles but also for cooking and cosmetics. (Photo by Gary A. Breitenbeck)

Southern states.

Tallow seeds contain 45-60 percent vegetable oil, about two to three times the amount found in an equivalent weight of soybeans. Commercial plantations in other countries typically contain about 160 trees per acre, trimmed low for hand harvesting. Yields average 12,500 pounds of seeds per acre containing 2,300 pounds of stillingia oil, 2,500 pounds of wax, 1,400 pounds of protein concentrate, 982 pounds of fibrous coat and 4,000 pounds of shell (endocarp). Per acre, these oil yields are 15 times more than soybeans, 10 times more than sunflower or safflower, seven times more than peanuts and five times more than rape seed. Annual commercial production averages about 645 gallons – the equivalent of 15.4 barrels of oil per acre. Some experts cite figures as high as 970 gallons or 23.1 barrels of oil per acre. The light-colored, brittle wood of the tallow tree appears to have limited value as lumber or even firewood, though extracts of bark, leaves and seed are used in traditional and modern Chinese medicine.

Conversion to biodiesel (transesterification) results in a liquid fuel. (Photo by Gary A. Breitenbeck)

Naturalized trees currently exist in a wild state where both seed yields and oil composition vary greatly among trees due to both genetic and environmental factors. Varieites with superior characteristics for bioenergy production are not yet available. Researchers in the LSU AgCenter seek to bring this aggressive tree into useful cultivation while minimizing potential adverse impacts on endangered ecosystems. Research is under way to address several areas critical to successful commercialization of the tallow tree as a bioenergy crop:

1. Selection from that naturalized population of elite trees capable of high yields of vegetable oil with superior characteristics for biodiesel production.
2. Development of tissue culture and conventional propagation techniques to provide commercial quantities of superior trees.
3. Development of management practices, including optimal spacing, pruning and fertilization.
4. Development of practical methods of mechanical harvesting, storage and processing of seed.

In dense stands, most tallow tees produce few seeds because of competition for light, water and nutrients. Occasionally, a tree growing within these stands produces a heavy seed crop, suggesting genetics is a key factor influencing yield. (Photo by Gary A. Breitenbeck)

In the event that invasiveness remains a critical issue, AgCenter researchers also are exploring the introduction of "termination technology," a genetic technique patented by the USDA to prevent seed germination.

Although hand harvesting is used in China and other countries where the tallow tree is cultivated, a practical method of mechanical harvesting is essential to commercial development in the United States. The size of the trees and its uneven maturity are two challenges to successful mechanical harvesting. In naturalized stands, maturity occurs over several weeks. By completion, the earliest seed has fallen or begun to decay on the tree. Attempts to thresh immature fruit rapidly results in clogged equipment. Fortunately, when young branches are cut from the tree and allowed to dry on the ground, the fruit uniformly matures within a few days. The AgCenter is exploring a promising technique that involves using a boom-mounted sickle bar to prune branches of ripening fruit from trees growing in rows. Fruit is allowed to mature on pruned branches, and then the seed is harvested with a combine modified to accommodate the wax-covered seed, which is slightly larger than soybean seed.

The invasive potential of the tallow tree merits serious consideration. So does the opportunity to restore economic prosperity to many of the most impoverished areas of Louisiana by converting many thousands of acres of marginal land currently colonized by the tallow tree to a highly profitable, low-input bioenergy crop. Because of the ability of the tallow tree to flourish on marginal land, it can be produced without adversely affecting our ability to produce food. This perennial oilseed crop does not require routine cultivation of the soil and therefore also can serve to prevent soil erosion and reduce pollution of surface waters while sequestering atmospheric carbon dioxide in its biomass. Harvesting the fruit before it is fully materu can serve to reduce rather than enhance its spread by birds and other means from areas heavily colonized with the tallow tree.

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