9.3.1 Cotton Harvesting

9.3.1.1 General

Wherever it is grown in the U. S., cotton is defoliated or desiccated prior to harvest. Defoliants are used on the taller varieties of cotton that are machine picked for lint and seed cotton, and desiccants usually are used on short, stormproof cotton varieties of lower yield that are harvested by mechanical stripper equipment. More than 99 percent of the national cotton area is harvested mechanically. The 2 principal harvest methods are machine picking, with 70 percent of the harvest from 61 percent of the area, and machine stripping, with 29 percent of the harvest from 39 percent of the area. Picking is practiced throughout the cotton regions of the U. S., and stripping is limited chiefly to the dry plains of Texas and Oklahoma.

Defoliation may be defined as the process by which leaves are abscised from the plant. The process may be initiated by drought stress, low temperatures, or disease, or it may be chemically induced by topically applied defoliant agents or by overfertilization. The process helps lodged plants to return to an erect position, removes the leaves that can clog the spindles of the picking machine and stain the fiber, accelerates the opening of mature bolls, and reduces boll rots. Desiccation by chemicals is the drying or rapid killing of the leaf blades and petioles, with the leaves remaining in a withered state on the plant. Harvest-aid chemicals are applied to cotton as water-based spray, either by aircraft or by a ground machine.

Mechanical cotton pickers, as the name implies, pick locks of seed cotton from open cotton bolls and leave the empty burs and unopened bolls on the plant. Requiring only 1 operator, typical modern pickers are self-propelled and can simultaneously harvest 2 rows of cotton at a speed of 1.1 to 1.6 meters per second (m/s) (2.5 - 3.6 miles per hour [mph]). When the picker basket gets filled with seed cotton, the machine is driven to a cotton trailer at the edge of the field. As the basket is hydraulically raised and tilted, the top swings open allowing the cotton to fall into the trailer. When the trailer is full, it is pulled from the field, usually by pickup truck, and taken to a cotton gin.

Mechanical cotton strippers remove open and unopened bolls, along with burs, leaves, and stems from cotton plants, leaving only bare branches. Tractor-mounted, tractor-pulled, or self-propelled strippers require only 1 operator. They harvest from 1 to 4 rows of cotton at speeds of 1.8 to 2.7 m/s (4.0 - 6.0 mph). After the cotton is stripped, it enters a conveying system that carries it from the stripping unit to an elevator. Most conveyers utilize either augers or a series of rotating spike-toothed cylinders to move the cotton, accomplishing some cleaning by moving the cotton over perforated, slotted, or wire mesh screen. Dry plant material (burs, stems, and leaves) is crushed and dropped through openings to the ground. Blown air is sometimes used to assist cleaning.

9.3.1.2 Emissions And Controls

Emission factors for the drifting of major chemicals applied to cotton were compiled from literature and reported in Reference 1. In addition, drift losses from arsenic acid spraying were developed by field testing. Two off-target collection stations, with 6 air samplers each, were located downwind from the ground spraying operations. The measured concentration was applied to an infinite line source atmosphere diffusion model (in reverse) to calculate the drift emission rate. This was in turn used for the final emission factor calculation. The emissions occur from July to October, preceding by 2 weeks the period of harvest in each cotton producing region. The drift emission factor for arsenic acid is 8 times lower than previously estimated, since Reference 1 used a ground rig rather than an airplane, and because of the low volatility of arsenic acid. Various methods of controlling drop size, proper timing of application, and modification of equipment are practices that can reduce drift hazards. Fluid additives have been used that increase the viscosity of the spray formulation, and thus decrease the number of fine droplets (<100 micrometers [μm]). Spray nozzle design and orientation also control the droplet size spectrum. Drift emission factors for the defoliation or desiccation of cotton are listed in Table 9.3.1-1. Factors are expressed in units of grams per kilogram (g/kg) and pounds per ton (lb/ton).

Table 9.3.1-1 (Metric And English Units). EMISSION FACTORS FOR DEFOLIATION OR DESICCATION OF COTTON[a]

EMISSION FACTOR RATING: C

Pollutant	Emission Factor[b]	
	g/kg	lb/ton
Sodium chlorate	10.0	20.0
DEF®[c]	10.0	20.0
Arsenic acid	6.1	12.2
Paraquat	10.0	20.0

[a] Reference 1.
[b] Factor is in terms of quantity of drift per quantity applied.
[c] Pesticide trade name.

Three unit operations are involved in mechanical harvesting of cotton: harvesting, trailer loading (basket dumping), and transport of trailers in the field. Emissions from these operations are in the form of solid particulates. Particulate emissions (<7 μm mean aerodynamic diameter) from these operations were developed in Reference 2. The particulates are composed mainly of raw cotton dust and solid dust, which contains free silica. Minor emissions include small quantities of pesticide, defoliant, and desiccant residues that are present in the emitted particulates. Dust concentrations from harvesting were measured by following each harvesting machine through the field at a constant distance directly downwind from the machine while staying in the visible plume centerline. The procedure for trailer loading was the same, but since the trailer is stationary while being loaded, it was necessary only to stand a fixed distance directly downwind from the trailer while the plume or puff passed over. Readings were taken upwind of all field activity to get background concentrations. Particulate emission factors for the principal types of cotton harvesting operations in the U. S. are shown in Table 9.3.1-2. The factors are based on average machine speed of 1.34 m/s (3.0 mph) for pickers, and 2.25 m/s (5.03 mph) for strippers, on a basket capacity of 109 kg (240 lb), on a trailer capacity of 6 baskets, on a lint cotton yield of 63.0 megagrams per square kilometer (Mg/km^2) (1.17 bales/acre) for pickers and 41.2 Mg/km^2 (0.77 bale/acre) for strippers, and on a transport speed of 4.47 m/s (10.0 mph). Factors are expressed in units of kg/km^2 and pounds per square mile (lb/mi^2). Analysis of particulate samples showed average free silica content of 7.9 percent for mechanical cotton picking and 2.3 percent for mechanical cotton stripping. Estimated maximum percentages for pesticides, defoliants, and desiccants from harvesting are also noted in Table 9.3.1-2. No current cotton harvesting equipment or practices provide for control of emissions. In fact,

Table 9.3.1-2 (Metric And English Units). PARTICULATE EMISSION FACTORS[a]
FOR COTTON HARVESTING OPERATIONS

EMISSION FACTOR RATING: C

Type of Harvester	Harvesting		Trailer Loading		Transport		Total	
	kg/km^2	lb/mi^2	kg/km^2	lb/mi^2	kg/km^2	lb/mi^2	kg/km^2	lb/mi^2
Picker[b]								
Two-row, with basket	0.46	2.6	0.070	0.40	0.43	2.5	0.96	5.4
Stripper[c]								
Two-row, pulled trailer	7.4	42	NA	NA	0.28	1.6	7.7	44
Two-row, with basket	2.3	13	0.092	0.52	0.28	1.6	2.7	15
Four-row, with basket	2.3	13	0.092	0.52	0.28	1.6	2.7	15
Weighted average[d]	4.3	24	0.056	0.32	0.28	1.6	4.6	26

[a] Emission factors are from Reference 2 for particulate of <7 µm mean aerodynamic diameter. NA = not applicable.
[b] Free silica content is 7.9% maximum content of pesticides and defoliants is 0.02%.
[c] Free silica content is 2.3%; maximum content of pesticides and desiccants is 0.2%.
[d] The weighted average stripping factors are based on estimates that 2% of all strippers are 4-row models with baskets and, of the remainder, 40% are 2-row models pulling trailers and 60% are 2-row models with mounted baskets.

equipment design and operating practices tend to maximize emissions. Preharvest treatment (defoliation and desiccation) and harvest practices are timed to minimize moisture and trash content, so they also tend to maximize emissions. Soil dust emissions from field transport can be reduced by lowering vehicle speed.

References For Section 9.3.1

1. J. A. Peters and T. R. Blackwood, *Source Assessment: Defoliation Of Cotton—State Of The Art*, EPA-600/2-77-107g, U. S. Environmental Protection Agency, Cincinnati, OH, July 1977.

2. J. W. Snyder and T. R. Blackwood, *Source Assessment: Mechanical Harvesting Of Cotton—State Of The Art*, EPA-600/2-77-107d, U. S. Environmental Protection Agency, Cincinnati, OH, July 1977.