

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.1 PRODUCTION

Endosulfan was first introduced into the United States in 1954 by Farbwerke Hoechst A.G. under the registered trademark, "Thiodan[®]" (Maier-Bode 1968). The main method of production involves the reaction of hexachlorocyclopentadiene and cis-butene-1,4-diol, which forms a bicyclic diol, followed by esterification and cyclization with thionyl chloride (SOCl₂) (O'Neil et al. 2006). Pure endosulfan is found as two different conformations, α and β . Technical-grade endosulfan, which must contain 94% endosulfan according to the specifications of the Food and Agricultural Organization of the United Nations (FAO), consists mainly of the α - and β -isomers in approximately a 7:3 ratio (Müller et al. 2009; FAO 2011a). One degradation or reaction product, endosulfan sulfate, has chemical properties similar to the pure substance and is formed from biotransformation, or oxidation of endosulfan. In the environment, both isomers of endosulfan can be metabolized to endosulfan sulfate by a variety of organisms (EPA 2010a).

As of 2012, there are only four active registrants producing endosulfan products in the United States. These include Makhteshim Chemical Works, Ltd. (Raleigh, North Carolina), Drexel Chemical Company (Memphis, Tennessee), KMG-Bernuth, Inc. (Houston, Texas), and Makhteshim-Agan of North America Inc. (Raleigh, North Carolina). Makhteshim Chemical Works produces technical-grade endosulfan (95%). Drexel Chemical Company produces technical-grade endosulfan (95%), and two emulsifiable concentrates containing 24.6 and 34% endosulfan. KMG-Bernuth produces an emulsifiable concentrate containing 30% endosulfan. Makhteshim-Agan produces two emulsifiable concentrates containing 50 and 33.7% endosulfan (NPIRS 2012). There are several non-U.S. producers of endosulfan (Meister et al. 2011). These producers must register their products with EPA in order to legally import endosulfan products into the United States (EPA 2012a). As a result of a voluntary cancellation and phase-out program, commercial availability of these products in the United States will become completely unavailable by July 31, 2016 (EPA 2012e).

In addition to technical and emulsifiable concentrates available in the United States, the FAO recognizes three other forms of commercial endosulfan that may be available internationally. A dustable powder is a homogeneous mixture of endosulfan and other additives that is fine, free-flowing powder. A wettable powder is a homogeneous mixture that is a fine powder. A miscible oil consists of technical endosulfan, other formulants, and no more than 5% water (FAO 2011a). Like the United States, endosulfan was earmarked for cancellation on a global scale beginning in 2012, after its incorporation into the Stockholm

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Convention on Persistent and Organic Pollutants in 2011 (FAO 2011b). Its use in countries adopting this provision is likely to diminish and end completely over the next few years. Continued use of endosulfan products will likely continue in countries that have not adopted this provision.

Few details are available on endosulfan's production volume in the United States. According to the EPA's Reregistration Eligibility Decision (RED) for Endosulfan (EPA 2002), total annual use was estimated at approximately 1.38 million pounds based on survey usage data between 1990 and 1999. The most recent data (2006–2008) indicate total usage in the area of 380,000 pounds annually (EPA 2010a). This is consistent with the general trend of declining use of endosulfan in the United States. These data give a rough estimate of the magnitude of endosulfan production. Since it has been scheduled for cancellation and phase-out, production and usage is expected to decline further.

No information is available in the TRI database on facilities that manufacture or process endosulfan because this chemical is not required to be reported under Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) (EPA 1998c).

5.2 IMPORT/EXPORT

Import and export data for endosulfan were not readily available. EPA regulates and monitors all importing and exporting activities for endosulfan according to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). All importers and exporters of endosulfan products must be registered (EPA 2012a). As of March 2012, there are only four active registrants producing endosulfan products (NPIRS 2012). It is not clear whether these registrants are active importers, exporters, or domestic producers. Although domestic use of endosulfan will end in 2016, FIFRA regulations allow for U.S. producers to export unregistered pesticides (EPA 2012a).

In addition to regulation under FIFRA, endosulfan has been added to the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, which the United States is in the process of ratifying (EPA 2012a; FAO 2011b). PIC Convention requirements may require adjustments to the current import and export procedures under FIFRA (EPA 2012a).

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5.3 USE

From 2002 to 2012, endosulfan was registered in the United States for restricted (non-residential) use as broad spectrum contact insecticide and acaricide for use on a wide variety of fruits, vegetables, grains, etc. grown for commercial purposes. It is particularly effective against such pests as aphids, fruit worms, beetles, leafhoppers, moth larvae, and whiteflies (EPA 2002, 2010a). The restricted use classification requires that registered products may only be applied by a “certified pesticide applicator” or under the direct supervision of a certified pesticide applicator (EPA 2012b). It is mostly applied as a foliar spray using aircraft or ground equipment, with single application rates ranging from 0.5 to 2.5 pounds of active ingredient per acre (lbs a.i./A) and minimum re-application intervals ranging from 5 to 15 days. Maximum total seasonal or yearly application rates range from 0.5 to 4.0 lbs a.i./A (EPA 2010a).

Beginning July 31, 2012, a voluntary cancellation and phase-out of endosulfan began and is scheduled to end by July 31, 2016. The phase-out will be executed in six phases over this 4-year period. During these phases, use of endosulfan on certain types of crops and products are scheduled to end (EPA 2012a). A detailed schedule of the last use dates for certain crops is included in Table 5-1. The restricted use classification will be maintained throughout the phase-out period.

Historical use trends of endosulfan indicate that its use was declining before the cancellation process was initiated. According to the EPA’s RED for Endosulfan (EPA 2002), total annual use was estimated at approximately 1.38 million pounds based on survey usage data between 1990 and 1999 (EPA 2010a). The most prevalent estimated crop uses of endosulfan during this period are summarized in Table 5-2. Approximately 20% of agricultural use consisted of application to cotton crops (USGS 2012a). According to the U.S. Geological Survey (USGS) 2012a pesticide use map for endosulfan, use of endosulfan during the period between 1999 and 2004 was concentrated (≥ 0.26 lbs per square mile) in the regions of central California, central Washington, southern Idaho, southern Arizona, northeastern Texas, northwestern North Dakota, southeastern Michigan, central Kentucky, northern Tennessee, western New York, southern Pennsylvania, southern New Jersey, eastern North Carolina, southern Georgia, and southern Florida. The most recent data (2006–2008) indicate national usage in the area of 380,000 lbs. a.i. annually (EPA 2010a).

California Department of Pesticide Regulation (CDPR) reported that the state-level use of endosulfan from 2001 to 2010 followed the national trend. In 2001, 153,479 pounds of endosulfan were used over 177,030 acres in the state of California. By 2010, that amount decreased to 35,877 pounds applied to

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Table 5-1. Endosulfan Crop Uses and Last Use Dates

Group	Date use ends	Crops being phased out
A	July 31, 2012	Almond, apricot, broccoli, Brussels sprouts, carrots, cauliflower, celery (non-Arizona), citrus (non-bearing), collard greens, dry beans, dry peas, eggplant, filbert, kale, kohlrabi, mustard greens, nectarine (California only), macadamia, plum, prune, poplars grown for pulp and timber, strawberry (annual), sweet potato, tart cherry, turnip, walnut, ornamental trees, shrubs, herbaceous plants Other uses on product labels not listed above or in Group B, C, D, E, or F
B	July 31, 2012	Cabbage, celery (Arizona only), cotton, cucumbers, lettuce, stone fruits not listed in group a, including nectarine (non-California), peaches, sweet cherry, summer melons (cantaloupe, honeydew, watermelon), summer squash, tobacco
C	July 31, 2013	Pear
D	December 31, 2014	All Florida uses of apple, blueberry, peppers, potatoes, pumpkins, sweet corn, tomato, winter squash
E	July 31, 2015	Apple, blueberry, peppers, potatoes, pumpkins, sweet corn, tomato, winter squash
F	July 31, 2016	Livestock ear tags, pineapple, strawberry (perennial/biennial), vegetable crops for seed (alfalfa, broccoli, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, collard greens, kale, kohlrabi, mustard greens, radish, rutabaga, turnip)

Source: EPA 2012e

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Table 5-2. 2002 Estimated Annual Agricultural Use of Endosulfan^a

Crops	Total pounds applied	Percent national use
Cotton	160,060	20.32
Tomatoes	88,607	11.25
Potatoes	87,452	11.10
Apples	62,973	7.99
Tobacco	58,016	7.36
Pears	43,730	5.55
Cucumbers and pickles	34,370	4.36
Lettuce	33,267	4.22
Green beans	28,923	3.67
Squash	28,632	3.63

^aRepresents estimated use over the 5-year period between 1999 and 2004.

Source: USGS 2012a

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46,513 acres (CDPR 2011). The use data of endosulfan in California from 2001 to 2010 are summarized in Figure 5-1.

Global use of endosulfan is also expected to decline since it has been marked for cancellation after its incorporation into the Stockholm Convention on Persistent and Organic Pollutants in 2011 (FAO 2011b). Its use in countries adopting this provision is likely to diminish and end completely over the next few years. Use of endosulfan products will likely continue in countries that have not adopted this provision.

5.4 DISPOSAL

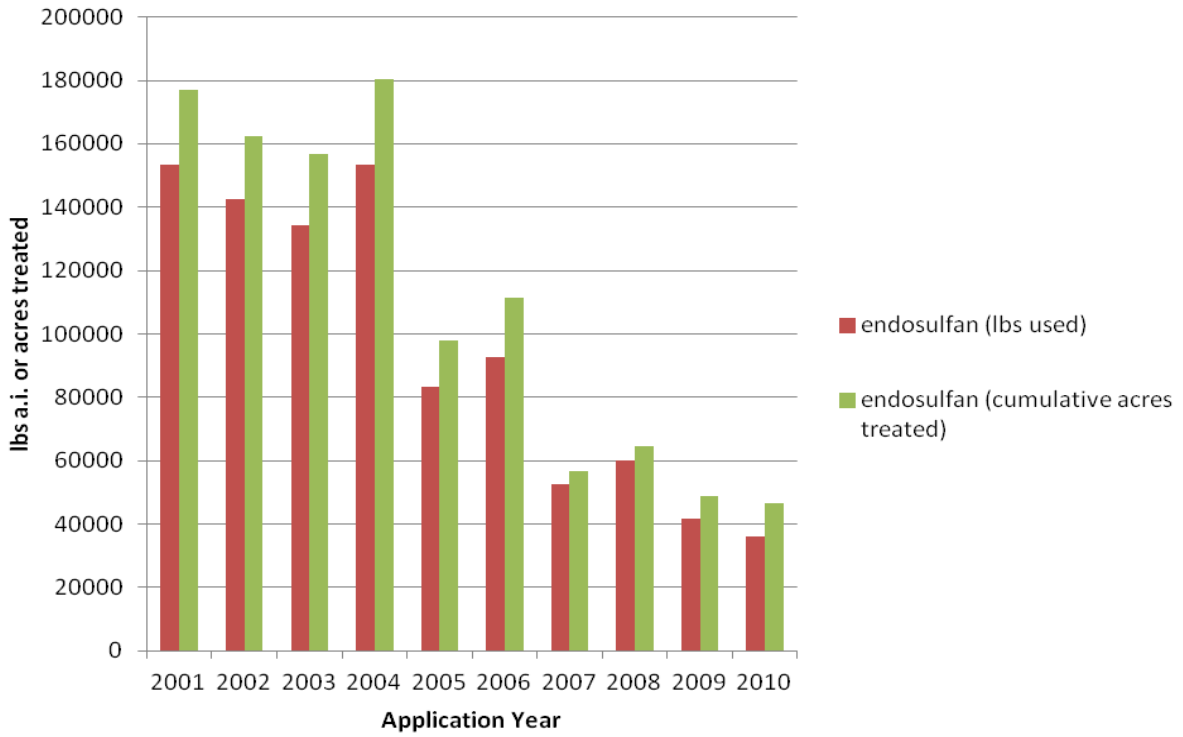
Endosulfan is listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA), which means that improper disposal of endosulfan products is a violation of federal law (EPA 2001). Disposal of wastes containing endosulfan is controlled by a number of federal regulations (see Chapter 8).

Since endosulfan cannot be used for residential purposes, disposal of this chemical via household hazardous waste programs is not allowed and these programs often prohibit farmers from participating. As a result, many states have enacted Clean Sweep programs, which allow for the safe collection and disposal of pesticide waste from farms, including those that are no longer registered. These programs are often managed by state agencies, but may be funded by various means such as pesticide registration fees, fee-based funds, state funds, EPA grants, participant fees, county funds, in-kind services, and other grants. Several states have permanently funded programs, while others have offered programs for various lengths of time. Most states have held at least one single collection event. Figure 5-2 illustrates which states offer Clean Sweep programs and level of availability (EPA 2001).

Hazardous wastes, such as endosulfan, are disposed of in high-temperature hazardous waste incinerators or in authorized hazardous waste landfills. In some states, unopened, registered products may be re-used through product exchanges, redistribution tables, and recycling centers (EPA 2001). All registered pesticide products must have storage and disposal instructions included on their label, which must include instructions on how to store, dispose of leftovers, clean an empty container, and dispose of an empty container (EPA 2012c).

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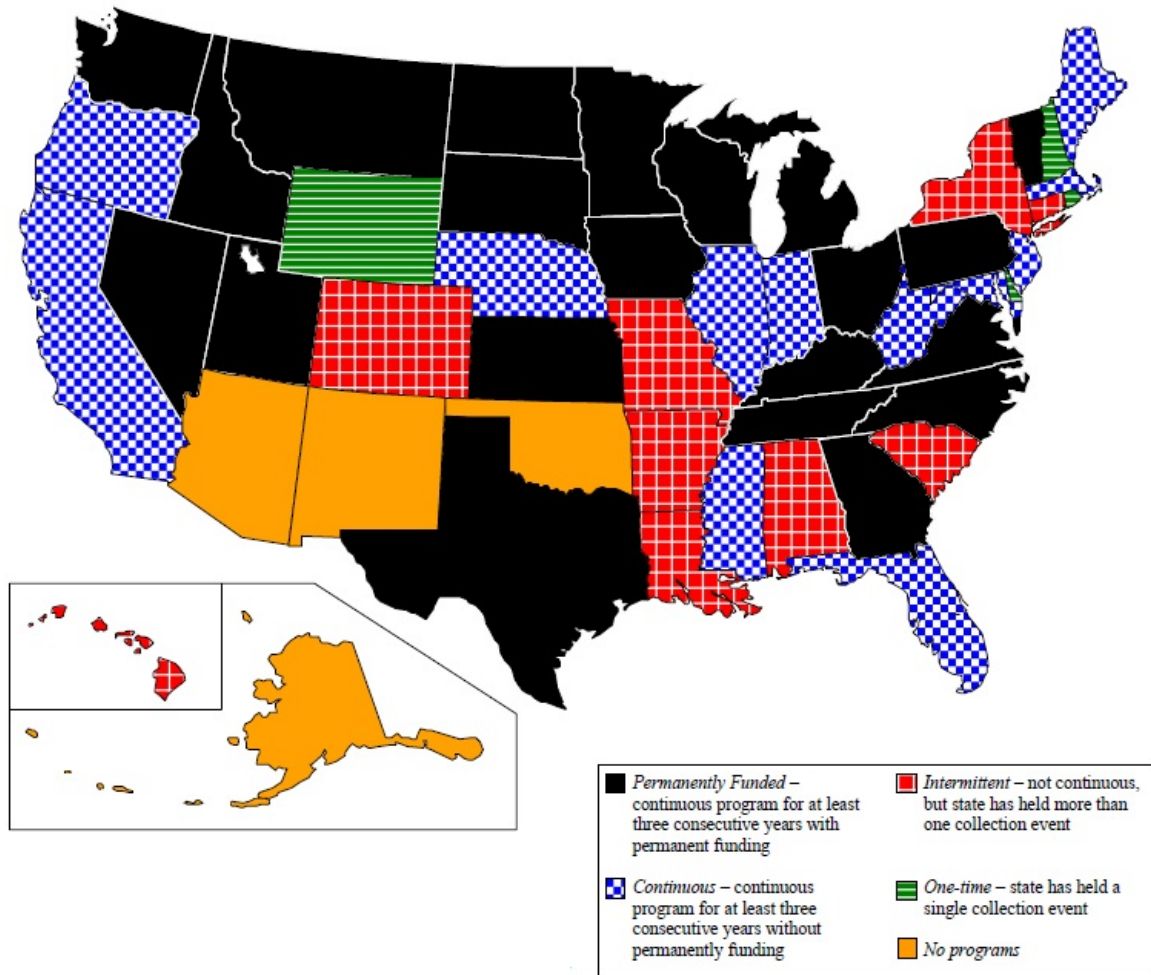
Figure 5-1. Endosulfan Use in California



Source: CDPR 2011

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Figure 5-2. State Clean Sweep Programs by Category



Source: EPA 2001