### Sources of Exposure

#### General Populations
- The diet is the main source of exposure for the general population.
- Breathing contaminated air or ingesting contaminated water are also potential routes of exposure.
- Exposure also can occur by touching contaminated soil or plants or fruits that have been sprayed with endosulfan.
- Living in proximity to sites where endosulfan was produced or where it was disposed of.

#### Occupational Populations
- Exposure of workers can occur during the manufacture of endosulfan.
- Pesticide applicators can be exposed by inhalation or skin contact if they do not wear proper protection.
- Farm workers may experience latent exposure in fields that were previously sprayed (occupational re-entry).
- The use of endosulfan is being restricted to certain crops and is scheduled to be canceled for all uses by 2016.

### Toxicokinetics and Normal Human Levels

#### Toxicokinetics
- There is indirect evidence that humans absorb endosulfan by the inhalation and/or dermal routes, but there is conclusive of gastrointestinal absorption; the extent of absorption is not known.
- In humans, endosulfan appears to accumulate in the liver, kidney, and brain, at least in the short term.
- In animals, endosulfan is transformed predominantly to polar and nonpolar metabolites by liver microsomal enzymes.
- Endosulfan and metabolites have been detected in the urine of humans after ingestion of the chemical.
- In animals, endosulfan and metabolites are excreted mainly in the feces within a few days or weeks.

#### Normal Human Levels
- No data are available.

### Biomarkers/Environmental Levels

#### Biomarkers
- The primary biomarkers for endosulfan exposure include tissue and excreta concentrations of endosulfan and its metabolite endosulfan sulfate.

#### Environmental Levels

**Air**
- From 3.3 to 8.3 pg/m³ in remote Arctic air. From 18 to 82 pg/m³ in rural areas, with spikes during growing seasons.

**Sediment and Soil**
- A national monitoring program reported that sediment samples obtained between 2005 and 2009 contained levels of endosulfan from 0.08 to 12.59 ng/g dry weight. The percent detection was 5.3%.

**Water**
- Endosulfan has low rates of detection in groundwater.

### Reference

### Chemical and Physical Information

**Endosulfan is a solid**
- Endosulfan is a cream-to-brown colored solid that may appear crystalline or in flakes. It is sold as a mixture of α- and β-endosulfan (called isomers).
- Endosulfan is a restricted-use pesticide that is applied to crops by aerial or ground-level foliar spray.
- It is particularly effective against aphids, fruit worms, beetles, leafhoppers, moth larvae, and white flies on a wide variety of crops.

### Routes of Exposure

- **Inhalation** – Significant potential route of exposure for pesticide applicators and crop pickers, particularly if the former do not use protective gear.
- **Oral** – Predominant route of exposure for general population through ingestion of contaminated food.
- **Dermal** – Important route of exposure for pesticide applicators and crop pickers.

### Endosulfan in the Environment
- Endosulfan can travel long distances by air. Levels in air depend on location; they are usually higher in rural areas.
- Endosulfan can be broken down in air by chemical reactions. Endosulfan sulfate may be broken down by sunlight.
- In water, endosulfan changes to a less toxic chemical, endosulfan diol. Endosulfan sulfate is more resistant to break down in water.
- In soil, endosulfan attaches to soil particles, which limits its movement towards groundwater.
- Endosulfan breaks down in soil; endosulfan sulfate is more resistant.
- It can build up in animals living in contaminated water.

### Relevance to Public Health (Health Effects)

**Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.**

#### Minimal Risk Levels (MRLs)

**Inhalation**
- No acute-, intermediate- or chronic duration inhalation MRLs were derived for endosulfan.

**Oral**
- An MRL of 0.007 mg/kg/day has been derived for acute-duration oral exposure (≤14 days).
- An MRL of 0.005 mg/kg/day has been derived for intermediate-duration oral exposure (15–364 days).
- The intermediate-duration oral MRL was adopted for chronic-duration oral MRL (≥365 days).

### Health Effects
- The main target of endosulfan toxicity is the nervous system.
- Exposure to high amounts of endosulfan induces hyperactivity and convulsions, regardless of the route of exposure. Severe poisoning may result in death.
- Studies in animals have shown that swallowing endosulfan in contaminated food for long periods of time affects mainly the kidneys.
- There is no conclusive evidence that endosulfan can cause cancer or any other disease in humans. Endosulfan did not cause cancer in animal studies.
- The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified endosulfan as to its ability to cause cancer.

### Children’s Health
- Children exposed to high amounts of endosulfan have shown the same neurological effects seen in poisoned adults.
- Endosulfan has been detected in human breast milk; therefore, it can be transferred to babies by nursing.
- Exposure of pregnant animals resulted in abnormalities in the skeleton and organs from the offspring. This often occurred with doses that were also toxic to the mothers.