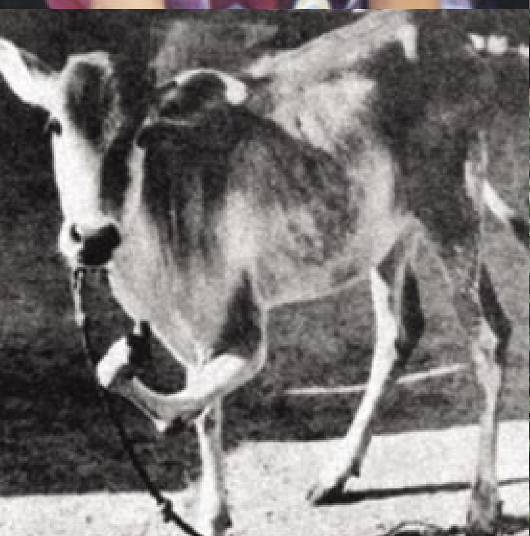
END OF THE ROAD FOR ENDOSULFAN

Pushing for a global ban on a deadly pesticide







ENVIRONMENTAL JUSTICE FOUNDATION

Protecting People and Planet

END OF THE ROAD FOR ENDOSULFAN

Protecting People and Planet

1 Amwell Street, London EC1R 1UL
Tel 44 (0) 207 239 3310 Fax 44 (0) 207 713 6501
info@ejfoundation.org www.ejfoundation.org

The Environmental Justice Foundation is a UK-based NGO working internationally on environmental security and human rights. UK charity registered in England and Wales (1088128).

PDF versions of this report can be found at www.ejfoundation.org/reports.

Comments on the report, requests for further copies or specific queries about EJF should be directed to info@ejfoundation.org.

This document should be cited as: EJF(2009) End of the Road for Endosulfan: pushing for a global ban on a deadly pesticide. Environmental Justice Foundation, London, UK.

ISBN No. 1-904523-18-8

This report was researched, written and produced by the Environmental Justice Foundation.

Layout and cover design by Guilherme Altmayer.

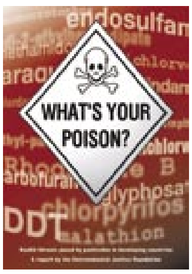
Printed on 100% post- consumer recycled paper using vegetable-based inks.

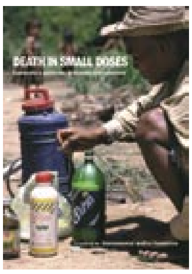
EJF would like to thank the following people and their organisations for the invaluable time and assistance with information, ideas and visual materials used in this report:

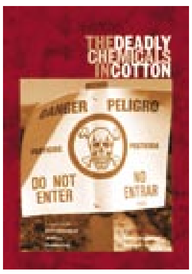
Bananalink, CEDAC, Damien Sanfilippo (PAN – UK), Davo Vodouhe, Elliott Cannell (PAN –UK), Eloise Touni (PAN – UK), Fernando Bejarano (CAATA), IPEN, Jayakumar C (Thanal), Karl Tupper (PANNA), Lars-Otto Reiersen (AMAP), Linda Craig (PAN – UK), Meriel Watts (PANAP), Shree Padre.

In thanking these individuals, we in no way imply that they or their organisations endorse the report's content.

Related EJF Publications (available online at www.ejfoundation.org)

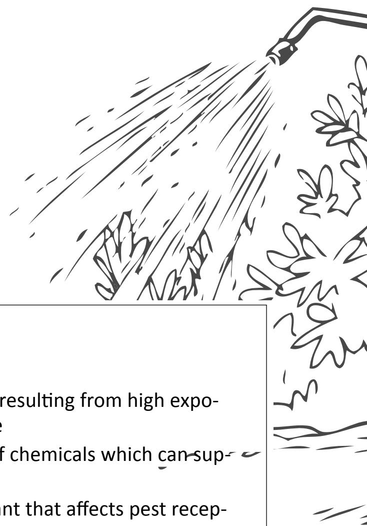






CONTENTS

Executive Summary	3
Introduction	4
Production and use	5
The danger to human health	6
Kerala: A modern-day tragedy leads to a ban	11
Endosulfan and the environment	12
Alternatives to endosulfan	15
End of the road for endosulfan?	20
Conclusions	21
Recommendations	22



GLOSSARY

Acute poisoning: the harmful health effects resulting from high exposure to a toxicant over a short period of time

Allelopathy: the production by plant roots of chemicals which can suppress weed growth

Antifeedant: a natural deterrent within a plant that affects pest receptors, discouraging them from feeding on that particular plant

Bioaccumulation: a process whereby an organism absorbs a substance faster than it is excreted, resulting in the organism having a higher concentration than the surrounding environment

Biomagnification: the process whereby the amount of a substance found in organisms progressively increases up the food chain

Chronic poisoning: the harmful health effects as a result of low-level exposure to a toxicant over a prolonged period

Cognitive: the internal mental processes of thought such as visual processing, memory, problem solving and language

Congenital deformities: the deformities that develop during the stages of foetal growth

Eco-toxic: the capability of being severely harmful to the environment

Endocrine system: the system of organs within the body that controls hormones. It is instrumental in regulating metabolism, growth, development and puberty, and issue function, as well as influencing mood

Genotoxic: the capability of causing damage to a cell's DNA

Haematological: something relating to blood, the blood-forming organs, and blood diseases

Haemotoxin: an agent capable of damaging red blood cells, disrupting blood clotting, organ degeneration and generalized tissue damage

Larvaticide: an insecticide that is specifically targeted against the larval life stage of an insect

Mutagenic: the capability of changing a cell's DNA, increasing the frequency of mutationonMany mutagens cause cancer

Neurotoxin: an agent capable of disrupting the normal functioning of the nervous system

Teratogenic effects: disfiguring birth defects or malformations

EXECUTIVE SUMMARY

©Carlos Latuff

- Endosulfan is a highly toxic chemical, poisonous to most living organisms. The United States Environmental Protection Agency classifies it as 'highly hazardous'.
- Endosulfan is readily absorbed by humans via the stomach, lungs and through the skin. It can cause endocrine disruption in both terrestrial and aquatic species. Endosulfan is a neurotoxin (damages the nervous system), haematoxin (damages blood) and nephrotoxin (damages kidneys). Laboratory studies have also shown that there are potential carcinogenic (cancer-causing) effects.
- Endosulfan has been linked to congenital physical disorders, mental disabilities and deaths in farm workers and communities across the globe. Symptoms of poisoning include headaches, dizziness, nausea, vomiting, mental confusion, convulsions, hyperactivity, seizures, coma and respiratory depression, in severe cases resulting in death.
- Endosulfan is a 'persistent organic pollutant' or 'POP', as defined under the Stockholm Convention: it persists in the environment, is bioaccumulative (can be concentrated in an organism faster than it can be lost), and demonstrates long range environmental transport from its original source (endosulfan has been detected in the Arctic and Himalayas), affecting remote human and wildlife populations.
- To date, 62 countries have banned the use of endosulfan within their borders as a result of human health and environmental concerns. A proposal to include endosulfan under the Stockholm Convention is also under consideration. If such a listing occurs, it will, in effect, lead to a global ban on endosulfan's production and use. Currently, the Indian Government, itself a major producer of endosulfan, vigorously opposes any international ban, stymieing efforts by other nations to safeguard human health and environmental protection.
- Until such time, voluntary actions have been undertaken by farmers to find economically viable, environmentally sustainable alternatives, including organic production methods.
- This report summarises the compelling evidence of the considerable threats that endosulfan poses to human health and environmental security. In light of the evidence presented, a number of recommendations are made to key decision-makers, with the ultimate aim of securing a global ban on this deadly chemical pesticide.

ACRONYMS

CIB	Central Insecticides Board (India)
CSE	Centre for Science and Environment, New Delhi
EPA	(United States) Environmental Protection Agency
FIPPAT	Fredrick Institute of Plant Protection and Toxicology
FPA	Fertilizer and Pesticides Authority (India)
IARC	International Agency for Research on Cancer
ICMR	Indian Council of Medical Research
IPM	Integrated Pest Management
NHRC	National Human Rights Commission (India)
NIOH	National Institute of Occupational Health
PAN	Pesticide Action Network
PCK	Plantation Corporation of Kerala
PMFAI	Pesticide Manufacturers & Formulators Association of India
WHO	World Health Organization
POPs	Persistent Organic Pollutants

A small price to pay for environmental justice

£5 / $6 per month could help kids get out of the cotton fields, end pirate fishing, protect farmers from deadly pesticide exposure, guarantee a place for climate refugees

This report has been researched, written and published by the Environmental Justice Foundation (EJF), a UK Registered charity working internationally to protect the natural environment and human rights.

Our campaigns include action to resolve abuses and create ethical practice and environmental sustainability in cotton production, shrimp farming & aquaculture. We work to stop the devastating impacts of pirate fishing operators, prevent the use of unnecessary and dangerous pesticides and to secure vital international support for climate refugees.

EJF have provided training to grassroots groups in Cambodia, Vietnam, Guatemala, Indonesia and Brazil to help them stop the exploitation of their natural environment. Through our work EJF has learnt that even a small amount of training can make a massive difference to the capacity and attitudes of local campaigners and thus the effectiveness of their campaigns for change.

If you have found this free report valuable we ask you to make a donation to support our work. For less than the price of a cup of coffee you can make a real difference helping us to continue our work investigating, documenting and peacefully exposing environmental injustices and developing real solutions to the problems.

It's simple to make your donation today:

www.ejfoundation.org/donate

and we and our partners around the world will be very grateful.

ENVIRONMENTAL JUSTICE FOUNDATION

Protecting People and Planet

INTRODUCTION

IT IS ESTIMATED THAT MORE THAN 5 BILLION LBS OF PESTICIDES ARE USED GLOBALLY EACH YEAR, WITH A TRADE VALUE OF AROUND US$32 BILLION[3].

Pesticides are hazardous by design; they are manufactured with the sole aim of killing, repelling or inhibiting the growth of specific organisms[4]. Yet accidental pesticide poisonings claim 20,000 human lives each year[4], while another 3 million people are non-fatally poisoned and nearly 750,000 new people experience chronic health problems from exposure each year[5].

Endosulfan is one of the world's most dangerous chemical pesticides, causing immediate and severe health impacts. It is listed by the World Health Organisation (WHO) as Class II- *moderately hazardous* but other authorities believe this underestimates its hazardous potential. It is very toxic to humans when inhaled or ingested, and harmful when it comes into contact with skin[6,7,8,9]. A 2007 United States Environmental Protection Agency (US EPA) assessment concluded that it cannot be used safely in the majority of scenarios for which it is currently approved, and classifies endosulfan as Category 1b - *highly hazardous*[10]. Meanwhile, the Intergovernmental Forum on Chemical Safety (IFCS) reported that it poses significant health problems for developing countries and economies in transition[11].

Endosulfan is regarded as one of the main causes of these poisonings in many countries[12]. Children and infants are disproportionately affected, as are farmers and communities in developing nations. Overall, developing countries use 25% of the world's pesticides, yet they experience 99% of the deaths[13]. Investigators have found that agricultural workers are not being adequately protected from pesticides, and that animals and non-handlers are coming into contact with the dangerous chemicals applied to crops.

Furthermore, endosulfan belongs to a group of chemicals termed 'persistent organic pollutants' (POPs), which are characterised by their high toxicity, long range transportation and persistence in the environment for long periods. POP chemicals also bioaccumulate; they store easily within fatty tissues and biomagnify by building up in food chains. The chemical has been found in remote regions including the Arctic, Antarctic, Alps and Himalayas and traces have been detected in the tissues of animals worldwide, including polar bears, antelope, crocodiles, Minke whales and African vultures. It is also a widespread contaminant of human breast milk[14]. These critical aspects of long-term environmental pollution, together with health concerns, have led to endosulfan being banned from use in 62 countries – from the EU to Saudi Arabia and Mali to Cambodia. The European Union has proposed a global ban, currently under consideration, under the Stockholm Convention on POPs.

This report considers the overwhelming evidence that the dangers associated with endosulfan use outweigh its benefits. It presents the results of numerous scientific studies showing the severe adverse effects endosulfan has on humans and the environment, and the arguments for viable alternatives. Altogether, there is a compelling case for a global ban on endosulfan under the Stockholm convention and, in the interim, for national governments and other stakeholders to take immediate action to eradicate this deadly pesticide.

ENDOSULFAN IS AN ORGANOCHLORINE PESTICIDE USED TO CONTROL A VARIETY OF INSECTS AND MITES ON A VERY WIDE RANGE OF CROPS[1] INCLUDING SOY, RICE, WHEAT, VEGETABLES, FRUITS, NUTS, COFFEE, TOBACCO AND COTTON. ENDOSULFAN IS APPLIED TO COTTON IN 9 OF THE TOP 10 COTTON PRODUCING COUNTRIES AND IS THE DOMINANT PESTICIDE IN THE COTTON SECTOR IN 19 COUNTRIES[2]. IT IS ONE OF THE MOST WIDELY USED PESTICIDES: APPROXIMATELY 338,000 TONNES WERE USED GLOBALLY IN 2005[9].

PRODUCTION AND USE

Endosulfan has been available for over 5 decades, but is now out of patent and today there are many generic forms available on the market, mainly produced in India, China and Israel. India is the fourth largest producer of pesticides in the world and the world's largest producer and user of endosulfan[15,16] with more than 60 manufacturers and formulators. According to the Indian Chemical Council (ICC), India's top three manufacturers produced 9,500 tonnes of endosulfan between 2007 and 2008, and 5,500 tonnes were used domestically[17]. The value of India's cumulative endosulfan exports in that period totalled 7,421.16 Rs Lacs (equivalent to US$151,598,737 – August 2009 conversion)[18]. Hindustan Insecticides Ltd, one of the largest producers of endosulfan with a production capacity of 1600 tonnes per annum, is a government-owned company with both domestic and international markets for endosulfan. It is not therefore surprising that the Government of India fiercely opposes endosulfan's inclusion in the Stockholm Convention[19].

THE MAJOR PRODUCERS OF ENDOSULFAN

Major Producers	Country
Excel Industries Ltd, Hindustan Insecticides Ltd, Coromandal Fertilizers Ltd, EID Parry	India
Asiachem Chemical, Jiangsu Anpon Electrochemical	China
Makhteshim Agan Industries	Israel

BAYER CROPSCIENCE

Bayer CropScience, a German company, used to be one of the largest manufacturers of endosulfan, continuing to produce endosulfan despite a European ban on its use. However, in response to mounting health concerns, Bayer CropScience ceased production of the active ingredient endosulfan at the beginning of 2007. Its sale of endosulfan will cease in all countries in which it's still registered by the end of 2010.

LEFT: Hindustan Insecticides Limited, a major producer of endosulfan, is a Government of India enterprise

All © EJF

TRADE NAMES

Agrisulfán, Afidan, Aikido, Akodan, Alodan, Axis, Benzoepin, Beosit, BIO 5462, Bromyx, Caiiman, Callistar, Callisulfan, Chlorbicyclen, Chlorthiepin, Crisulfan, Cyclodan, Cytophos, Devisulfan, Endocel, Endofan, Endoflo, Endomight Super, Endopol, Endosan, Endosol, Endosulfan 35 EC, Endo 35 EC, Endotaf, Endoxilan, Enrofán, Ensure, ENT 23979, FAN 35, Farmoz, Flavylan 350E, FMC 5462, Galgofon, Galgptal, Global E, Golden Leaf Tobacco Spray, Hexasulfan, Hildan, HOE 2671, Insectophene, Isolan, Kop-thiodan, Lucasulfan, Malix, Misulfan, NIA 5462, Niagara 5462, Novasulfan, Palmarol, Parrysulfan, Phaser, Rasayansulfan, Red Sun, Rocky, Sharsulfan, Sialan, Sonii, Sulfan, Thifor, Thimul, Thiodan, Thiofanex, Thiofor, Thioflo, Thiomet, Thiomul, Thionate, Thionex, Thiosulfan, Thiosulfax, Thiokil, Thiotox, Tionel, Tionex, Tiovel, Tridane, Termizol pó, Veldosulfan, Vulcán, Zebra Ciagro.

THE DANGER TO HUMAN HEALTH

Endosulfan is acutely toxic and is readily absorbed by the stomach and lungs, and through the skin. Symptoms of acute poisoning include headaches, dizziness, nausea, vomiting, mental confusion, convulsions, hyperactivity, seizures, coma and respiratory depression, in severe cases resulting in death. Whilst acute symptoms occur in close relation to a single exposure to a high dose of a chemical, chronic poisoning symptoms occur after repeated exposure to low levels of agents over a long time period.

EXPOSURE TO ENDOSULFAN[20]

DIETARY EXPOSURE

- Ingesting food that has been sprayed with endosulfan
- Drinking water from contaminated ground or surface stores

OCCUPATIONAL EXPOSURE

- Skin exposure or inhalation during pesticide mixing, loading and/or applying a pesticide or re-entering treated sites

ACCIDENTAL EXPOSURE

- Skin exposure or inhalation due to proximity to endosulfan use

Human exposure to endosulfan is a global problem. Occupational exposure is unavoidable for those who use it, and is exacerbated by poor practice standards and inadequate protective clothing and equipment for handlers and workers. For many farmers in developing countries, the cost of protective wear can be prohibitive or they may simply have no access to it, and workers tend to spray barefoot or in sandals, with no breathing apparatus.

One study found that 100% (n=220) of endosulfan sprayers in Spain[21] had residues in their blood , and in 2007 the US EPA stated that even with the maximum recommended protective equipment, mixers, loaders and handlers of endosulfan are at short to intermediate-term risk[22]. Workers may be further at risk because they are unable to read instructions and warnings on pesticide containers, either because of illiteracy or due to labelling in a language other than their own.

Accidental exposure is very commonplace; there are countless reports of non-handlers and animals being in the fields at the time of spraying[23,24]. EJF investigators in India and Mali have observed insecticides being sprayed as close as 2 metres from children working in cotton fields, directly exposing young girls and boys to inhalation, ingestion and skin absorption of these deadly chemicals. Previous investigations in Cambodia – prior to a national ban on endosulfan's use – revealed similar situations, especially on family-owned plots close to homes where infants and young children were present[25].

Many individuals are also unwittingly exposed far from application sites due to endosulfan's long range transportation capabilities. In 2006, a survey of homes in Paris found that 79% had endosulfan residues in the air, and 20% of the people sampled were found to have traces on their hands[26,27]. Endosulfan has also been detected in human breast milk and placental samples in Egypt, Madagascar, South Africa, El Salvador, Kazakhstan, India, Indonesia, Pakistan, Spain, Colombia, Nicaragua, Sub-Saharan Africa, Denmark and Finland[36].

Many workers directly handle endosulfan with no protective clothing ©EJF

RIGHT: 99% of grapes sampled from European supermarkets in a 2008 survey contained pesticides, including endosulfan

©Hanspeter Klasse

FROM THE SOURCE TO OUR TABLES

Ingestion is another major source of exposure; traces of endosulfan have been detected in a great number of supermarket goods including vegetables, seafood, spices, and even wine corks[28] and infant formula[29]. The US Food and Drug Administration have detected it in more than 700 of the 5,000 commonly consumed food products in the USA[30], and it has been detected in European fruit and vegetables.

A 2008 Europe-wide supermarket survey revealed high levels of pesticides in table grapes, where 99% of grapes sampled contained pesticides, and on average 7 pesticides were detected per sample. Italian-grown grapes bought from one major food retailer in France were found to contain endosulfan, even though its use has been illegal in Europe since 2007[31].

In 2008, trace analysis of cherry tomatoes for sale in New Zealand revealed endosulfan residues in both domestically-grown tomatoes and those imported from Australia[32]. Similarly, New Zealand government food residue testing in 2008 found residues in lettuce, strawberries and courgettes[33]. This follows the 2005 South Korean ban on New Zealand-exported beef because of endosulfan contamination, which cost the industry $30 million. More traces of endosulfan were found in a 26kg carton of beef exported in 2008[34]. Since these episodes, the government of New Zealand has banned endosulfan, with no further use permitted after January 16th 2009.

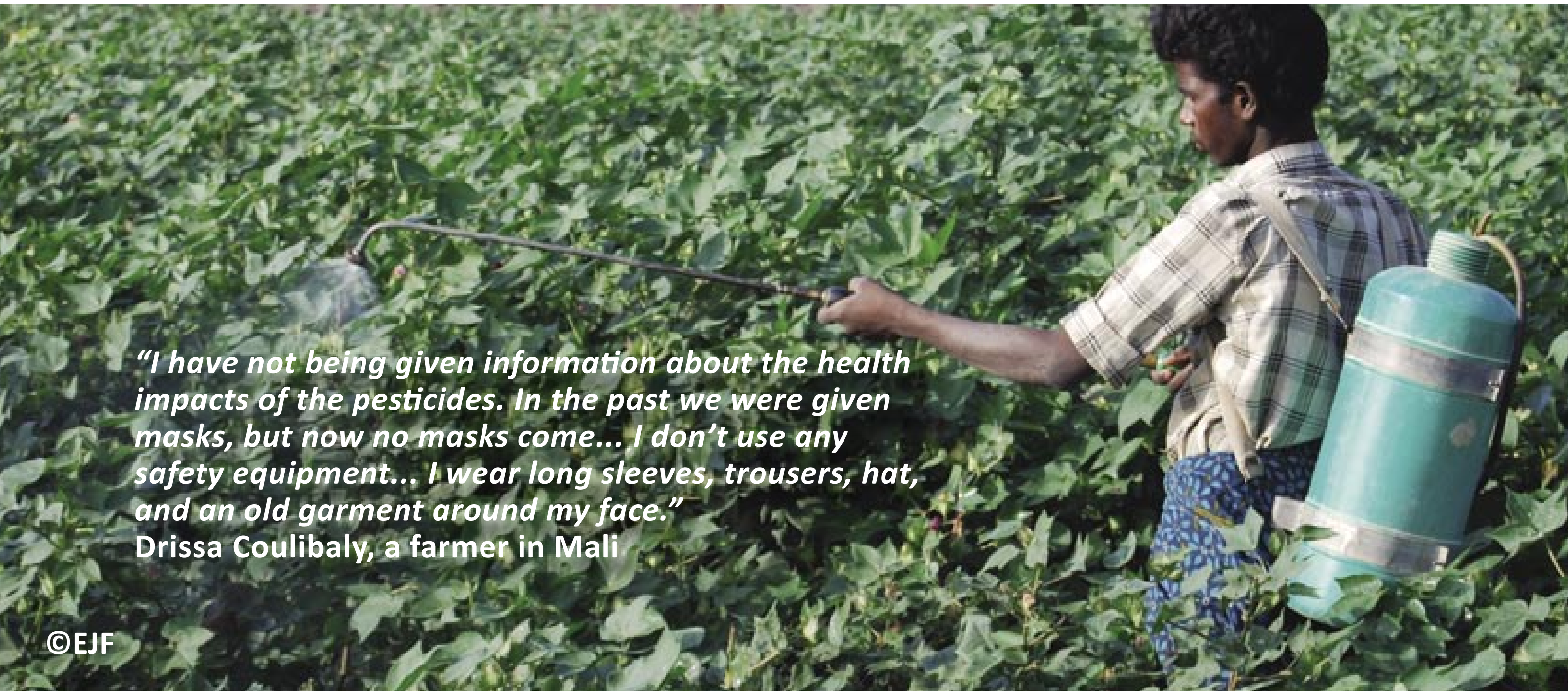
INTOLERABLE LIMITS

In its 2002 re-assessment of the human and environmental effects of endosulfan, the US EPA found that children aged 1-6 faced unacceptable risks from endosulfan in food – particularly from beans and peas. In order to mitigate human health and ecological risks, the Agency was required to end its use on five food crops and reduce its use on a further twenty-seven[20]. However, it took five years before these changes were implemented.

EPA's re-calculations in 2007 found that occupational handlers were actually more at risk than the 2002 assessment indicated[10]. However, in this same year, the EPA raised their threshold of concern for food exposure, which PANNA argues gives the illusion that it is unlikely to be a health problem for the majority, ignoring the significant threat to foetuses and infants observed in laboratory studies[108].

VULNERABLE GROUPS

Some populations are particularly sensitive to endosulfan's neurotoxic effects; these include unborn children, infants and the elderly. Certain medical conditions also make people particularly sensitive to adverse affects. The ATSDR identifies people with liver or kidney disease; pre-existing anaemia or haematological disorders; neurological problems especially seizure disorders; people with HIV/AIDs and people with protein-deficient diets such as the malnourished poor, chronic alcoholics and dieters as vulnerable groups[35].



"I have not being given information about the health impacts of the pesticides. In the past we were given masks, but now no masks come... I don't use any safety equipment... I wear long sleeves, trousers, hat, and an old garment around my face."
Drissa Coulibaly, a farmer in Mali

©EJF

THE DANGER TO HUMAN HEALTH

A DEADLY THREAT: ACUTE POISONING

Absorption of endosulfan through the gastrointestinal tract is extremely efficient – around 90% is absorbed. Similarly, absorption through the skin can be high; as much as 50%. Once in the body, the chemical will primarily target the central nervous system[36] and can cause immediate symptoms such as nausea, vomiting, dizziness and seizures[37]. Other common symptoms include skin rashes; eye, nose and throat problems; headaches; diarrhoea; depression; loss of coordination; inability to stand; and loss of consciousness[38].

Acute poisoning by endosulfan has been responsible for many deaths world-wide:

- In Brazil, **313 deaths** were attributed to endosulfan poisoning between 1982 and 1991[39].
- In the 1990s, there was at least **one death in the USA** attributable to endosulfan poisoning, and another case of irreversible and extensive neurological impairment[40].
- In South Africa in 2003, **two children died** after having direct contact with a goat treated with endosulfan[36].
- In November 2008, around 60 school children from a government-run boarding school in Jharkhand, India, were hospitalized after drinking milk contaminated with endosulfan. **Five boys died**[41].

"When I spray the field everyone is in it, including the children"
N'Go Dembele, a farmer in Mali

WEST AFRICA

THE DELETERIOUS IMPACTS OF ENDOSULFAN ARE PARTICULARLY WELL DOCUMENTED IN WEST AFRICAN COTTON-GROWING COUNTRIES.

In the late 1990s, endosulfan was reintroduced across West Africa to combat cotton pests that had built up a resistance to other agrochemicals. After the first cotton season (1999-2000), stories of poisonings and deaths within farming communities began to emerge. Independent surveys conducted in Benin, Senegal, Mali and Burkina Faso between 2000 and 2004 revealed that endosulfan was responsible for the majority of all acute pesticide poisoning cases and a significant number of deaths[38]. Between 2000 and 2003, 400 people in Benin were poisoned by endosulfan and endosulfan poisoning accounted for more than half of all poisoning-related deaths[38].

Unfortunately, accidental exposure - particularly by eating contaminated food - is by far the most common way that people are poisoned. In one incidence, a young boy of eight had been helping his parents by weeding in the cotton fields. Feeling thirsty, he ran back to the house, but found an empty container along the way and used it to scoop up some water from a nearby ditch. He did not return home so a village search was mounted. Villagers found his body next to the empty endosulfan bottle he had used to drink from. In Benin in 2000, a father left his pesticide-soaked work clothes on the roof of the house over night, in order to keep them safely out of reach from his young children. It rained overnight, and the water ran over his clothes and into the family's water containers. The next morning the children used this water for drinking and washing. Within minutes they suffered headaches, nausea and convulsions. They were immediately rushed to the nearest health centre, but all four children died within 20 hours[38].

In an attempt to prevent more tragedies like these, Senegal, Mauritania, Mali, Guinea Bissau, Burkina Faso, Chad, Cape Verde, Gambia and Niger[42] have introduced bans on endosulfan's use. In February 2008, the government of Benin, one of the three largest cotton producers in the region, announced the pesticide would be banned after existing stocks were used up.

LEFT: Endosulfan poisoning accounted for more than half of all poisoning-related deaths in Benin between 2000 and 2003 ©EJF

CHRONIC EXPOSURE

THE FOETUS AND CHILDREN UNDER 19 YEARS OF AGE

Endosulfan accumulates in fatty tissue, placental tissue, umbilical cord blood and breast milk. This means that a foetus can be exposed when in utero and then re-exposed after birth through the consumption of breast milk. PAN Europe notes that endosulfan has been found in samples from women in Egypt, Madagascar, South Africa, El Salvador, Kazakhstan, India, Indonesia, Pakistan, Spain, Colombia, Nicaragua, Denmark and Finland, and in umbilical cord blood samples in Denmark, Finland, Spain, USA, and Japan. A survey of women in Denmark and Finland found endosulfan in all samples of breast milk (total = 130) and in all placental samples (total = 280)[109]. This exposure takes place at critical periods of development, and can have a profound life-long impact.

AUTISM

A 2007 study in the USA found that the risk of Autism Spectrum Disorder (ASD) increased with maternal proximity to application of endosulfan and dicofol (another pesticide), during key periods of gestation and with increases in the amount of pesticide applied[43].

BELOW: Child labourers in India eating with their hands after working with pesticide-covered plants ©EJF

ABOVE: Eight month old Sainaba lives in the Kasaragod district close to where Endosulfan has been sprayed. She suffers from hydrocephalus ©Shree Padre

CONGENITAL PHYSICAL DEFORMITIES

A relationship has been observed between maternal exposure and foetal malformations in the skull, ribs and spine of rats[44].

Physical malformations observed in humans include cleft palates, harelips, club feet, limb malformations, eye deformities and extra fingers and toes[45].

In a control-compared study of 170 children exposed to endosulfan in Kerala State, India, 5.8% showed congenital abnormalities and 21.8% showed menstrual disorders[46].

REPRODUCTIVE DEVELOPMENT

Endosulfan is an endocrine disruptor; it prevents and inhibits the natural hormonal signalling systems. Endocrine disruptors may alter feedback loops in the brain, pituitary, gonads, thyroid, and other components of the endocrine system . Studies show that endosulfan is particularly disruptive and inhibitive to male and female sex hormones[48,49,50].

Delayed sexual maturity and sex hormone synthesis have been observed in males of 10-19 years old who have been exposed to endosulfan. There may also be a relationship between exposure and the prevalence of congenital abnormalities related to testicular descent[43].

"When they were spraying pesticides we were forced to work. I would develop serious headaches. Many times I fell unconscious"
Nagamma, an 11 year old child labourer in India who had been working in cottonseed fields since she was 8 years old

THE DANGER TO HUMAN HEALTH
CHRONIC EXPOSURE

ADULTS

CARCENOGENIC EFFECTS?

Endosulfan has not been classified as carcinogenic by the International Agency for Research on Cancer (IARC), which means that some regulatory bodies labour under the misapprehension that there is no evidence of a relationship between exposure and cancer.

In both animal and human studies, exposure has been found to cause a proliferation of breast cancer cells, to activate or antagonize cell receptors, interfere with mammary gland development, and disrupt a variety of hormonal mechanisms including the production of estrogens, all of which have the potential to increase the risk of breast cancer[51]. This increased risk could be intergenerational (i.e. it might affect both mother and child)[51].

Many studies also show endosulfan to be genotoxic and mutagenic[52,53] – it interferes with the integrity of cell genetic material (DNA) causing mutations and the development of tumours. Studies show it acts as a tumour promoter in the liver, causing exposure-related increases in cancerous cells and inhibiting natural cell defense responses[54].

HAEMATOLOGICAL EFFECTS

Long-term oral and dermal exposure in male rats has been observed to cause aneurysms (blood-vessel dilations)[55].

Blood and urine samples from exposed persons have also identified endosulfan as the cause of decreased white blood cell counts, increased blood sugar levels, and increased enzyme and cardiac marker levels (indicative of heart attacks and tissue and muscle damage)[56].

THE IMMUNE SYSTEM

The immune system is adversely affected by endosulfan because exposure decreases the white blood cell count. These cells are vital for functions such as fighting infections, allergies and for tumour suppression[51, 55].

RENAL EFFECTS

Long-term oral and dermal exposure in rats has been found to result in rapidly progressive Glomerulonephritis[55]. This is a renal disease that affects the small blood vessels in the kidneys.

NEUROLOGICAL EFFECTS

Those exposed over prolonged periods have been found to experience cognitive and emotional deterioration, severe impairment of memory and inability to perform most daily tasks. Some have also experienced gross impairment of visual-motor coordination[57, 58].

Exposure has also been linked to conditions such as cerebral palsy, epilepsy[59] and it may increase the risk of Parkinson's disease[60].

INFERTILITY

Although there are insufficient studies to be able to predict the impact of pesticides on the fertility of exposed populations, studies have shown that there is an association between pesticide exposure and reduced sperm quality in humans[48,49,55].

RIGHT: Dermatitis from contact with pesticides

©CEDAC

KERALA: A MODERN-DAY TRAGEDY LEADS TO A BAN

The plight of people in Kerala State, India, is a particularly dramatic example of how endosulfan use can devastate human health. A combination of 20 years of aerial spraying on cashew plantations and unique circumstances mean that residents were excessively and repeatedly exposed to the chemical.

In the initial years of spraying, few residents had ever seen a helicopter or plane and would come out of their homes to watch, getting showered with the chemical where they stood. Workers in the plantations were also directly exposed to endosulfan as they stood on the edges of the fields during spraying, marking the boundaries of the spray zone. Aerial spraying of the pesticide over the cashew plantations technically should have taken place no more than 3m from the canopy level but, because of power lines above the fields spraying was conducted at a higher height enabling the pesticide to be spread further. Workers and locals were then re-exposed indirectly to the chemical during their daily tasks such as washing in contaminated water and burning contaminated wood during cooking.

Sruthi from Padre, Kerala, was born with staghorn limbs. Her mother died of cancer and her father is very ill. Since 2002, the community has taken care of her. Now a bright young student, Sruthi has undergone multiple surgeries and every year she has to undergo artificial limb modification.

The impacts of this exposure soon became apparent as wildlife died in the fields and animals were born with severe deformities. A high number of people began to suffer from severe and debilitating neurophysical conditions. A local doctor, Dr Mohana Kumar, conducted a survey and found 202 cases of people with psychiatric problems, mental disabilities, epilepsy, congenital anomalies, as well as cancer deaths and suicides from only 400 homes in a 4km^2 area[58]. Later, a District Committee found that the combined rate of locomotor disability rate and mental disability was 107% higher than the state average[61].

Public outcry and continued petitioning from citizen groups as a result of this problem eventually persuaded the Kerala High Court to impose a state-wide ban on the use of endosulfan in 2002, and in 2006 the new Chief Minister of the State for Kerala, Sri V S Achutanandan, officially acknowledged the plight of endosulfan victims. Collaborative efforts and a Victims Relief and Remediation Cell now offers Rs. 50,000 (US$1,000) in compensation to 180 surviving family members, and at least 300 more have been identified as victims. Medical and Social Remediation is being provided to at least 3000 villagers, many of them children[62].

The state ban is a success for Kerala, but the suffering in this unique case does highlight the need for global elimination. Unfortunately, the Government of India is heavily invested in the continued use of endosulfan, as it owns one of the largest global manufacturers, Hindustan Insecticides Ltd.

LEFT: Avinash from Paleppady in Kerala has cerebral palsy and cannot walk or talk

©Shree Padre

ENDOSULFAN AND THE ENVIRONMENT

The effects of endosulfan on non-target species can be swift and devastating. Through surface run-off, evaporation, or seepage into ground water stores, a variety of wildlife species – as well as humans – can be at risk from its harmful effects. Farmers in Benin have observed birds and frogs dying after eating insects sprayed with endosulfan[63]. According to one such farmer, "Fields smell awful two or three days after spraying because virtually every living thing has been killed and starts to rot"[64].

Endosulfan is considered to be very toxic to nearly all kinds of organisms[65]. It is highly to moderately toxic to birds and extremely toxic to aquatic organisms (notably fish but also amphibians, shrimp and prawns, aquatic snails and plants and coral reef organisms). In laboratory studies it has also shown high toxicity in rats, and it appears that female rats are 4–5 times more sensitive than male rats[66].

Research has found that even at sublethal doses endosulfan induces behavioural and biochemical changes in fish. Its high toxicity has been responsible for devastating fish stocks across the globe. In 1995, contaminated run-off from cotton fields in Alabama killed more than 24,000 fish along a 25km stretch of river. This was despite the fact that the pesticide had been applied according to instructions[67]. Similarly, mass fish deaths have been reported in India[68], Benin[69], Sudan[70] and Germany[71].

According to Hiranyagarba Shastri, a villager in Padre, "After each spraying the fish in people's ponds would die." Then fish and frogs started disappearing altogether. The spraying also used to coincide with the flowering season and would interfere with pollination. This subsequently affected honey bee activity.[74]

ABOVE: Endosulfan spills into rivers have been responsible for mass fish kills in the USA, India, Benin, Sudan and Germany.
©LaDon Swann

TOXICITY TO BENEFICIAL INSECTS AND POLLINATORS

A study by the University of Florida found that endosulfan is highly toxic to honey bees – which are key pollinators for many plant species[112]. Endosulfan has also been found to kill beneficial micro-organisms, insects and fungi[72,73]. Spraying in cotton fields in India has correlated with a 60.5% decline in actinomycetes, micro-organisms that are essential for nutrient cycling in soil[75]. It has also been linked to reduced emergence and parasitism of the parasitic wasp *Trichogramma pretiosum*, which is useful in controlling populations of various moth pests[76]. It is similarly toxic to earthworms, spiders and many species of predacious mites[36].

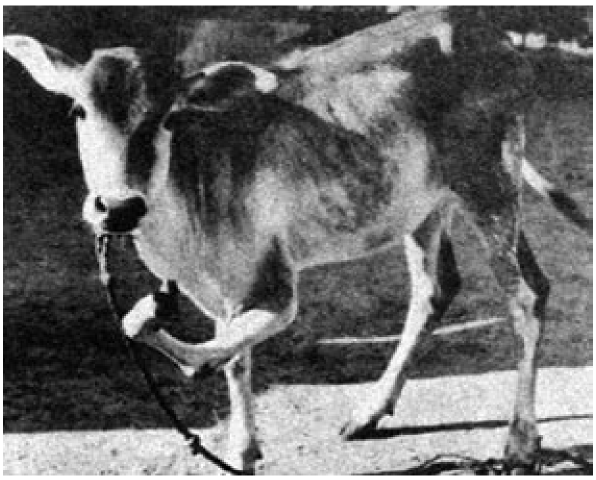
LEFT: Abandoned pesticide containers are a common source of environmental contamination ©EJF

Endosulfan and its POP characteristics

LONG-RANGE ENVIRONMENTAL TRANSPORTATION

Like the widely banned pesticides DDT, chlordane and dieldrin, endosulfan is an organochlorine and as such, is persistent in the environment. Due to its ability to evaporate and travel long distances in the atmosphere, endosulfan has become one of the world's most widespread pollutants.

Within two days of spraying, up to 70% of endosulfan can volatize from leaf and soil surfaces[77], and can then be transported by wind over long distances. It has an estimated atmospheric half-life of 27 days (± 11 days), although this figure could be far higher, depending on air temperature[65]. A further 2% of the sprayed chemical is carried off in surface run-off, while 1% remains in the soil. Therefore, around 73% of the applied pesticide leaves the site of application[78]. The US EPA notes that, "Monitoring data and incident reports confirm that endosulfan is moving through aquatic and terrestrial food chains and that its use has resulted in adverse effects on the environment adjacent to and distant from its registered use sites"[79].



ABOVE: Endosulfan exposure can cause physical deformities in animals ©Shree Padre

Residues of endosulfan have been observed in every corner of the Earth, great distances from the places where it has been released. Residues have now been found in remote ecosystems such as the Arctic[80], the Antarctic, the Great Lakes, the Canadian Rockies and the rainforests of Costa Rica[22], as well as in grasses on Mt. Everest[81] and in snow in the Italian Alps[82]. Saharan dust, contaminated with three different forms of endosulfan and blown across the Atlantic, has been detected in air samples taken from the Caribbean[83]. Analysis has shown that endosulfan is also contaminating groundwater stores across the globe. Studies have found it in 38% of samples taken in Portugal[84], 83% of samples from tube wells in agricultural areas of India[85], and in all samples of groundwater in Morocco[86] and frequently in samples of Guatemalan surface and ground water[87].

Residues of endosulfan have also been detected in the tissues of animals across the globe, including antelope, crocodiles, African vultures, and in the blubber of elephant seals in the Antarctic, in the tissue and blood of polar bears in Svalbard and in the blubber of minke whales[14,88].

BIOACCUMULATION

Endosulfan stores easily within the fatty tissues of living organisms, and it accumulates in concentration whilst exposure continues – that is, the organism absorbs endosulfan at a greater rate than it can be excreted. Studies have shown that both aquatic and terrestrial species can accumulate concentrations of endosulfan to a significant extent[23], but the susceptibility to bioaccumulation varies greatly between species – for example, oysters and bivalves appear to accumulate very little endosulfan, whilst some fish species accumulate endosulfan much more readily[65]. Terrestrial species show a greater relative potential for accumulation than aquatic species, and monitoring data has shown that concentrations of endosulfan have increased over time in beluga whale blubber samples from the Canadian Arctic[89], the tissue of freshwater tetra in Brazil[90] and even in plants. Two year old conifer needles in Western national parks of the USA were found to have three times the concentration of endosulfan that one year old needles had . This characteristic, teamed with endosulfan's high toxicity, means there is significant potential for damage[88].

ENDOSULFAN AND THE ENVIRONMENT

PERSISTENCE

Endosulfan degrades relatively quickly in water (half-life = 2-22 days), but in soil degrades slowly (its half-life ranges 28-391 days[88]. The major degradation product, endosulfan sulphate is not only more persistent but is also toxic. The combined half-lives range from around 9 months to 6 years and anaerobic conditions might extend these half-lives significantly[65]. By means of comparison, the Stockholm Convention regards chemicals as persistent if they have a half-life greater than 183 days[88]. In Kerala, India, residues were still detected in stream water and pond sediments a year and a half after spraying ceased[48].

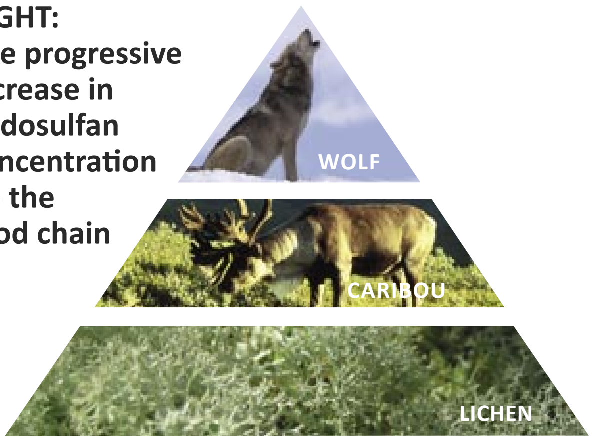
THE LAG EFFECT

A recent study[110] found that the toxic effects of endosulfan exposure can take more than four days to manifest. Scientists from the University of Pittsburgh, USA, found that up to 97% of some species of tadpole perished days after they had been removed from direct exposure to endosulfan. This potentially calls into question the US EPA's standard four-day toxicity test for chemicals, which could underestimate the physiological impact of endosulfan.

BIOMAGNIFICATION

Research indicates that endosulfan can also biomagnify up food-chains[10], so that higher level predators have higher concentrations in their bodies. It is thought that its biomagnification may be greater in terrestrial ecosystems than in the marine food chain, based on modelling of Arctic food chains, where concentrations increased from lichen to caribou (*Rangifer tarandus*) and caribou to wolves (*Canis lupus*)[78].

RIGHT: The progressive increase in endosulfan concentration up the food chain



©BIEN52, Dean Biggins/ US Fish and Wildlife Service

Endosuflan has been found in the blood of polar bears.

©Steve Amstrup/ U.S. Fish and Wildlife Service

ENDOSULFAN IN THE ARCTIC

Residues of endosulfan detected in parts of the Arctic, where there are no human activities to explain the contamination, show that the polar region is acting as a sink for this pollutant that is being transported over long distances. Endosulfan is accumulating in the polar region, and in fact atmospheric levels of alpha-endosulfan (the major component of technical endosulfan) are now considered comparable to levels near application sites[92]. Unlike some of the other persistent pollutants, endosulfan levels in the remote Arctic are not showing a declining trend over time[92]. Scientists have known for more than a decade that the levels of POPs in this region are high enough to adversely affect some indigenous communities and marine animals[92]. In the case of endosulfan, the pollutant has been found to travel up the food chain, in some cases increasing in concentration, affecting species that traditionally form the mainstay of indigenous diets. Thus, indigenous people must either face a significant health and food security threat by continuing with their traditional diet[10,92], or switch to a more 'western' diet which has been linked to obesity, diabetes, anemia, and dental problems[93].

"To discover that the food which for generations has nourished them and kept them whole physically and spiritually is now poisoning them is profoundly disturbing and threatens Indigenous Peoples' cultural survival." AMAP[94]

ALTERNATIVES TO ENDOSULFAN

Endosulfan is not the only viable option for protecting crops, and promoting sustainable, economically and technically viable alternatives to endosulfan will help secure public and environmental health. Alternatives do not have to reduce crop yields either; sixty-two countries have banned the use of endosulfan and are introducing alternatives that can maintain yields. Furthermore, alternatives may have to be used as pests continue to become resistant to the chemical; at present, resistance has developed in at least 28 species affecting at least 22 crops[95].

There are less toxic chemical alternatives, and Integrated Pest Management (IPM) is a method of reducing or avoiding some of the worst aspects of chemical pesticide use. A 2008 PAN Germany report noted that endosulfan, which lost its national registration approval in 1991, has been successfully replaced with other methods, including non-chemical pest control methods in an IPM system[96]. However, IPM does not eradicate the use of pesticides, and many farmers around the globe are therefore taking the opportunity to convert their production to organic methods, thereby eliminating the risks posed by chemical pesticides (as well as fungicides and herbicides). This development can be welcomed for its positive role in protecting human health and the natural environment, without compromising the livelihood needs of farmers.

Organic production has been proven in many instances to maintain, or even increase, profit margins for producers. Twenty-two countries now produce organic cotton, with India, Syria, Turkey, China, Tanzania, USA, Uganda, Peru, Egypt and Burkina Faso producing the greatest amounts[97]. Efforts by Pesticide Action Network, together with the International Federation of Organic Agricultural Movements and others, are pioneering research, education and outreach to farmers across the globe[98,99]. Many of the case studies included in this section are testimony to these efforts to support and promote successful organic production in a variety of crops.

"Organic farming...saves lives from not using pesticides. We no longer have debt problems. Income is all profit at the end of the season. Land and soil are preserved."
Benin Farmer Gera Paul

A BAN DOESN'T SPELL DISASTER - THE CASE OF SRI LANKA

Endosulfan was one of three pesticides responsible for many of the severe poisoning cases in Sri Lanka during the 1980s and early 1990s. As a result, endosulfan was banned in 1998. A 2008 study concluded that this ban did not affect the yield sizes of any of the 13 evaluated crops for 1990–2003, nor did it increase the costs of rice production. It has, however, been linked to a significant reduction in accidental poisoning deaths, a 40–50% progressive reduction in suicide by self-poisoning with pesticides and a reduction in the overall suicide rate over 1995–2002[100].

BELOW: Organic farming is better for the environment, safer for workers and could increase profit margins for farmers ©EJF

ALTERNATIVES TO ENDOSULFAN

NON-CHEMICAL ALTERNATIVES

PHYSICAL CONTROL METHODS[101,102]

Pest control measure	Mechanism	Other benefits
Bagging fruit	Recycled newspapers or plastic bags are used to bag maturing fruit to protect it from fruit flies	• Protects the fruit from scratches and damage • Gives a reliable indicator of the harvest yield
Companion planting	A diverse group of crops are planted to attract beneficial insects to pollinate or predate on other insects	• Can act as a sacrificial crop to protect the main crop • Can act as a buffer to protect vulnerable growing crops • Nitrogen fixing
Composting	Decaying organic matter is used to control pathogens Materials could include tank silt, compost, vermicompost, poultry manure, green leaf manure and cowdung	• Improves soil quality
Crop rotation	The rotation of crops between family groups is used to eliminate host-specific, disease-causing organisms by starvation	• Improves soil quality
Trapping	Pests are trapped and killed e.g. Pheromone traps, light traps, sugar-based traps, soil traps (deep ditches, sticky board traps and protective collars around plant stems)	
Hand picking	The hand picking of pests allows a targeted approach to specific pests in their egg and adult forms	
Mulching	An organic or inorganic layer is added to act as a barrier to pests	• Enables the environmental conditions to be kept more stable • Provides good conditions for earthworms and natural enemies • Protects soils against heavy rains
Pruning	Infected leaves or leaves with egg masses are removed	• Improves circulation between plants • Encourages natural enemy predation • Helps limit the spread of diseases
Provision of bird perches	Birds which predate on pests are encouraged	• Increases biodiversity

BOTANICAL PESTICIDES

There are numerous botanical pesticides that can be grown and mixed by farmers with comparably no risk to health. These include larvaticides formulated using aloe extract; repellents using plants like lemongrass or coriander, or cow urine or buttermilk solutions; and insecticides using ginger and chilli. Farmers can even formulate botanical rodenticides using Gliricidia or the leaves and unripe fruit of papaya plants. Many of the plants used in these formulations have multiple benefits for crop growing. Neem, for example, is a repellent, insecticide, antibacterial agent, anti-fungal agent, antifeedant, a growth inhibitant, and crop and grain protectant. Studies show that its use carries no side-effects for humans, and it does not persist in the environment. It is not harmful to beneficial species like earthworms. Its target species – such as leafhoppers, aphids, and whitefly, do not build up a resistance to it[97].

ALTERNATIVES TO ENDOSULFAN
ORGANIC CROP PRODUCTION

THE ECONOMICS OF SWITCHING TO ORGANIC PRODUCTION

There can be no doubt that a switch to organic production can have economic advantages. Market research shows that premium prices are favoured towards organic products, where organic cotton prices are as much as 20-30% higher than conventional cotton prices[97]. Research also shows that consumers are willing to spend more for environmentally sensitive products: up to 20% more for general eco-products, and up to 100% more for organic food products[103]. The market for these products is expanding rapidly and producers should take note. The 2007/8 organic cotton crop year experienced an estimated 152% overall increase in production on 2006/7. Approximately 60% of this was from the expansion of pre-standing projects, whilst 40% was newly certified or previously unknown projects[97].

Comparative profits of agrochemical-based production and organic production: an Indian example[105]

	Jillela Yella Reddy, Kallem Village, Warrangal, using pesticides and fertilizer	Ponnam Mallaiah, Warrangal, using organic farming methods
Investment on cotton crop on one acre	Rs. 15,250	Rs. 8,550
Total yield	12 quintals	10 quintals
Total gross income	Rs. 24,600	Rs. 22,000
Net Income	Rs. 9,350	Rs. 13,450

ORGANIC CROPS IN NORTHERN IRELAND

The College of Agriculture, Food and Rural Enterprise (CAFRE) in Northern Ireland has been growing organic crops to provide concentrate feed for its sheep and cattle for a number of years. They grow oats and triticale, with no problems from weeds because of their allelopathy. They also grow an oat and pea mixture in order to increase the protein content of the feed. The college reported gross margins in 2006 of £1,682 for triticale, £1,275 for oats and £1,252 for the oat and pea mixture (based on production costs and potential sale value) – significant margins compared to the top 25% benchmarked figure for conventional spring barley crops, which was £529 per hectare[104].

ORGANIC COTTON IN INDIA

Organic farmers in India have shown that organic practices can be far more profitable than conventional methods, with revenues from organic sales approximately 30% higher than from conventional sales[98].

Successful organic alternatives have included[98]:

- More robust cotton crop alternatives
- Maintaining a diverse crop rotation
- Intercropping with maize and pigeon peas as trap crops, or with flowering plants to attract beneficial insects
- The use of repellents and botanical pesticides
- Using 'Tricho cards' that hold parasitized eggs. Once placed in the field, the emerging parasitic wasp (Trichogramma) will parasitize the eggs of other insects. In India it is used to parasitize the eggs of the bollworm moth, one of the key cotton pests.

A 2009 report by Indian NGO Thanal documents the economic benefits of conversion to what is termed 'Non Pesticidal Management' (NPM). Since 2002, three thousand villages in Andhra Pradesh have been moving to more sustainable methods of farming, with farmers themselves lending support and advice to other farming communities seeking to move away from a dependency on endosulfan and other pesticides. By 2009, the programme for NPM covered an area of 1.7 million acres, or 5% of total agricultural land in Andhra Pradesh. The programme is based on principles including ecological sustainability (no chemicals, no GMO, low use of energy and water, economic sustainability), locally-available inputs to help generate benefits for the local economy, social empowerment, and the promotion of local decision-making and cooperatives[102].
Prior to the NPM programme, one village, Enabavi, was spending around Rs. 64,200 (US$1300 at 2009 conversion rates) on 214 litres of endosulfan per year[102].

"I used to cultivate cotton which is a pesticide intensive crop. Aphids, whitefly, bollworms and green leaf hopper created problems for me. I resorted to chemical pesticides to protect my crops but found nothing worked for me. After I turned to NPM, dependency on externalities have reduced considerably. There is no yield reduction and so my revenue is the same, but expenditure came down from Rs. 3,000 to Rs. 300 [US$60 to US$6]. NPM needs extra manpower and care. But it gives confidence and freedom from external risks. Moreover it creates more local economic opportunities". Ettaboina Siddulu, farmer, Enabavi, Warangal district, Andhra Pradesh, India

THE BENEFITS OF SWITCHING TO ORGANIC PRODUCTION: WESTERN AFRICA

Model projections show that the benefits of switching to organic crop production could apply to many cotton producing countries, particularly in western Africa. Projections based on Mali's organic production versus conventional methods indicate that switching could increase farmers' profits in the mid-to long-term, with extra revenue from higher premium prices. Switching would also have environmental benefits - it would likely increase soil fertility as well as halt the release of toxic pesticides. People would benefit from improved health and would need to spend less on medicine to treat the results of exposure to pesticides[103].

In Benin, a growing number of cotton farmers have proven that cotton can be grown without endosulfan using alternative pest management techniques, integrated indigenous techniques, and bio-control mechanisms. The use of food sprays to encourage predators has helped to control caterpillar pests and bollworm in particular[98].

ENDOSULFAN: ALTERNATIVES IN LATIN AMERICA

Two recent PAN reports document insect management alternatives to endosulfan for a variety of crops. Mechanisms include interspersed multiple crops; leaving the host habitats for predatory insects, parasitic wasps and caterpillars; and the use of beneficial fungus alongside the use of wasps (particularly useful to combat the spread of the coffee berry borer)[106]. Successful alternatives have been employed in the production of vegetables, coffee, tobacco and beans in Chile, Cuba, Bolivia, Paraguay and Costa Rica.

BELOW: Women prepare neem mixture, a natural pesticide

©Pesticide Action Network UK

END OF THE ROAD FOR ENDOSULFAN?

In addition to the national bans implemented by 62 countries to date, endosulfan has been considered for global regulation under two Conventions. As commentators have noted, however, the manufacturers of endosulfan, especially those in India, have opposed any regulation. The result has been that "so-called scientific processes have become highly charged politically, and their integrity endangered." Meriel Watts, PAN ANZ[27]

THE PIC PROCESS AND ROTTERDAM CONVENTION

The Rotterdam Convention addresses international trade in hazardous chemicals. It does not restrict trade but, through the legally-binding Prior Informed Consent (PIC) procedure, promotes information exchange about hazardous chemicals and assists less developed countries in enforcing national bans and restrictions on listed chemicals. In effect, a country must give prior informed consent before a listed chemical can be imported.

In March 2007, the Chemical Review Committee of PIC agreed that endosulfan should be included in Annex III (the list of chemicals banned or severely restricted). At the Conference of the Parties in October 2008, almost all of the country delegations supported its inclusion, bar a handful of signatories who raised concerns, which was enough to prevent a consensus decision, as required under the Convention for any new listing. The Indian Government led the opposition to the listing. Significantly, this delegation was guided by representatives of the Indian Chemical Council (ICC) and government-owned Hindustan Insecticides Limited: one of the largest manufacturers of endosulfan. Without a consensus, the final decision on whether to include endosulfan has now been postponed until 2010.

"India will be remembered as putting the economic interests of its chemical industry ahead of the health and welfare of the users of the industry's products"
Karl Tupper, Pesticide Action Network North America

THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS (POPS)

The Stockholm Convention on Persistent Organic Pollutants (POPs) aims to protect human health and the environment by globally banning the production and use of persistent, bioaccumulative chemicals. A number of chemicals, including DDT, are already listed under the Convention. The EU has proposed that endosulfan be added to the list, but before a ban can be achieved a chemical must go under the lengthy review process and then discussion at a Conference of the Parties. In November 2008, the POPs Review Committee (POPRC) could not reach consensus and a vote was taken: the majority of parties voted for it to progress through the review process, while India and China refused to vote, and Germany, Ghana and Sierra Leone abstained[107].

As a result of this vote, in 2009 the POPRC will develop a 'risk profile', assessing whether endosulfan is likely to lead to such adverse environmental and human impacts that global action is warranted, and this will be reviewed at the next POPRC meeting in October 2009. Should the POPRC decide on the basis of the risk profile that the proposal should proceed, a 'risk management evaluation' will be the next step, analyzing the range of options for endosulfan's management and elimination.

At the end of the process, POPRC will make a recommendation to the COP and a vote (consensus or by 3⁄4 majority vote is required) on whether to list endosulfan will be taken.

TOWARDS GLOBAL ERADICATION – NATIONAL ACTIONS LEAD THE WAY

Currently 62 countries have banned endosulfan, and others are reassessing its use within their borders. In 2007, the US EPA released calculations showing that endosulfan cannot be used safely in the vast majority of scenarios for which it is currently approved, leaving farmers exposed to unacceptably high levels of risk. To date, the EPA has been petitioned by international scientists, health professionals, farmworkers and non-profit organisations, and in April 2009 re-opened a '60-day docket' opportunity for public comment, to which tens of thousands of individuals signed petitions calling for action. Following the recent announcement of bans from New Zealand, Iran and the Philippines it is clear that national sovereignty can play a significant role in addressing this global problem.

WHY ENDOSULFAN IS A POP[88]

Criteria	Evidence
Persistence	Est. half-life in soil of 28-391 days
Bioaccumulation	Predicted biomagnification factor (BMF) values ranging from 2.5 to 28 for herbivorous and carnivorous wildlife. The main concern comes from the combination of its bioaccumulation potential with its high toxicity and eco-toxicity
Potential for long-range environmental transport	RLevels of 0.9 and 3.02 ng/g have been observed in the blubber of elephant seals in the Antarctic. Evidence of transportation is confirmed by Arctic monitoring data. Volatilization is well documented and an atmospheric half-life of 27 days (± 11 days) has been estimated.
Adverse effects	Results show it has the potential to cause endocrine disruption in both terrestrial and aquatic species. Associated medical conditions include neurotoxicity, haematological effects and nephrotoxicity but the chemical shows no carcinogenic or mutagenic properties. Studies vary on the conclusion for teratogenic effects. Endosulfan is metabolised quickly and some metabolites show significant toxicity.

COUNTRIES THAT HAVE BANNED ENDOSULFAN
Austria, Bahrain, Belgium, Belize, Benin, Bulgaria, Burkina Faso, Cambodia, Cape Verde, Chad, Colombia, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Gambia, Germany, Greece, Guinea Bissau, Hungary, Indonesia, Iran, Ireland, Italy, Jordan, Kuwait, Latvia, Lithuania, Luxembourg, Malaysia, Mali, Malta, Mauritania, Mauritius, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Philippines, Poland, Portugal, Qatar, Romania, Saudi Arabia, Senegal, Singapore, Slovakia, Slovenia, Spain, Sri Lanka, St Lucia, Sweden, Syria, United Arab Emirates, United Kingdom

COUNTRIES THAT HAVE RESTRICTED ENDOSULFAN
Australia, Bangladesh, Canada, Honduras, Iceland, Japan, Korea, Madagascar, Panama, Russia, Thailand, USA

COUNTRIES REASSESSING ENDOSULFAN
Brazil, Canada, Uruguay, USA, Venezuela

COUNTRIES MANUFACTURING ENDOSULFAN
China, Israel, India

CONCLUSIONS

Endosulfan is a toxic pesticide and persistent organic pollutant linked to severe adverse effects. It has been responsible for hundreds of deaths worldwide, and significant short and long-term human health impacts. Endosulfan kills indiscriminately and is devastating to the environment, contaminating soils, air and water, and damaging aquatic and terrestrial species alike, including those that are beneficial to crop health. Endosulfan's ability for long-range environmental transport, together with its adverse effects support the need for concerted international action.

Alternatives to endosulfan use have proven to be environmentally sustainable and socially and economically viable. Increasing numbers of farmers are turning to organic production methods that utilise a variety of means to control pests naturally, and without resorting to chemical pesticides.

To date, 62 countries have already voluntarily banned the use of endosulfan within their borders, and all but a small number of parties to the Rotterdam Convention supported its inclusion in the annexes of the Convention in late 2008. Efforts to prevent a global ban are inextricably linked to self-interest – in particular, one of the world's leading producers of endosulfan is administered by the Indian Government, which has consistently opposed any regulation of endosulfan.

Endosulfan has killed, and will continue to kill and maim if it continues to be legal. National prohibitions on use, together with inclusion under the Stockholm Convention will ensure endosulfan's eradication from global use and an opportunity to protect people and their shared environment from this deadly chemical.

©EJF

RECOMMENDATIONS

CONSUMERS AND THE WIDER PUBLIC SHOULD:

- Call on their government to implement a national ban on endosulfan if it has not already done so.
- Encourage their government – if a signatory party – to support the inclusion of endosulfan into the Stockholm Convention and the Rotterdam Convention.
- Make their concerns known to food and clothing retailers, and ask if the companies they buy from can give assurances that endosulfan has not been used in the production process.
- Support the production and trade of organic products.

AGROCHEMICAL COMPANIES SHOULD:

- Immediately cease to manufacture endosulfan and dispose of all stockpiles safely.

AGRICULTURAL WORKERS AND FARMERS SHOULD:

- Avoid the use of endosulfan, and seek alternatives.
- Implement organic production methods wherever possible.

RETAILERS SHOULD:

- Monitor their supply chains, instructing suppliers not to source from producers that use endosulfan.
- Offer organic alternatives for consumers.

NATIONAL GOVERNMENTS SHOULD:

- Sign and ratify the Stockholm Convention and support the inclusion of endosulfan into the Convention annexes.
- Sign and ratify the Rotterdam Convention on the Prior Informed Consent (PIC) procedure and support the inclusion of endosulfan under the PICs procedure.
- Announce domestic prohibitions on the manufacture, import, sale and use of endosulfan, and ensure that there are adequate resources available to ensure effective implementation and compliance.
- Support the expansion of organic farming through the provision of technical and financial support for organic farmer field schools, research dissemination and awareness-raising.

THE UNITED NATIONS FOOD AND AGRICULTURE ORGANISATION SHOULD:

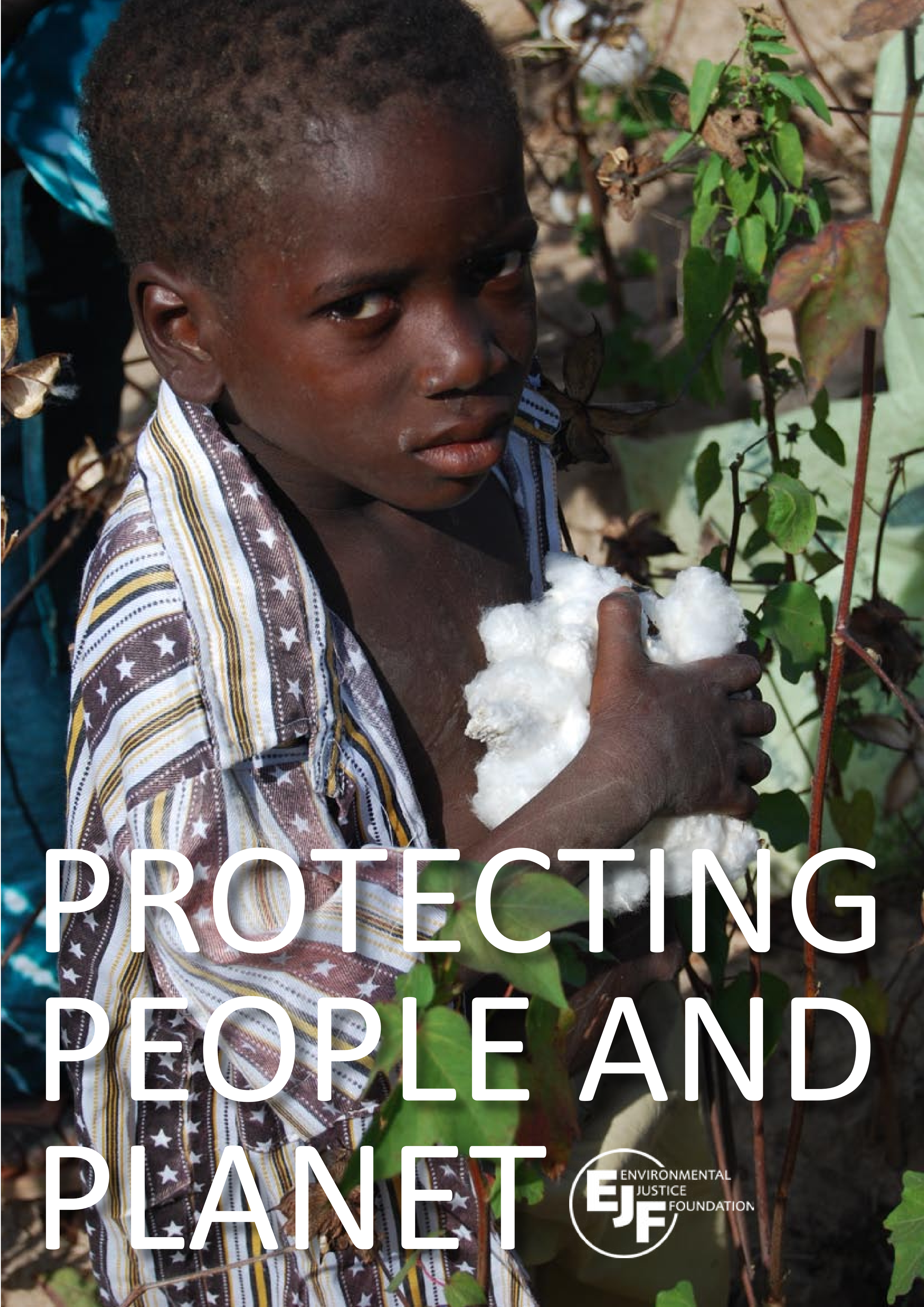
- Expand and build on current organic and Integrated Pest Management (IPM) projects, particularly in Africa and Asia, and ensure that IPM projects do not permit or promote the use of endosulfan.
- Support the wider dissemination of information on organic production methods and the conversion to production that is not reliant on harmful chemical pesticides.

THE WORLD HEALTH ORGANISATION SHOULD:

- Upgrade endosulfan from Class II (*moderately hazardous*) to Class Ib (*highly hazardous*).

REFERENCES

1. International Programme on Chemical Safety (2000) PIM 576: Endosulfan. Available online- http://www.inchem.org/documents/pims/chemical/pim576.htm, accessed on 18/02/09
2. Cotton Production Practices, International Cotton Advisory Committee (2005) http://www.icac.org
3. US EPA. 2000-2001 Pesticide Market Estimates. Available online- http://www.epa.gov/oppbead1/pestsales/01pestsales/table_of_contents2001.htm, accessed on 20/02/09
4. WHO,UNEP & FAO (2004) Childhood Pesticide Poisoning: information for advocacy and action. UNEP
5. Hart, K. and Pimentel, D.: 2002, 'Public health and costs of pesticides', in D. Pimentel (ed.), Encyclopedia of Pest Management, New York, Marcel Dekker, pp. 677–679.
6. CIB website: product directory- Endosulfan. Available online- http://cibrc.nic.in/prodinfo.asp?Product_id=34, accessed on 04/02/09
7. EPA Endosulfan factsheet. Available online- http://www.epa.gov/oppsrrd1/REDs/factsheets/endosulfan_fs.htm, accessed on 04/02/09
8. ERMA New Zealand. Evaluation sheet. Available online- http://www.ermanz.govt.nz/consultations/ceir/m.pdf, accessed on 04/02/09
9. German Federal Environment Agency (February 2009) Appendum to Dossier prepared in support of a proposal of Endosulfan to be considered as a candidate for inclusion in the UN-ECE LRTAP protocol on persistent organic pollutants. German Federal Environment Agency.
10. US EPA (16/11/07) Endosulfan Updated Risk Assessments, Notice of Availability, and Solicitation of Usage Information. Federal Register Environmental Documents. US EPA
11. IFCS (2003) Acutely Toxic Pesticides: Initial Input on Extent of Problem and Guidance for Risk Management. Forum Standing Committee Working Group. Forum IV Fourth Session of the Intergovernmental Forum on Chemical Safety, Bangkok, Thailand, Nov 1-7.
12. Kishi. M (2002) Initial Summary of the Main Factors Contributing to Incidents of Acute Pesticide Poisoning. Report to IFCS Forum Standing Committee Working Group
13. Ngowi.A, Wesseling. C, & London. L (2006) Pesticide Health Impacts in Developing Countries in D. Pimentel (ed.), Encyclopedia of Pest Management, New York
14. PAN Europe , endosulfan fact sheet, 2008
15. The New Agriculturist. News Brief: India's Endosulfan debate. Available online- http://www.new-ag.info/02-5/newsbr.html, accessed on 30/01/09
16. Li. Y & Macdonald. R (2005) Sources and pathways of selected organochlorine pesticides to the Arctic and the effect of pathway divergence on HCH trends in biota: a review. Sci Total Environ. Vol. 342: p87-106
17. Indian Chemical Council (ICC) Form for submission of information specified in Annex E of the Stockholm Convention pursuant to Article 8 of the Convention
18. Department of Commerce, India. Export-Import Data Bank. (38081031 ENDOSULPHAN TECHNICAL) Available online- http://commerce.nic.in/eidb/ecomcnt.asp, accessed on 30/01/09
19. http://www.hil-india.com/ENDOSULFAN.html
20. US EPA (November 2002) Endosulfan RED Facts. Pesticides: Re-registration. Available online- http://www.epa.gov/pesticides/reregistration/REDs/factsheets/endosulfan_fs.htm, accessed on 12/02/09
21. PAN Europe. Endosulfan- Fact Sheet. Drawn from 'Information for the consideration of Endosulfan, Provision of information to the Stockholm Convention Secretariat for use by the POPs Review Committee (POPRC), PAN International, 30 June 2008'
22. US EPA. (16/11/07) Note to reader. Endosulfan Readers Guide. EPA-HQ-OPP-2002-0262-0057. http://www.regulations.gov
23. PAN North America (13/06/00) Endosulfan Deaths in Benin. Pesticide Action Network Updates Service (PANUPS)
24. EJF field investigations in India, Mali, 2007.
25. EJF field observations, Cambodia 2000, 2001.
26. Bouvier.G, Blanchard. O, Momas. I & Seta. N (2006) Pesticide exposure of non-occupationally exposed subjects compared to some occupational exposure: A French pilot study. Science of the Total Environment. Vol.366 (1): p74-91
27. Watts. M (2008) Time to act on Endosulfan. Pesticide News. Vol. 81: p3-7
28. Strandberg. B & Hites. R (2001) Concentration of organochlorine pesticides in wine corks. Chemosphere. Vol. 44 (4): p729-35
29. Mezcua. M, Repetti. M, Aguera. A, Ferrer. C, Garcia-Reyes. J & Fernandez-Alba. A (2007) Determination of pesticides in milk-based infant formulas by pressurised liquid extraction followed by gas chromatography tandem mass spectrometry. Anal Bioanal Chem. Vol. 55 (26): p10548-56
30. US Food and Drug Administration (FDA) (December 2006) Total Diet Study Market Baskets 1991-3 through 2003-4. US FDA. Maryland, USA
31. PAN Europe (24/11/08) Press Release: Pesticides in grapes: unsafe, illegal and unauthorised. Available online- http://www.pan-europe.info/Media/PR/081124.html, accessed on 13/02/09
32. PAN NZ, Soil & Health Association of New Zealand & Organic NZ (23/07/2008) Press Release: More Endosulfan in Tomatoes - This Time Australian Ones Are Worse! Available online- http://www.panna.org/files/PANOrganicNZpressRe20080723.pdf, accessed on 13/02/09
33. PAN NZ, Soil & Health Association of New Zealand & Organic NZ (12/05/08) Highly Toxic Endosulfan Found in Lettuce, Strawberries, Courgettes. Available online- https://www.panna.org/files/EndosulfanPANNZ.pdf, accessed on 13/02/09
34. The New Zealand Herald (05/07/08) NZ exports at risk after insecticide found in beef. Available online- http://www.nzherald.co.nz/trade/news/article.cfm?c_id=96&objectid=10520027&ref=rss, accessed on 13/02/09
35. ATSDR (2000) Toxicological Profile for Endosulfan. Agency of Toxic Substances and Disease Registry, Atlanta, USA. http://www.atsdr.cdc.gov/toxprofiles/tp41.html
36. Watts. M (2008) Endosulfan Monograph. PAN Asia & Pacific
37. Karatas. A, Aygun. D & Baydin. A (2006) Characteristics of endosulfan poisoning: a study of 23 cases. Singapore Med. J. Vol. 47 (12): p1030-1032
38. Glin. L et al (2006) Living with Poison: Problems of Endosulfan in West African cotton growing systems. PAN UK. London, UK
39. The Hindu (10/07/02) Study finds pesticide 'highly hazardous'. The Hindu Online- http://www.hinduonnet.com
40. Brandt. V et al (2001) Exposure to Endosulfan in farmers: Two case studies. American Journal of Industrial Medicine. Vol. 39: p643-649
41. Kumar. R (14/11/08) Five kids die after taking milk and snack at school- Tragedy on eve of children's day. The Telegraph. Calcutta, India.
42. Correra I. 2007. Décision No /MC/2007 Interdiction de L'Endosulfan. Comité Permanent Inter-Etats de Lutte contre la Secheresse dans le Sahel. Nov 13, République Islamique de Mauritanie.
43. Roberts. E, English. P, Grether. J, Windham. G, Somberg. L & Wolff. C (2007) Maternal residence near agricultural pesticide applications and autism spectrum disorders among children in the California Central Valley. Environ. Health Perspect. Vol. 115 (10): p1482–1489
44. Singh. N, Sharma. A, Dwivedi. P, Patil. R & Kumar. M (2007) Citrinin and endosulfan induced teratogenic effects in Wistar rats. J Appl Toxicol. Vol. 27 (2): p143-151
45. Rupa. D, Reddy. P, Reddi. O (1991) Reproductive performance in population exposed to pesticides in cotton fields in India. Environ Res. Vol. 55(2): p123-8
46. Yadav. K & Jeevan. S (2002) Endosulfan conspiracy. Down to Earth. www.cseindia.org/html/endosulfan/endosulfan_index.htm
47. Landrigan. P, Garg. A & Droller. D (2003) Assessing the Effects of Endocrine Disruptors in the National Children's Study. Environmental Health Perspectives. Vol.111(13): p 1678-1682
48. Saiyed. H, Dewan. A, Bhatnagar. V, Shenoy. U, Shenoy. R, Rajmohan. H, Patel. K, Kashyap. R, Kulkarni. P, Rajan. B, & Lakkad. B (2003) Effect of endosulfan on male reproductive development. Environ. Health Perspect. Vol. 111 (16): p1958-1962
49. POPRC (27/08/08) Consideration of chemicals newly proposed for inclusion in Annexes A, B or C of the Convention: endosulfan. UNEP. Geneva, Switzerland
50. Andersena. H, Vinggaardb. AM, Høj Rasmussena. T, Gjermandsenc. I & Bonefeld-Jørgensenc. E (2002) Effects of Currently Used Pesticides in Assays for Estrogenicity, Androgenicity, and Aromatase Activity in Vitro. Toxicology and Applied Pharmacology. Vol.179(1): p1-12
51. Breast Cancer Network (NZ) (07/11/08) Application HRC07003: An application by ERMA for the reassessment of endosulfan and formulations containing endosulfan under section 63 of the Act. Available online- http://www.breastcancernetwork.org.nz/docs/Endosulfan_Submission.doc, accessed on 12/02/09
52. Lu. Y, Morimoto. K, Takeshita. T, Takeuchi. T, & Saito. T (2000) Genotoxic effects of alpha-endosulfan and beta-endosulfan on human HepG2 cells. Environ Health Perspect. Vol.108(6): p559–561
53. Bajpayee. M, Pandey. AK, Zaidi. S, Musarrat. J, Parmar. D, Mathur. N, Seth. PK, Dhawan. A (2006) DNA damage and mutagenicity induced by endosulfan and its metabolites. DNA damage and mutagenicity induced by endosulfan and its metabolites. Vol. 47(9): p682-692
54. Fransson-Steen. R, Flodström. S & Wärngard. L (1992) The insecticide endosulfan and its two stereoisomers promote the growth of altered hepatic foci in rats. Carcinogenesis. Vol. 13 (12): p2299-2303
55. Galatone. V, Environment Canada (09/01/09) Endosulfan: Canada's submission of information specified in Annex E of the Stockholm Convention pursuant to Article 8 of the Convention. Available online- http://www.chm.pops.int/, accessed on 05/01/09)
56. Durukan. P et al (2009) Experiences with endosulfan mass poisoning in rural areas. European Journal of Emergency Medicine. Vol.16 (1): p53-56
57. Aleksandrowicz. D (1979) Endosulfan Poisoning and Chronic Brain Syndrome. Arch. Toxicol. Vol. 43 (1): p65-68
58. The Hindu (22/07/01) Cashews for human life? Available online- http://www.hindu.com/thehindu/2001/07/22/stories/13220611.htmm accessed on 30/01/09
59. Joshi. S (2001) Children of Endosulfan. Down to Earth. Vol.19 (28)
60. Jia. Z & Misra. H (2007) Developmental exposure to pesticides zineb and/or endosulfan renders the nigrostriatal dopamine system more susceptible to these environmental chemicals later in life. Neurotoxicology. Vol. 28 (4): p727-35
61. NIOH (2003) Final Report of the Investigation of Unusual Illnesses Allegedly Produced by Endosulfan Exposure In Padre Village of Kasargod District (N Kerala). National Institute of Occupational Health, Indian Council for Medical Research, Ahmedabad
62. THANAL (30/10/08) Statement at the High-level Ministerial Segment of the Fourth Rotterdam (PIC) Convention Conference of Parties (COP4) in Rome, Italy.
63. Ton. P et al. 2000. Endosulfan deaths and poisonings in Benin. Pesticides News 47.
64. Myers. D (2000) Cotton Tales. New Internationalist May 2000.
65. EU Endosulfan proposal. (27/08/08) UNEP/POPS/POPRC.4/14. UNEP. Available online- http://chm.pops.int/Convention/POPsReviewCommittee/Chemicalsunderreview/tabid/43/language/en-US/Default.aspx, accessed on 12/02/09
66. UNEP & GEF (2002) United Nations Environment Programme Regionally Based Assessment of Persistent Toxic Substances: Sub-Saharan Africa Regional Report. UNEP Chemicals. Geneva, Switzerland.
67. IPEN Pesticide Working Group Secretariat. Endosulfan - Fact sheet and Answers to Common Questions. Available online-
http://thanaluser.web.aplus.net/sitebuildercontent/sitebuilderfiles/endosulfan_factsheet.pdf, accessed on 04/02/09
68. Suchitra. M (March 2004) Unchecked pollution on the Periyar. India Together - http://www.indiatogether.org/2004/mar/env-periyar.htm
69. Ton. P et al (2000) Endosulfan deaths and poisonings in Benin. Pesticide News. Vol. 13 (7)
70. Dinham. B (1993) The pesticide hazard. Zed Books. London, UK
71. International Programme on Chemical Safety (1984) Environmental health criteria 40: Endosulfan. WHO/UNEP/ILO. Geneva, Switzerland
72. Beyond Pesticides - http://www.beyondpesticides.org/dailynewsblog/?p=401
73. Awaknavar, J. S., Karabhantanal, S. S. (2005) Toxicity of pesticides to earthworm, Polypheritima elongata (Michaelsen). Journal of Ecotoxicology & Environmental Monitoring
74. Down to Earth (April 2004) There is no justice. Down to Earth. Vol. 12 (20040415)
75. Vig. K, Singh. D, Agarwal. H, Dhawan. A, Dureja. P (2008) Soil microorganisms in cotton fields sequentially treated with insecticides. Ecotoxicol Environ Saf. Vol. 69(2): p263-76
76. Bastos. C, de Almeida. R, Suinaga. F (2006) Selectivity of pesticides used on cotton (Gossypium hirsutum) to Trichogramma pretiosum reared on two laboratory-reared hosts. Pest Manag Sci. Vol. 62: p91–8.
77. Kennedy. I et al (2001) Off-Site Movement of Endosulfan from Irrigated Cotton in New South Wales. Journal of Environmental Quality. Vol. 30: p683-696
78. Kelly. B & Frank. A (2003) An Arctic Terrestrial Food-Chain Bioaccumulation Model for Persistant Organic Pollutants. Environ Sci Technol. Vol. 37(13): p2966-2974
79. US EPA. 2007. Addendum to the Ecological Risk Assessment for Endosulfan. EPA-HQ-OPP-2002-0262-0063.
80. AMAP (2004) AMAP Assessment 2002: Persistent Organic Pollutants (POPs) in the Arctic. Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway.
81. Wang. X, Yao1. T, Cong1. Z, Yan. X, Kang. S & Zhang. Y (2007) Distribution of Persistent Organic Pollutants in Soil and Grasses Around Mt. Qomolangma, China. Archives of Environmental Contamination and Toxicology. Vol. 52(2): p 153-162
82. Herbert. B, Halsall. C, Fitzpatrick. L, Villa. S, Jones. K & Thomas. G (2004) Use and validation of novel snow samplers for hydrophobic, semi-volatile organic compounds (SVOCs). Chemosphere. Vol. 56 (3): p227-235
83. Garrison. V et al (2006) Saharan dust – a carrier of persistent organic pollutants, metals and microbes to the Caribbean? Int. J. Trop. Biol. Vol. 54 (Suppl. 3): p9-21
84. Goncalves. C, Silva. J, Alpendurada. M (2007) Evaluation of the pesticide contamination of groundwater sampled over two years from a vulnerable zone in Portugal. J Agric Food Chem Jul. Vol. 55(15): p6227-35
85. Kumari. B, Madan. V, Kathpal. T (2008) Status of insecticide contamination of soil and water in Haryana, India. Environ Monit Assess. Vol. 136(1-3): p239-44
86. El Bakouri. H, Ouassini. A, Morillo Aguado. J, Usero García. J (2007) Endosulfan sulfate mobility in soil columns and pesticide pollution of groundwater in Northwest Morocco. Water Environ Res. Vol. 79(13): p2578-84
87. GEF CAC (2002) Regionally Based Assessment of Persistent Toxic Substances – Central America and the Caribbean Regional Report. Global Environment Facility, United Nations Environmental Programme, Geneva. http://www.chem.unep.ch/Pts/
88. POPRC4/5: Endosulfan - http://chm.pops.int/Portals/0/docs/from_old_website/documents/meetings/poprc/chem_review/Endosulfan/Endosulfan_AnnexD_e.pdf
89. Stern. G & Ikonomou. M (2003) Temporal trends of organochlorine contaminants in SE Baffin (Pangnirtung) beluga, 1982-2002. Synopsis of Research conducted under the 2001-2003 Northern Contaminants Program. Ottawa ON, Indian and Northern Affairs Canada: p358-361
90. Jonsson. C & Toledo. M (1993) Bioaccumulation and elimination of endosulfan in the fish yellow tetra (Hyphessobrycon bifasciatus). Vol. 50 (4): p572-577
91. Landers. D et al (2008) The Fate, Transport, and Ecological Impacts of Airborne Contaminants in Western National Parks (USA). EPA/600/R-07/138. US EPA, Office of Research & Development, NHEERL, Western Ecology Division, Corvallis, Oregon.
92. AMAP (2009) Arctic Pollution 2009. Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway.
93. ACAT (2009) Persistent Organic Pollutants in the Arctic: A Report for the Delegates of the 4th Conference of the Parties Stockholm Convention on Persistent Organic Pollutants. ACAT
94. AMAP (2002) Arctic Pollution 2002: Persistent Organic Pollutants, Heavy Metals, Radioactivity, Human Health, Changing Pathways. Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway.
95. Whalon. M, Mota-Sanchez. D, Hollingworth. R, Duynslager. L (2008) Arthropod Pesticide Resistance Database. Michigan State University.
96. http://www.pesticideresistance.org/ cited in Watts, 2008
97. Organic Exchange (2008) Organic Cotton Farm and Fiber Report 2008. Organic Exchange. Texas, USA
98. Haffmans. S et al (2008) Phasing in Alternatives to Endosulfan. PAN Germany for PAN International. Hamberg
99. Cited in Ferrigno. S (2004) Organic Cotton: A practical guide to the UK market. Pesticide Action Network UK
100. Manuweera. G, Eddleston. M, Egodage. S & Buckley. N (2008) Do Targeted Bans of Insecticides to Prevent Deaths from Self-Poisoning Result in Reduced Agricultural Output? Environmental Health Perspectives. Vol. 116 (4)
101. PAN Germany (2008) How to Grow Crops without Endosulfan. PAN Germany, Hamburg
102. Thanal & IPEN (2009) Does endosulfan have an alternative? Thanal. Kerala, India
103. Lakhal. S & H'Mida. S (2007) The economics of organic and conventional cotton cultivation in Mali: country and farmers analysis. Oxford Business and Economics Conference, June 24-26 20 7. Oxford University, UK
104. Saunders. A (November 2007) PA278/07 Organic Crops – How Do They Perform? Department of Agriculture and Rural Development, Northern Ireland Government. Available online- http://www.dardni.gov.uk, accessed on 18/02/09
105. Down to Earth (15/01/09) Cover story: Farming, a good career. (http://www.downtoearth.org.in/cover.asp?foldername=20090115&filename=news&sid=10&sec_id=9)
106. Alternatives to Endosulfan in Latin America, RAP-AL, IPEN and RAPAM, 2008 (Spanish version) 2009 (English).- http://www.rap-al.org/articulos_files/Alternativas_12_Julio.pdf
107. IISD Reporting Services (20/10/08) Summary of the Fourth Meeting of the Persistent Organic Pollutants Review Committee of the Stockholm Convention: 13-17 October 2008. Earth Negotiations
108. PANNA's Technical Comment Letter to the EPA submitted Feb 19, 2008 - http://www.panna.org/files/PANNA-Endosulfan-Comments.pdf
109. Shen. H et al (2007) Concentrations of persistent organochlorine compounds in human milk and placenta are higher in Denmark than in Finland. Hum. Reprod. pp1-10
110. Mossler. M, Aerts. M and Nesheim. O (reviewed March 2009) CIR 1238: Florida Crop/Pest Management Profiles: Tomatoes. Pesticide Information Office, Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida


PROTECTING
PEOPLE AND
PLANET
EJF
ENVIRONMENTAL
JUSTICE
FOUNDATION