THE DEADLY CHEMICALS IN COTTON

A report by the
Environmental Justice Foundation

in collaboration with
Pesticide Action Network UK

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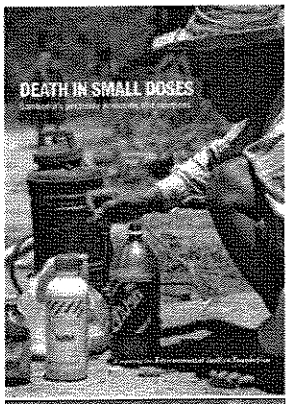

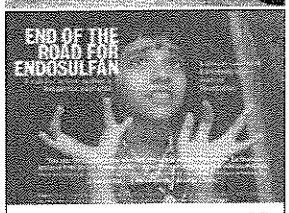

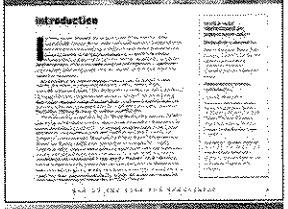

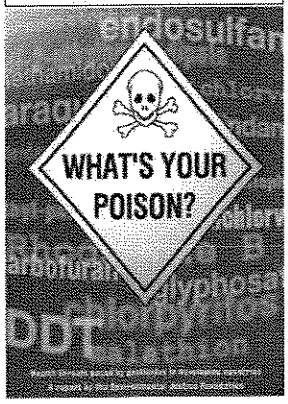

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Pesticide Action Network UK promotes healthy food, agriculture and an environment which will provide food and meet public health needs without dependence on toxic chemicals.

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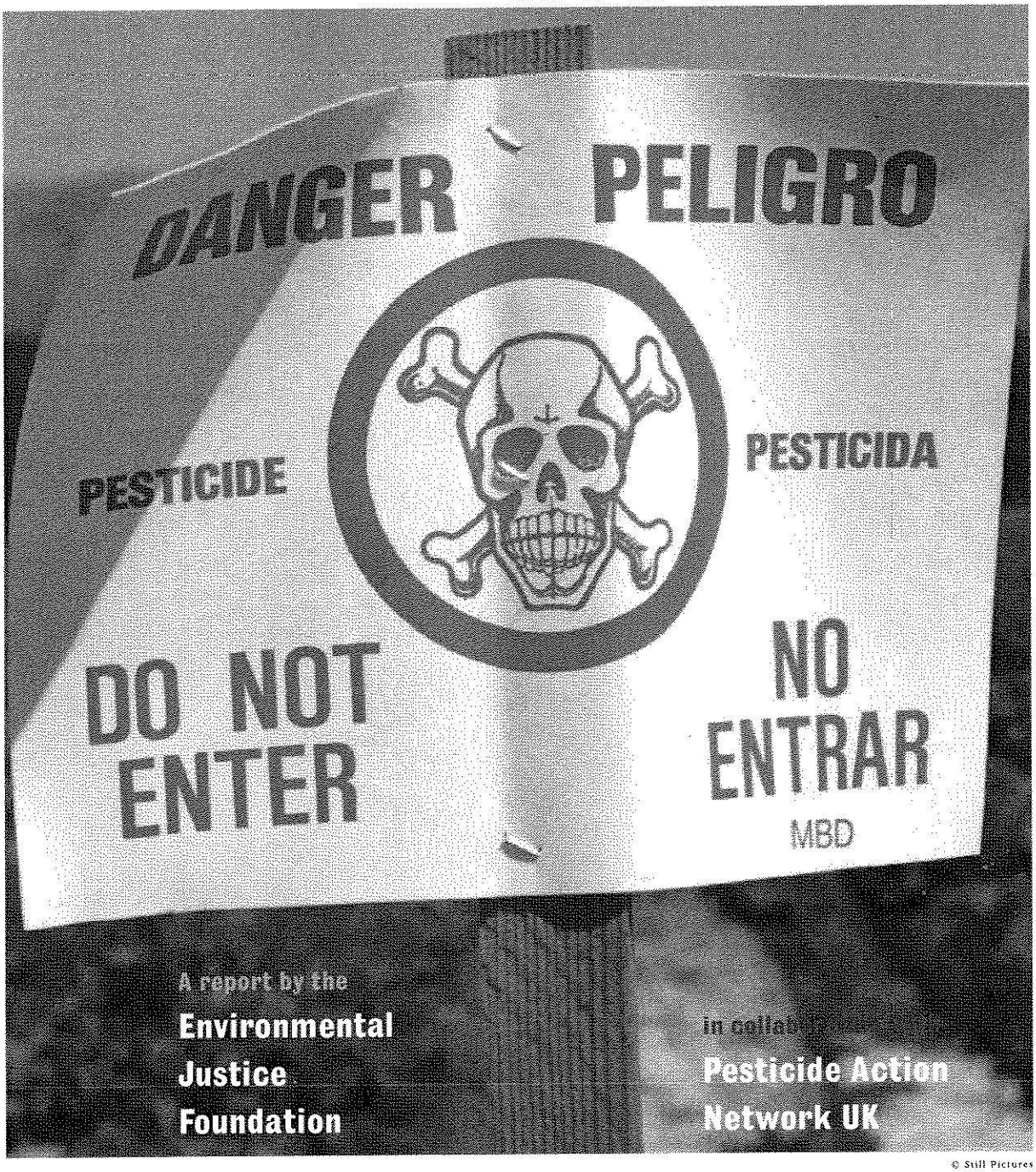
THE DEADLY CHEMICALS IN COTTON



A report by the
Environmental Justice Foundation

in collaboration with
Pesticide Action Network UK

EXECUTIVE SUMMARY

- Cotton is the world's most important non-food agricultural commodity, yet it is responsible for the release of US$ 2 billion of chemical pesticides each year, within which at least US$ 819 million are considered toxic enough to be classified as hazardous by the World Health Organisation. Cotton accounts for 16% of global insecticide releases – more than any other single crop. Almost 1.0 kilogram of hazardous pesticides is applied for every hectare under cotton.
- Between 1 and 3% of agricultural workers worldwide suffer from acute pesticide poisoning with at least 1 million requiring hospitalization each year, according to a report prepared jointly for the FAO, UNEP and WHO. These figures equate to between 25 million and 77 million agricultural workers worldwide.
- Acute symptoms of pesticide poisoning include headaches, vomiting, tremors, lack of coordination, difficulty breathing or respiratory depression, loss of consciousness, seizures and death. Chronic effects of long-term pesticide exposure include impaired memory and concentration, disorientation, severe depression and confusion.
- In India, home to over one third of the world's cotton farmers, cotton accounts for 54% of all pesticides used annually – despite occupying just 5% of land under crops. In a single 5 month observation period, 97 cotton farmers experienced 323 separate incidents of ill health. Of these 39% were associated with mild poisoning, 38% with moderate poisoning, and 6% with severe poisoning.
- A single drop of the pesticide aldicarb, absorbed through the skin can kill an adult. Aldicarb is commonly used in cotton production and in 2003 almost 1 million kilos was applied to cotton grown in the USA. Aldicarb is also applied to cotton in 25 other countries worldwide.

ABOVE: *Cotton accounts for 16% of global insecticide releases – more than any other single crop. Almost 1.0 kilogram of hazardous pesticides is applied for every hectare under cotton.*

- In Uzbekistan, the world's second largest cotton exporter, toxic agrochemicals first applied to cotton 50 years ago now pollute the country's land, air, food and drinking water. Despite the substantial damage that these chemicals cause to human health and the environment, Uzbekistan's dictatorship still sanctions the use of cotton pesticides so toxic that they were banned under the Soviets.

- Despite being particularly vulnerable to poisoning, child labourers throughout the world risk exposure to hazardous pesticides through participation in cotton production. In India and Uzbekistan children are directly involved in cotton pesticide application. While in Pakistan, Egypt, and Central Asia child labourers work in cotton fields either during or following the spraying season. Children are also often the first victims of pesticide poisonings, even if they do not participate to spraying, due to the proximity of their homes to cotton fields, or because of the re-use of empty pesticide containers.

- Hazardous pesticides associated with global cotton production represent a substantial threat to global freshwater resources. Hazardous cotton pesticides are now known to contaminate rivers in USA, India, Pakistan, Uzbekistan, Brazil, Australia, Greece and West Africa. In Brazil, the world's 4th largest consumer of agrochemicals, researchers tested rainwater for the presence of pesticides. 19 different chemicals were identified of which 12 were applied to cotton within the study area.

- 99% of the world's cotton farmers live and work in the developing world where low levels of safety awareness, lack of access to protective apparatus, illiteracy, poor labelling of pesticides, inadequate safeguards, and chronic poverty each exacerbate the damage caused by cotton pesticides to low income communities. Together developing world farmers are responsible for producing 75% of global cotton production.

- While the bulk of global cotton production occurs in developing countries, the majority of cotton products are sold to consumers in the developed world, with North America alone responsible for 25% of global household cotton product consumption, and Europe accounting for a further 20%.

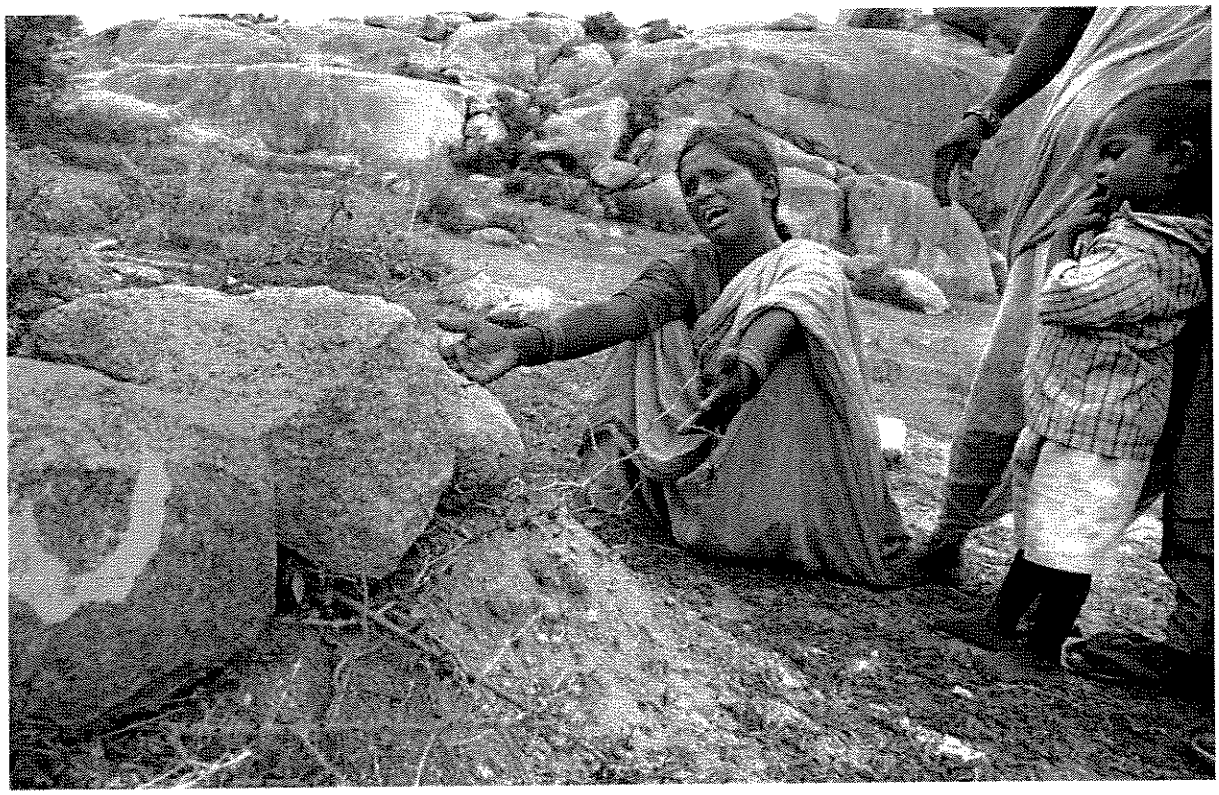
- Since the 1980s the global consumption of cotton has risen dramatically; almost doubling in the last 30 years. With demand now in excess of 25 million tonnes annually, the world's consumers buy more cotton today than ever before.

- The world's cotton farmers produce around 34 million tonnes of cottonseed annually in addition to the fibre. Cottonseed is used as an animal feed and, in the form of cottonseed oil, as a common cooking product accounting for approximately 8% of the world's vegetable oil consumption. Data compiled by FAO/WHO show the potential for pesticides to contaminate both refined cottonseed oil and cottonseed derivatives fed to animals.

- A 2004 study conducted by researchers at the Technical University of Lódz, in Poland, has shown that hazardous pesticides applied during cotton production can also be detected in cotton clothing.

- Purchasing decisions made by consumers have the ability to directly impact production methods and thereby both environmental security and social equity.

- Organic cotton production offers a strong alternative to current production methods. Consumer demand for organic cotton currently stands at between US$ 800 million and US$ 1 billion, and is growing rapidly such that demand currently outstrips supply. With strong demand, organic cotton production not only offers a more environmentally and socially sustainable alternative, but is economically viable. Cotton traders and investors (public and private) should encourage the conversion of conventional cotton production to organic methods.



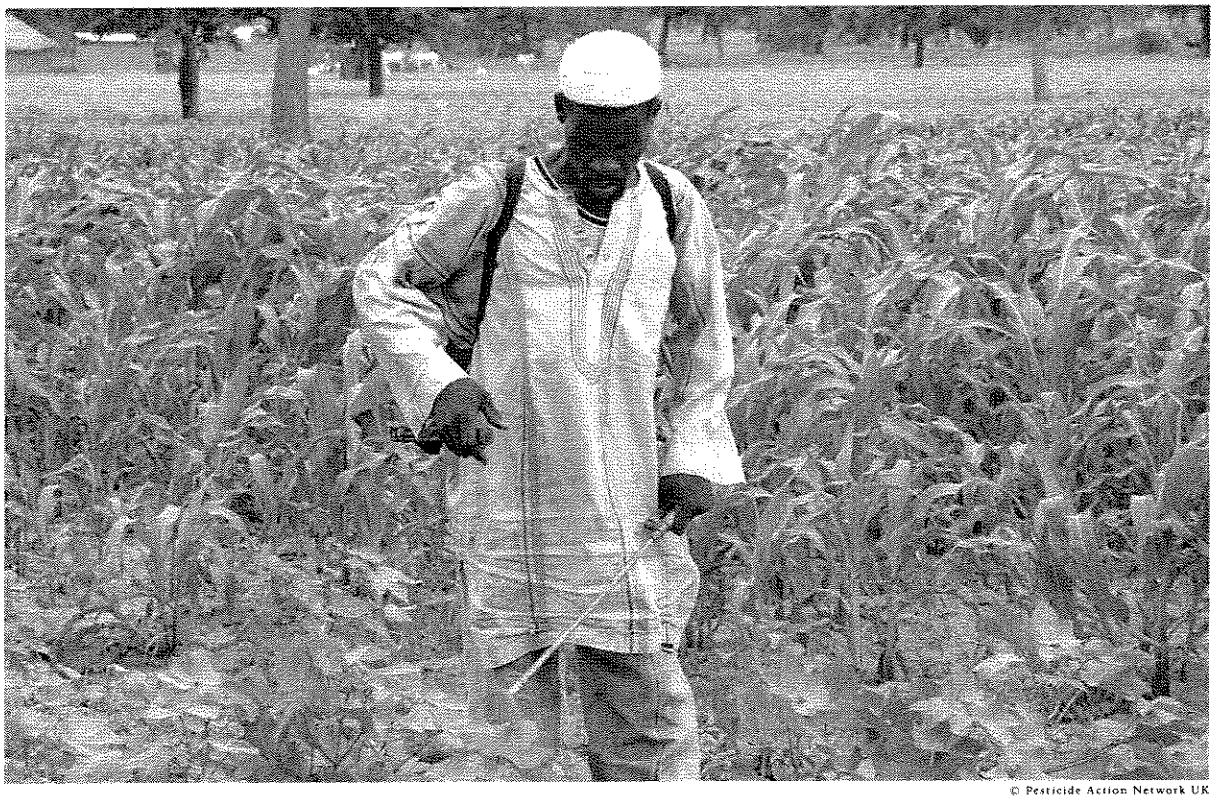
INTRODUCTION

ABOVE: [redacted] *and her family weep at the grave of her son* [redacted] *who died after spraying pesticide on cotton crops. Andhra Pradesh, India.*

In the Indian cotton growing season of 2005, researchers set out to investigate the impact of acute pesticide poisoning on cotton farmers living in three villages in Andhra Pradesh. The scientists recruited 50 female cotton growers who were asked to record the adverse health impacts experienced by themselves and by one designated male relative. While the design of the experiment was simple, the evidence it uncovered was deeply disturbing. Over a five month growing season, the 97 cotton labourers involved in the study experienced a total of 323 separate incidents of ill health, of which 83.6% were associated with signs of mild to severe pesticide poisoning. Reported symptoms included burning eyes, breathlessness, excessive salivation, vomiting, nausea, dizziness, blurred vision, muscle cramp, tremors, loss of consciousness and seizures. In total up to 10% of all spraying sessions were associated with three or more neurotoxic or systemic symptoms.

In reporting their study, the scientists behind the investigation described India's 10 million cotton farmers as working in a highly unsafe occupational environment where protective measures and equipment for the safe handling and spraying of pesticides are far from being adopted; people work bare-foot and bare-handed wearing only traditional sarongs; cotton farmers are directly exposed to pesticides for between 3 and 4 hours per spraying session, and concentrated chemical products are mixed with water using bare hands.

These harrowing observations of farmers exposed to hazardous pesticides are not untypical of cotton production in the developing world. Yet they stand in stark contrast to the overtly safety conscious shopping malls of Western Europe and America, where newly washed tile floors are earmarked with notices warning shoppers not to slip. However, despite the scant similarities between the developing world's 27 million cotton farmers and Western consumers, the two groups are inextricably linked by cotton: the world's most important non-food agricultural commodity – a fibre we now produce and consume in greater abundance than ever before.



© Pesticide Action Network UK

Up to 99% of the world's cotton farmers live and work in the developing world, where cotton is predominantly a smallholder crop grown by the rural poor[12].

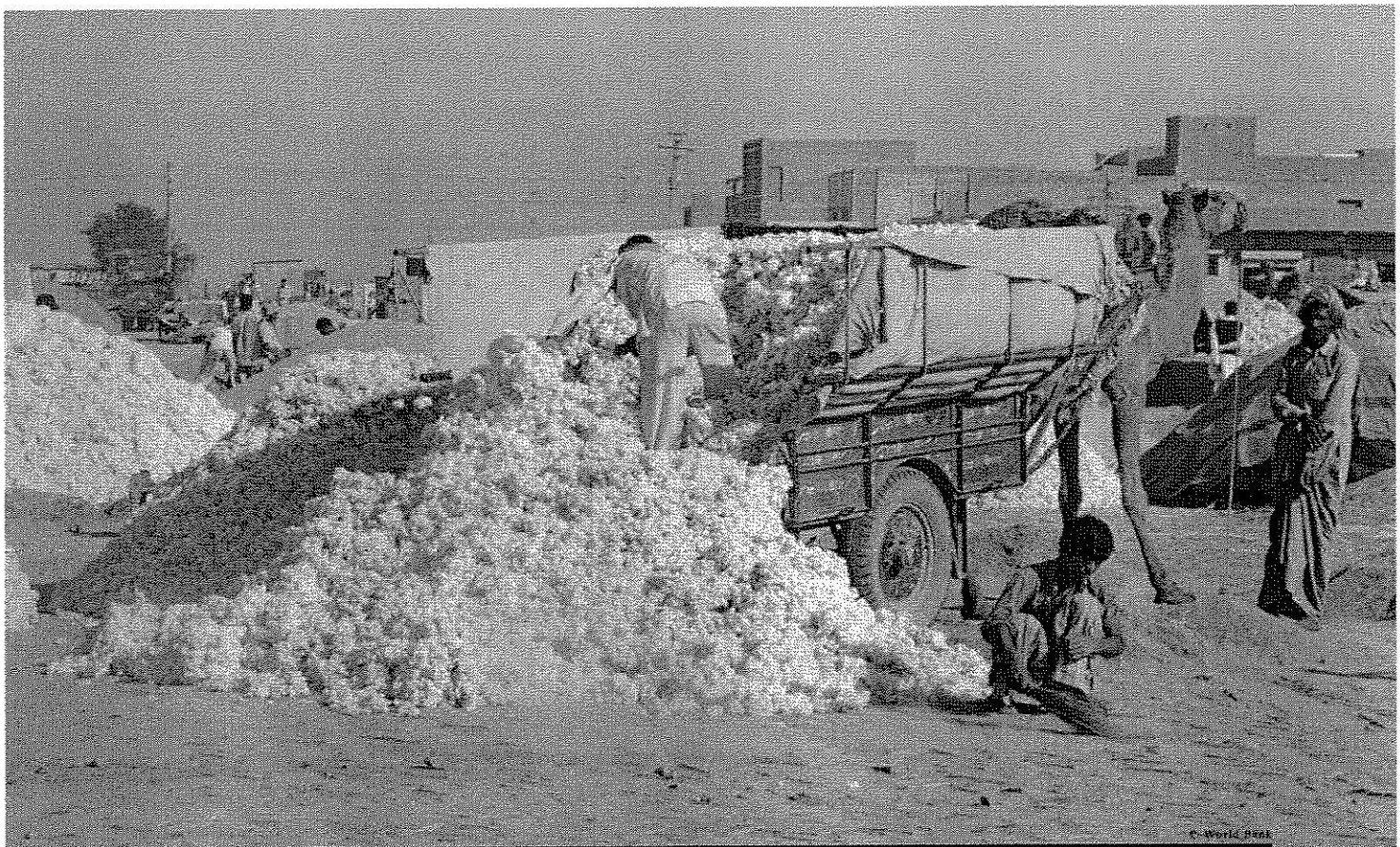
[redacted], FAO (Regional office for Asia and the Pacific)

Up to 99% of the world's cotton farmers live and work in developing world countries; with almost two-thirds residing in either India or China, and with many of the remainder located in West Africa, or South America. Predominantly members of the rural poor, these smallholders typically cultivate cotton on plots of less than one-half hectare, or on parts of their farms, as a means of supplementing their income.

But the cultivation of cotton comes at an appalling price. Between them, the world's cotton farmers are responsible for handling US$ 2 billion of agrochemicals every year; US$ 819 million of which are toxic enough to be classified as hazardous by the World Health Organisation. These chemicals include some of the most poisonous substances applied to crops anywhere in the world – and they are commonly used in developing countries without any of the safeguards, regulations or protections expected in the West.

In total almost one kilogram of hazardous pesticides is applied per hectare under cotton, and cotton is responsible for 16% of global insecticide usage – a figure higher than any other single crop. The risks these farmers take are exacerbated by the circumstances of their relative poverty, lack of effective regulation systems, poor labelling of pesticides, illiteracy, insufficient knowledge of pesticide hazards, and lack of protective equipment, each acting to sponsor exposure to hazardous pesticides.

This report reveals the way in which most of the developing world's cotton farmers work and the hazardous pesticides which contaminate their environment and threaten their health. It presents an astonishing picture of the harm caused to supply wealthy, predominantly western consumers, and with it, presents a compelling case for immediate action by all parties involved: business, consumers, politicians, unions, and farmers.



More than three quarters of cotton output is accounted for by developing countries

, Senior Economist at the World Bank (2003)

A Rich Man's Commodity...Is A Poor Man's Crop

In 2004, for the first time, the world's cotton harvest totalled over 100 million bales[1] (21.8 million tonnes). This milestone was not a freak occurrence, but the result of sustained increases in the amount of cotton we produce and consume. Worldwide, cotton production has almost doubled since the early 1980s[2] and with consumers now buying more cotton than ever before[3], growth forecasts predict further increases in production over the next five years[4].

Up to 80% of all cotton-fibre products are destined for the consumer market[5]. Within this figure, a disproportionate volume of cotton manufactures is sold to consumers in the developed world where higher per capita GDP translates directly into greater levels of fibre consumption[6]. The primary product manufactured from cotton is clothing, which accounts for some 60% of the world's total cotton production[7], with a further 35% used to make home furnishings[8]. While the bulk of such products originate from Asia, the majority are sold to consumers in the developed world, with North America alone responsible for 25% of global household cotton product consumption, and Europe accounting for a further 20%[9]. In recent decades these countries have witnessed dramatic growth in demand for cotton products, with US per capita end-use consumption increasing from 7 to 16 kg/year in the last 25 years[10].

North America and Europe account for 45% of global household cotton product consumption, despite being home to just 13% of the world population[11]

While the bulk of cotton-fibre products is sold to consumers in wealthy nations, up to 99% of the world's cotton farmers live and work in the developing world. Almost two thirds live in either India (10 million) or China (7.5 million)[12]. These farmers, unlike their counterparts in the US or Australia, are predominantly members of the rural poor often cultivating cotton on plots of less than one-half hectare[13], or on parts of their farms, as a means of supplementing their livelihoods[14].

In total, farmers in the developing world are responsible for over 75% of global cotton production[15], with those in China, India, Pakistan, Uzbekistan and Brazil accounting for 55% of the world harvest. In other developing countries cotton plays a vital role in supporting the national economy, accounting for approximately 80 percent of export earnings in Benin, 50 percent in Mali, 40 percent in Burkina Faso and between 10 and 20 percent in Chad and Togo[16].

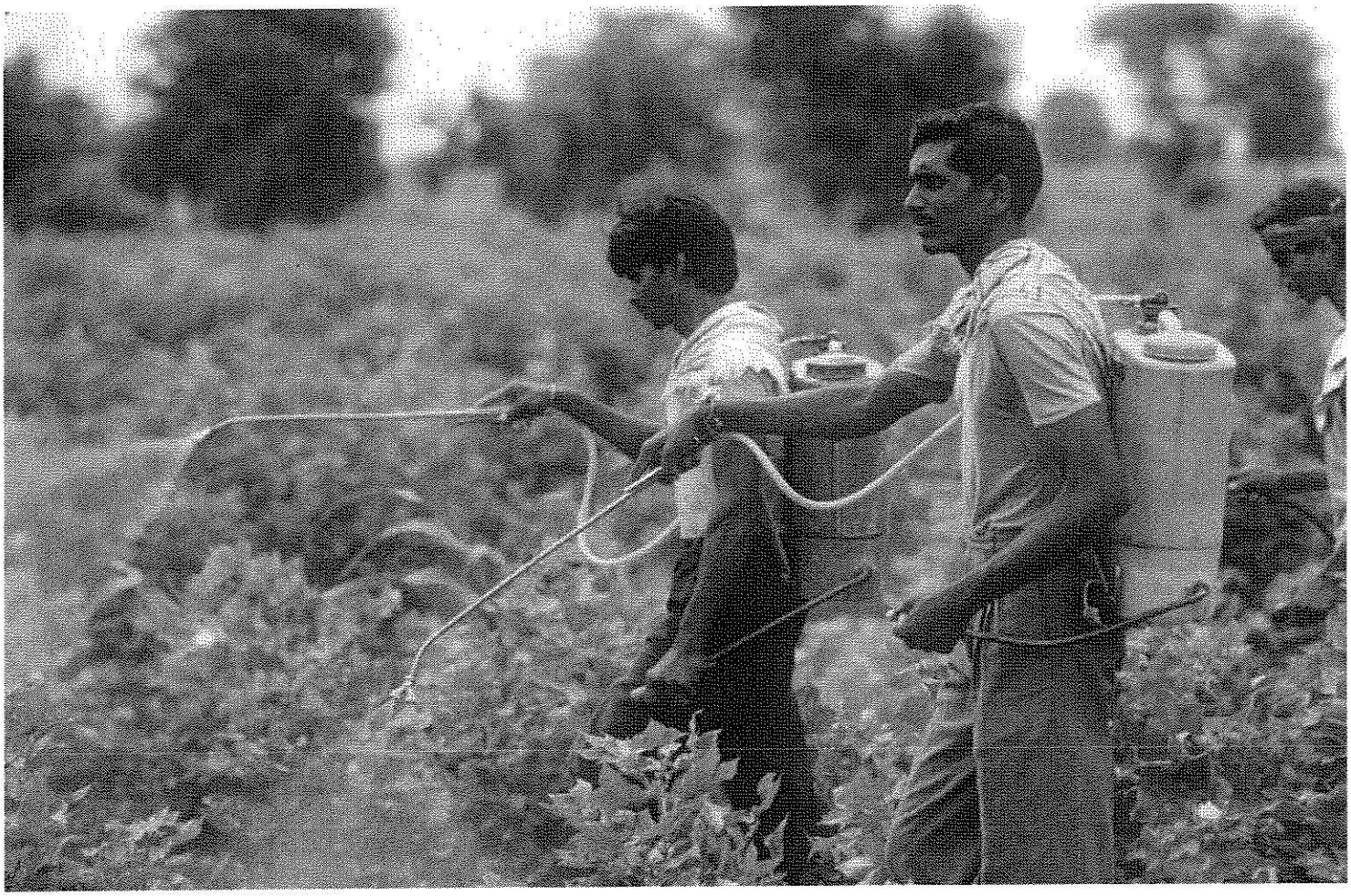
THE CHEMICALS IN COTTON

From its initial cultivation in the Indus valley and South America in 3,000 BC, up until the 1950s, global cotton production occurred predominantly without the use of hazardous agrochemicals[1]. For some 5,000 years cotton pests were controlled by agricultural management and tillage practices. Pest cycles were taken into consideration before planting and at harvesting, crop rotations were used, and cotton was planted at lower densities to reduce the impact of pest populations[2].

Soon after the Second World War, global cotton production changed dramatically when a number of newly discovered neurotoxic chemicals – such as DDT – were first introduced as an alternative means of pest control. Perceiving these chemicals to be a cheaper alternative to the use of labour and machinery, cotton farmers began to use these and former methods of pest control were largely abandoned[3]. However, for many developing world cotton farmers, the switch to toxic pesticides is a comparatively recent phenomenon. In Pakistan for example, just 5-10% of cotton cropland in the Punjab was treated with pesticides in 1983[4]. By 1991 this figure had escalated to 95-98%.

BELOW: *The world's cotton farmers spend a total of US$ 2 billion on agricultural pesticides every year, of which over US$ 819 million worth are toxic enough to be classified as hazardous by the World Health Organisation.*

© Still Pictures



In total the world's cotton farmers apply a staggering US$ 1,310 million of insecticides to cotton each year: far more than is applied to any other single crop worldwide – including maize, rice, soybeans and wheat[13]

A Chemical World

Today cotton farmers from as far apart as Egypt, India, Peru and Australia spend a total of US$ 2 billion on agricultural pesticides every year[5]. Of these chemical applications at least US$ 819 million are toxic enough to be classified as hazardous by the World Health Organisation such as deltamethrin and endosulfan, which are the two most widely used insecticides on cotton[6]. Within this figure a staggering US$ 112 million is spent on aldicarb (WHO Ia) – the world's second biggest selling cotton pesticide, and one of the most toxic chemicals in global agriculture (see table below). Other hazardous pesticides used in large volumes include parathion (WHO Ia), methamidophos (WHO Ib) and alpha-cypermethrin (WHO II). In total almost 1.0kg of hazardous pesticides is applied for every hectare of global cropland under cotton[7].

While the bulk of these pesticides are released by the world's major cotton producing countries, the use of hazardous pesticides in cotton production has become a truly global phenomenon. Of 33 countries responding to a 2005 survey, which together account for 90% of the world's cotton production[8], all of them listed at least 1 hazardous pesticide among the ten most commonly used by their own domestic cotton producers[9]. These countries include 16 from Africa, 7 from Asia and 5 from South America. Within this, 18 respondents, (Argentina, Brazil, Cote d'Ivoire, Egypt, Ethiopia, Greece, India, Iran, Madagascar, Mexico, Pakistan, Peru, Philippines, Sudan, Thailand, Turkey, Zambia and Zimbabwe) listed 'Extremely Hazardous' or 'Highly Hazardous' pesticides among those commonly used[10].

The Dirtiest Crop in the World ?

The bulk of pesticides associated with global cotton production are targeted at insect pest populations. Indeed, insecticides account for almost 60% of all agrochemicals applied to cotton worldwide[12]. From the perspective of human health this statistic is highly significant, as many insecticides act by impairing biological processes such as the nervous and reproductive systems – which are common among all animals; including humans.

In total the world's cotton farmers apply US$ 1,310 million of insecticides to cotton each year: far more than is applied to any other single crop worldwide – including maize, rice, soybeans and wheat[14]. Despite accounting for just 2.5% of global cropland[15], cotton in responsible for the release of 16% of global insecticides (by market share)[16]. While it is difficult to obtain comprehensive global data on the application of hazardous pesticides in world agriculture, the fact that cotton outstrips all other major crops in terms of insecticide applications supports the view that cotton has become the world's 'dirtiest' agricultural commodity.

Pesticide Toxicity Classification

The World Health Organisation classifies pesticides according to acute toxicity, using the LD50 (Lethal Dose 50%) benchmark. LD50 denotes the amount of a chemical required to kill 50% of an exposed population of laboratory rats. There are two measures for each product, oral LD50 (the product is administered orally) and dermal LD50 (the product is administered through the skin).

	Oral LD50		**Dermal LD50**	
	mg per kg body weight required to kill 50% of rat population			
WHO category	**solids**	**liquids**	**solids**	**liquids**
Ia Extremely hazardous	5 or below	20 or below	10 or below	40 or below
Ib Highly hazardous	5-50	20-200	10-100	40-400
II Moderately hazardous	50-500	200-2000	100-1000	400-4000
III Slightly hazardous	Over 500	Over 2000	Over 1000	Over 4000

Organic cotton plant, Benin.
© OBEPAB

World Cotton Production: an overview

Cultivated in over 80 countries worldwide – and on all 6 continents [1], cotton is the world's most important non-food agricultural commodity[32]. The world's largest producer is China where farmers harvest 4.6 million tonnes of fibre annually. While the Indian cotton harvest totals just over half that of China's, India has the largest area under cotton cultivation, over 8.3 million hectares – located mainly in the country's North and West[33]. The most productive cotton producer in the world is Australia which harvests an average 1,689 kilos of fibre per hectare under cotton – over 5 times as much as in India. Responding to both local needs and consumer demands, organic cotton is now grown in over 20 countries around the globe. Organic cotton production has increased 5-fold over the past 4 years.

The Major Hazardous Pesticides in Cotton

	WHO Class	Mass (Metric tonnes)	Value (US$ million)
Insecticides			
Malathion	III	12,600	164
Aldicarb	Ia	3,650	112
Parathion	Ia	3,625	60
Acephate	III	1,920	51
Methamidophos	Ib	2,100	51
Alpha-cypermethrin	II	180	50
Beta-cyfluthrin	II	135	47
Dimethoate	II	2,000	42
Deltamethrin	II	133	40
Chlorpyrifos	II	1,280	40
Herbicides			
Methylarsonic acid	III	2,245	33
Pendimethalin	III	1,690	33
Fluazifop-p-butyl	III	100	24
Bromoxynil	II	355	17
Fungicide			
Etridiazole	III	50	12
Thiram	III	390	5
Metalaxyl	III	25	4

Data for 2002, from Agranova Alliance (2003)[33]

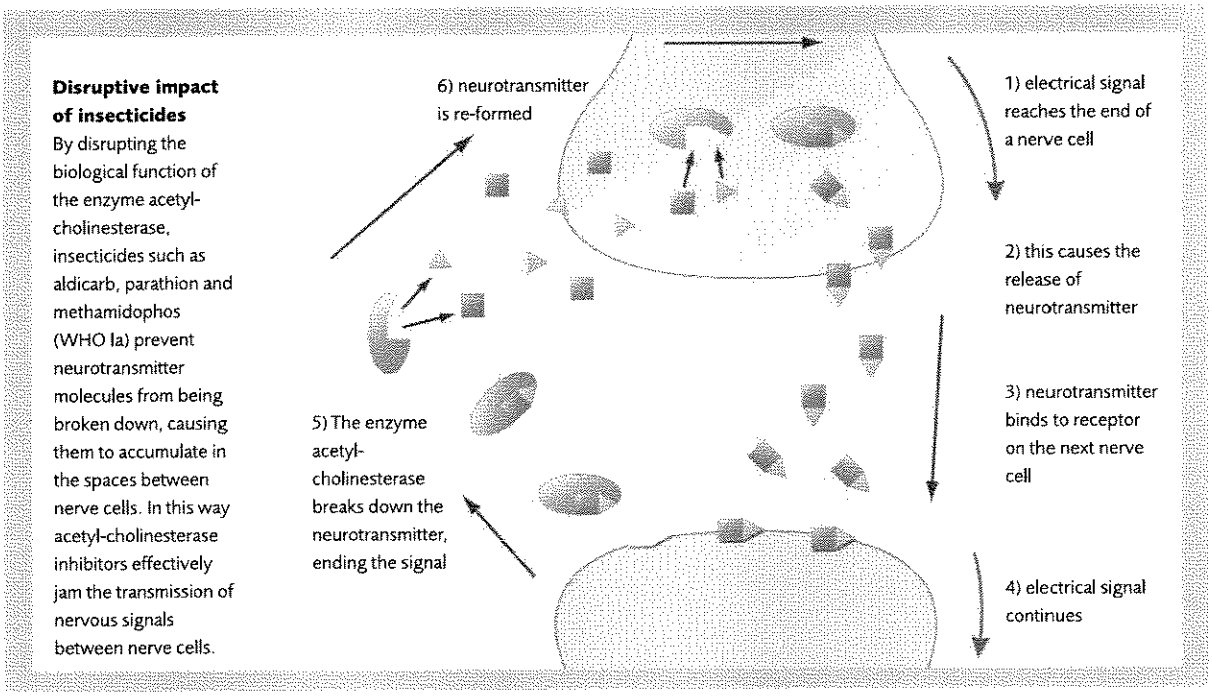
DEATH IN THE FIELDS

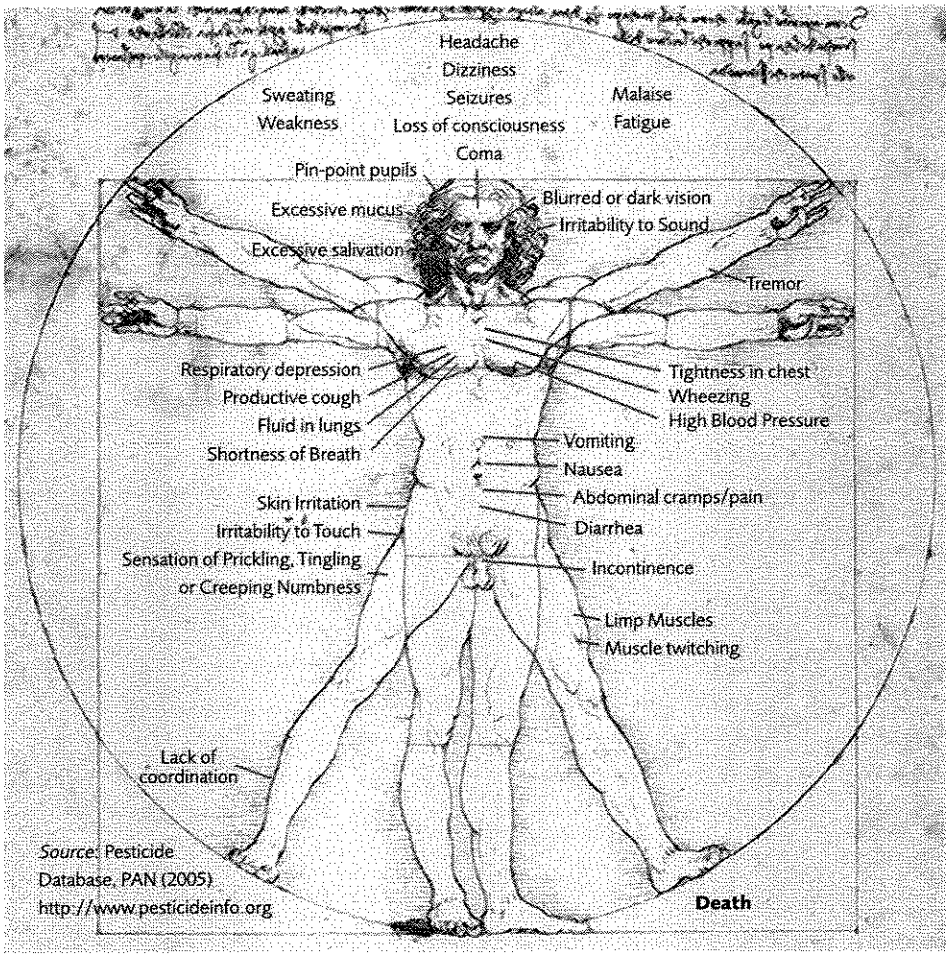
How and why pesticides damage human health

Pesticides are hazardous by design: chemicals manufactured with the aim of killing, repelling or inhibiting the growth of living organisms by impairing biological processes essential for the maintenance of life[1]. In many cases pesticides not only affect the physiology of the pest species they are intended to control, but also impact upon the well-being of human adults and children. This phenomenon is particularly associated with insecticides, many of which are designed to interfere with biological systems common throughout much of the animal kingdom, such as the nervous and reproductive systems. Indeed of the 201 agrochemicals classified by the WHO as being either 'Extremely', 'Highly' or 'Moderately' hazardous, insecticides represent by far the biggest group (52%). By comparison the proportion of herbicides (15%), fungicides (14%), and rodenticides (10%) included within these hazard classifications is substantially smaller[2].

Of particular risk to human health is a class of insecticides which act by disrupting the enzyme acetyl-cholinesterase, a molecule essential for the proper functioning of both the insect and human nervous system. This category includes the insecticides aldicarb (WHO Ia), parathion (WHO Ia), and methamidophos (WHO Ia) – all of which are among the top 10 pesticides applied by cotton farmers globally[3]. By disrupting the activity of acetyl-cholinesterase these insecticides prevent individual nerve cells from communicating with one another, thereby impairing nervous co-ordination, and leading to symptoms ranging from tremors, nausea, and weakness to paralysis and death[4]. Exposure to acetyl-cholinesterase-inhibiting pesticides has also been linked to impaired neurological development in the foetus and in infants, chronic fatigue syndrome, and Parkinson's disease[5].

ILLUSTRATION: *Normal acetyl-cholinesterase activity*





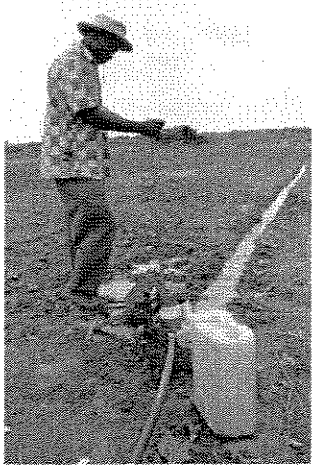
Acute vs. Chronic Poisoning

Pesticides can have both acute and chronic health impacts, depending on the nature of exposure. Acute poisoning is caused by exposure to a high dose of a toxic chemical, on one occasion. Symptoms of poisoning develop in close relation to the exposure and, in extreme cases, can result in death. The extent of acute poisoning symptoms depends both on the toxicity of the product and on the quantity absorbed. Acute effects can be delayed by up to four weeks and can include cramping in the lower limbs that leads to lack of coordination and paralysis. Improvement may occur over months or years, but some residual impairment may remain. Very high doses may result in unconsciousness, convulsions and death.

By contrast, chronic poisoning results from repeated exposure to toxic agents over a longer period, with only a low dose entering the body each time. Normally, no symptoms develop in relation to each exposure. Instead, victims gradually become ill over a period of months or years. Over time poison can accumulate in the body, or cumulative damage can become significant enough to cause clinical symptoms. Chronic effects of long-term pesticide exposure include impaired memory and concentration, disorientation, severe depressions, irritability, confusion, headache, speech difficulties, delayed reaction times, nightmares, sleepwalking, drowsiness and insomnia[12]. An influenza-like condition with headache, nausea, weakness, loss of appetite, and malaise has also been reported[13]. Some symptoms may only appear later in life, or even in the next generation. These include learning difficulties, behavioural and reproductive defects (e.g. accelerated puberty, infertility), and increased susceptibility to cancer[14]. Other long-term effects include teratogenesis (inducing embryo malformation) and DNA mutations (inducing genetic or chromosomal mutations)[15].

Double trouble: Immunotoxicity

Pesticides may also disrupt the body's immune system, suppressing normal immune responses, and reducing resistance to bacterial, viral and other infections[6]. While these effects are difficult to study because there are so many factors affecting human immune function, several persuasive studies indicate that immune system effects may be consequences of pesticide exposure[7]. For example, among Indian factory workers chronically-exposed to pesticides, blood lymphocyte levels were found to have decreased by as much as 66%[8]. Immune system abnormalities have also been observed among farm workers in the former Soviet Union, where pesticides are used heavily[9]. A comparison between pesticide-exposed children with non-exposed controls revealed significantly higher rates of infectious disease in the exposed children[10]. One important link is that people whose immune systems have been artificially depressed through taking immunosuppressive drugs after transplants, are at higher risk of developing the same profile of cancers as those observed among farmers[11]: a correlation which may be due to compromised immuno-activity caused by long term pesticide exposure.



Dangers for the Developing World

While hazardous pesticides are applied to cotton grown worldwide, their negative impact on human health is visited disproportionately upon those living and working in the developing world[16]. Not only are these countries home to 99% of the world's cotton farmers[17], but low levels of safety awareness, lack of access to protective apparatus, illiteracy, poor labelling of pesticides, inadequate safeguards, and chronic poverty each exacerbate the damage caused by cotton pesticides among these low income communities.

According to a recent publication prepared jointly for the FAO, UNEP and WHO, between 1% and 3% of agricultural workers worldwide suffer from acute pesticide poisoning: with at least 1 million requiring hospitalization each year[18]. While these percentages may at first appear small, their global significance is substantial. Worldwide, the agricultural workforce stands at 2.6 billion people[19] (over 40% of the total world population[20]). This figure sets the number of agricultural workers affected by acute pesticide poisoning at between 26 million (1%) and 77 million (3%) worldwide – an upper limit which significantly outstrips the population of the United Kingdom[21].

While it is difficult to quantify the share of global pesticide poisonings directly associated with cotton, the crop undoubtedly plays a major role in causing short-term ill health among agricultural workers worldwide. Not only does cotton account for some US$ 819 million dollars of hazardous pesticides annually, but within this figure cotton represents 16% of global insecticides usage – a larger share than any other single agricultural commodity. To add to this, in some major developing world cotton producing countries, such as India and Pakistan, cotton production accounts for over 50% of all pesticides used in agriculture – despite covering just 5 and 15% of primary cropland respectively[22].

Acute Pesticide Poisoning

The victims of cotton pesticide poisoning experience a broad spectrum of negative health impacts ranging from headaches, to seizures, loss of consciousness, and in severe cases death[23]. A 2005 study of 97 farmers working to grow cotton in 3 different villages in India underlines the array of symptoms that cotton pesticide poisoning can cause. Over a 5 month observation period, the labourers reported headaches, excessive sweating, burning eyes, running nose, breathlessness, excessive salivation, skin rashes, vomiting, nausea, dizziness, blurred vision, staggering gait, muscle cramp, twitching eyelids, tremors, loss of consciousness and seizures[24]. In total, 323 separate incidents of ill health were reported. Of these 39% were associated with symptoms of mild poisoning, 38% with moderate poisoning, and 6% with severe poisoning. While these data relate to just 97 workers among India's population of 10 million cotton farmers[25], they hint at a substantial health problem at the heart of the global cotton producing sector.

While developing countries account for less than 30% of global pesticide consumption[26], the bulk of pesticide poisonings occur in a developing world scenario; including an estimated 99% of pesticide induced deaths[27]. The reasons for this skewed distribution are twofold. Firstly, the developing world is home to 96% of the global agricultural workforce[28]. The majority of these labourers are found in Asia (1,900 million) and Africa (443 million), with a mere 1.3% of working in either the EU (27.3 million) or the USA (6.3 million)[29]. Secondly, developing world countries are characterised by agricultural practices which encourage substantial exposure to hazardous pesticides.

Chronic Disease

Alongside the immediate health risks associated with poisoning, those working in cotton production are exposed to the longer-term dangers of chronic disease. While these effects are inherently harder to detect due to the time lag between exposure and the onset of disease[30], their impact on human health may be just as significant. Although few field investigators have directly measured the long term health impacts of pesticide exposure in agricultural labourers, studies of

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laboratory animals, together with a growing body of epidemiological research, and reported incidents involving human exposure, suggest pesticides may be responsible for causing: spontaneous abortions, stillbirths, birth defects, early neonatal deaths, disruption of the endocrine system, sterility, decreased intelligence, behavioural abnormalities, leukaemia, lymphoma, brain cancer, and a weakened immune system[33]. The only study known to the authors which attempts to examine the long term health impacts of exposure to hazardous pesticides among labourers working in cotton production, found significantly lower levels of serum acetyl-cholinsterase in exposed participants, coupled with lower neurobehavioural functioning in tests designed to assess visuomotor speed, visual attention, auditory attention and memory, and visual memory[34].

An Egyptian study of 52 cotton labourers working in the Menoufiya Governate found that 88% of participants had never used protective clothing[36]. Only 6% of workers reported frequently wearing face masks over their nose and mouth.

Non-occupational exposure

While the agricultural labourers who work in close contact with hazardous cotton pesticides are among those worst affected by exposure, the health impacts of chemicals applied to cotton extend far beyond those directly involved in pesticide applications. Accidental exposure and poisoning involving individuals of all ages not directly involved in agricultural labour is known to result from inappropriate storage of pesticides (a recent survey by PAN-UK found that 86% of households surveyed stored their pesticides in their bedroom[35]), open access to contaminated equipment, and pesticide drift from spray application in the field[37]. A 2002 survey of cotton farms in Tanzania found that cotton pesticides were stored in bedrooms, near food, or near open fires in 2 out of 10 farms[38]. Furthermore, in many developing countries empty pesticide containers are often re-used by farm workers to carry drinking water. A recent investigation to identify the cause of serious illnesses among a village community in Madhya Pradesh (a cotton producing region of India) found that many villagers were using empty pesticide containers in this way. Analyses of food samples and human blood, revealed high levels of endosulfan[39]: a major pesticide used in Indian cotton production[40].

Children in cotton

Because of their smaller body size, differing metabolism, and rapidly growing and developing organ systems, children are inherently more vulnerable to the negative impacts of exposure to pesticides[41]. This places children who live in cotton farming communities, particularly in the developing world, at greater risk of ill health through association with hazardous agrochemicals applied to cotton.

ABOVE: *Pesticide containers: resold and reused to carry drinking water putting families at further risk from poisoning.*
© OBEPAB

Globally the number of children poisoned by pesticides is thought to be substantial[42]. Such poisonings occur in the context of cotton production in a number of different ways. Contact may arise through the involvement of children in agricultural labour. In parts of Uzbekistan[43] and India[44], children are known to work directly in cotton pesticide application. While in Egypt, Pakistan, Uzbekistan, Turkmenistan, Tajikistan, and India, children regularly work in the cotton fields during, or following, the spraying season when levels of pesticide residues are high[45]. Other scenarios include children following their parents during spraying operations, children coming into contact with inappropriately stored equipment and pesticides, children playing close to cotton fields following pesticide application, when family members fail to wash their clothes following work in contaminated fields, and when the spraying of pesticides occurs close to living quarters, or drifts into neighbouring fields, homes or schools[46].

While evidence of ill-health among children exposed to cotton pesticides is poorly documented, a study conducted in India found evidence that children living in cotton producing regions may be at risk of impaired mental development. Released in 2003, the analysis tested a total of 899 children in Indian states where pesticides are used intensively in cotton production, and compared the results with a nearly equal number of children living in areas where few agricultural pesticides are applied[47]. In more than two thirds of the tests, children living in cotton producing areas performed significantly worse in tests designed to assess mental ability, memory, concentration, cognitive skills, balance, and co-ordination.

Something in the water

Globally, 99% of deaths relating to pesticides occur in developing world countries[35]

Numerous studies undertaken in major cotton producing countries such as USA, India, Pakistan, Uzbekistan, Brazil, Australia, Greece and in West Africa have documented detectable levels of hazardous pesticides commonly applied to cotton in local water resources[48]. While this type of contamination undoubtedly occurs regardless of the economic status of the countries involved, it is likely to pose a greater threat to communities living in the developing world, where drinking water is less often treated and quality monitoring facilities are often lacking.

A 2005 study analysed samples of water taken from 6 locations in Lake Volta: the most important inland water resource in Ghana. The lake is fed by the river Volta which originates from Burkina Faso, Cote d'Ivoire and Togo, and flows through farming regions in these countries, before reaching Ghana[49]. These farming regions are noted for their production of cotton, among other crops. Lindane was detected in 22.7% of the samples, while endosulfan showed up in up to 18%[50]. Endosulfan is commonly applied to cotton growing in Cote d'Ivoire, while in Togo, lindane is applied to cotton in response to disease[51].

US scientists tested water samples taken from the Mississippi Embayment (Arkansas, Kentucky, Louisiana, Mississippi, Missouri and Tennessee), a major area for cotton production in the United States[52]. Dicrotophos (WHO Ib), an organophosphate used extensively in the cotton growing areas was the most frequently detected (35% of samples)[53]. Methyl parathion (WHO Ia), the most used insecticide in the cotton growing areas was the second most frequent contaminant (18%). The researchers also found traces of profenofos (12%), malathion (12%), cyanazine (46%), fluometuron (57%), and norflurazon (49%) – all pesticides applied to cotton growing in the region[54].

In Brazil, the world's 4th largest consumer of agrochemicals, researchers analysed samples of water taken from streams, rivers and surface water in the Pantanal basin, southern Mato Grosso state. Among other pesticides the scientists detected traces of alachlor (WHO III), chlorpyrifos (WHO II), endosulfan (WHO II), metolachlor (WHO III), monocrotophos (WHO Ib) and profenofos (WHO II): all pesticides applied to cotton within the study area[55]. The scientists also analysed rain water collected from sites in the same region finding traces of 19 different pesticides – 12 of which were applied to cotton. Almost 80% of samples taken from the *planalto* region – the major region of cotton production with in the study area – contained endosulfan.

Chemicals in the food chain

The primary economic rationale underlying the production of cotton is the trade in cotton fibre, which accounts for around 80% of a cotton farmer's income[57]. In addition to fibre, the world's cotton farmers produce around 34 million tonnes of cottonseed every year[58]. This high protein commodity is not only used as an animal feed, but is also a source of cottonseed oil: around 3.1 million tonnes is used in the preparation of food each year[59]. In total, cottonseed oil represents approximately 8% of the world's vegetable oil consumption[60], providing the major source of fat and oil in Mali, Chad, Burkina Faso, Togo, Ivory Coast, and Cameroon[61], and forms a significant part of the diet of the Middle East (3.8 g/day), Far East (0.5 g/day), and Latin America (0.5 g/day)[62].In total, as much as 65% of harvested cotton produce may enter the human food chain[63].

Data collected by the FAO/ WHO Joint Meetings on Pesticides Residues in Food, show that hazardous pesticides applied to cotton – including aldicarb (WHO Ia), parathion (WHO Ia), methyl parathion (WHO Ia), methamidophos (WHO Ib), deltamethrin (WHO II), imidacloprid (WHO II), and chlorpyrifos[64] (WHO II) – can potentially contaminate both refined cottonseed oil, and cottonseed derivatives commonly fed to animals. Given that 75% of global cotton production occurs in developing communities, and that less than 5% of cottonseed, and cottonseed derivatives, are traded internationally[65], these chemicals may pose a significant threat to communities in the developing world where the facilities necessary for monitoring pesticide contamination are often lacking.

While these data represent mere snapshots of the global situation, they offer a stark warning. Given that the use of such toxic pesticides is widespread, evidence of contamination found at one location points to a potential far greater problem worldwide. Furthermore, the few studies which have analysed the frequency of cottonseed contamination have found pesticide residues to be widespread. A recent analysis of cottonseed samples harvested in 5 locations in India found 26 % to be contaminated with chlorpyrifos (WHO II), 22% with endosulfan (WHO II),and 16% with ethion (WHO II)[68]. While a parallel study conducted in Pakistan found almost 75% of cottonseed samples to be contaminated with pesticides, with 41% exceeding the prescribed maximum residue limits[69]. According to a recent study conducted by researchers in India, "Because of the injudicious and indiscriminate use of insecticides, it is feared that cotton reaching the market may be heavily contaminated with insecticide residues."[70]

Contaminated Cattle

Around 23 million tonnes of cottonseeds and their derivatives are fed to animals every year. This comprises 6.8 million tonnes of whole cottonseeds, and 16.4 million tonnes of cottonseed hulls and meal[71]: by-products of the extraction of cottonseed oil. These materials are rich in energy, protein, fibre, and minerals such as potassium, sodium, magnesium and phosphorus[72], and can represent as much as 25% of a dairy herds total nutritive ration[73].

Cottonseeds, and their derivatives, are also known to contain hazardous pesticide residues, often at levels significantly higher than those observed in cottonseed oil. Furthermore there is strong evidence that residues consumed by animals can be incorporated into food products. In laboratory experiments, hens reared on food containing parathion (WHO 1a) and methamidophos (WHO 1b) showed traces of the pesticides in their eggs[74], while cattle reared on diets containing parathion (WHO 1a), aldicarb (WHO 1a), and methamidophos (WHO Ib), passed these chemicals into their milk[75].

Analysis of cows' milk destined for consumption in Brazil, where endosulfan is used extensively in cotton production but on few other crops, found that 10% of samples contained traces of the pesticide[76]. Earlier research conducted in Nicaragua uncovered traces of organochlorine residues in samples of cows milk from at least 38 different sites around the country; the most heavily contaminated milk came sites of intensive cotton production[77]. Thus, globally, cottonseed used as animal feed represents a second significant pathway by which hazardous pesticides applied to cotton may enter the human food chain.

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Take the shirt off my back?

Hazardous pesticides applied during cotton production can also be detected in cotton clothing. In 2004, a team of scientists based at the Technical University of Lódz analysed garments manufactured from cotton originating from Uzbekistan, Kazakhstan, Turkmenistan, Tajikistan, and USA[78]. Their research uncovered detectable traces of parathion (WHO Ia) and endosulfan (WHO II), as well as numerous persistent organic pollutants such as aldrin, endrin and DDT.

WEST AFRICA

[redacted], *former Director, Pesticide Action Network UK*

Cotton is the lifeblood of at least one and a half million farming families, 10 million people, in francophone West Africa[1]. In Benin, it supports over 50% of the population, and in Mali 20%[2]. The resourceful farmers rely entirely on rainfall for water. They are dependent on a highly controlled infrastructure for their seeds, fertilisers and pesticides provided on credit, as well as for advice and collection of the harvested cotton.

The pesticides used in the cotton growing areas are extremely dangerous, and the poor conditions allow little protection against adverse impacts on human health or the environment. Poisonings and ill-health are widespread. The pesticides are supplied on credit by a national distribution structure organised through national cotton companies, once owned by the State in each country but increasingly privatised or part privatised. Most of these companies in turn are linked to a French company, [redacted], still 40% owned by the French government[3].

Guidance for farmers is developed in research centres in France and West Africa, which recommend pesticides and spray regimes. In some ways this advice has prevented the extreme excesses of pesticide use. Spraying is conducted largely on a calendar basis – meaning that farmers are given set spraying dates, generally six to 10 times a season[4] – whereas in cotton-growing areas of certain developing countries pesticide spraying has escalated to 30-40 times a season[5,6]. However under the local conditions, this has not reduced farmers' problems.

In the late 1990s the insect pests developed resistance to the commonly-used pesticides. In Benin, insecticide costs rose 86% between 1999 and 2000, and reached an average of US$97 per hectare in 2001 [7]. To combat resistance, the research institutes recommended the reintroduction of endosulfan for the first two sprays of the season. Although classified by the World Health Organisation as 'moderately hazardous', this organochlorine insecticide is known for its adverse health and environmental impacts. The cotton advice regimes had recognised the dangers of the extremely toxic organophosphates used throughout the 1980s and early 1990s (although insect resistance was a primary reason for change), and problems from the use of a chemical as dangerous as endosulfan should have been predicted. Its use under the common conditions in West African cotton farming households seemed at the best ill-advised, and at worst irresponsible.

At the end of the first season after endosulfan was introduced in Benin (1999-2000), stories of poisonings and deaths among farming communities in the cotton growing areas emerged. In one area, the authorities reported that cotton pesticides had claimed at least 37 lives, and an additional 36 were identified with serious health problems. The government did not follow up with further investigations. Following these stories, the local non-governmental organisation, Organisation Béninoise pour la Promotion de l'Agriculture Biologique (OBEPAB) carried out an independent investigation in 2000 and, among families interviewed, confirmed 24 fatalities. They estimated that at least 70 deaths occurred just in the cotton areas it investigated[8]. OBEPAB followed this with investigations in the following two seasons, from 2000-2003. During this period they investigated and recorded 577 poisoning incidents in the villages visited, which included 97 fatalities[9].

The main products responsible for incidents were those containing the active ingredient endosulfan, accounting for 69% of the cases. The second offending product, causing 14% of poisonings, was a mixture of the pyrethroid lambda-cyhalothrin and an organophosphate – in some cases dimethoate and in others profenofos. This mixture is recommended for farmers to spray at least four times, after the first two sprays of endosulfan[10].

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 by the path and used it to scoop up some water from a ditch. He did not return home, and a village search found his body next to the empty endosulfan bottle innocently used to quench his thirst[11].

The reasons for the poisoning are various, and in addition to occupational exposure include food contamination, confusion of pesticides with food or drink, and self harm. They reveal numerous family tragedies. In one case a father left his pesticide-soaked work clothes on the roof of the house out of the reach of his four children, aged six to eight. It rained during the night, and the water passed through his clothes, dripping into domestic water vessels. The next morning the children drank and washed using water from the vessels and some minutes later suffered headaches, nausea and convulsions. They were taken urgently to the health centre, but all four children died within about 20 hours. In another case three boys aged 12-14 were weeding their father's cotton fields, which were cultivated with maize. The father had sprayed endosulfan on cotton the previous day. After weeding, the boys ate some maize cobs, but it had been contaminated with spray drift. Fifteen minutes later they started vomiting. They were taken to hospital, but the boy of 12 died. In another instance, 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 by the path and used it to scoop up some water from a ditch. He did not return home, and a village search found his body next to the empty endosulfan bottle innocently used to quench his thirst[11].

In a further study carried out by OBEPAB in 2004 which interviewed 197 villagers, all recorded some impacts from pesticide exposure. A medical study of 14 farmers from nine small villages found similar problems. The medical investigation recorded pesticide incidents and symptoms, and found that some people have been incapacitated for life: they have lost visual acuity, experience regular pain from conjunctivitis, and suffer serious metabolic and digestion problems[12].

No industrialised country would allow pesticides to be used under the conditions prevalent in African cotton fields. Farmers cannot follow recommended precautions. Personal protective equipment is not available or affordable – and in any event the heat and humidity makes it impossible to work with some of the essential items. Pesticide application is hard work, and users breathe in strongly while spraying. Most cotton pesticides are applied with light ULV sprayers: hands are easily saturated and light changes of the wind wafts spray onto the body and clothing. Where a backpack sprayer is used, these often leak as there are few maintenance facilities, and filling the tank is a high risk activity. In Benin, the survey found particular problems for women farmers, who do not have access to spray equipment and will often apply pesticides with same small hand pump used for spraying household insecticides, or even spread with a bucket and brush. Spray drift frequently contaminates farmers and those living and working nearby.

Pesticides are valuable, and are stored in the house. Farming communities live in basic housing, and few have lockable or isolated storage facilities. After use, the empty containers are generally reused. Typically, water is not readily accessible near the fields of the drier zones where cotton is grown, and few houses have running water or a nearby standpipe. Farmers and workers cannot immediately wash their hands or bodies splashed with pesticides. The task of washing out spray equipment and work clothing is generally assigned to women, who may need to use the same bowls as for washing, clothes, cooking or eating utensils, or possibly for food preparation.

The structural aspects of supply, credit, advice and training delivery ignore the reality that pesticides can be used under these conditions without risk.

The culture of cotton pesticide use has encouraged farmers to use pesticides on all crops, and particularly on the widely grown cowpea. Cowpea is largely cultivated by women, and is important for both domestic consumption, and as a source of cash from sales onto the local market. Cotton pesticides are widely used on this crop because of their ready availability. There are few outlets for pesticides in rural areas of Benin, and the input distribution system for cotton pesticides is one of the main sources of supply. Farmers explain that they cannot rely on supplies of the recommended products for cowpeas, and thus use the readily available cotton pesticides[13].

These problems of high costs of pesticide use, both economically and on the health of farming households, are replicated throughout the cotton growing areas of Benin. A study in five of the francophone West African cotton-growing countries (Burkina Faso, Cameroon, Mali, Senegal) found similar cases of poisoning and ill-health, including fatalities, associated with the current spray regimes[14].

Farmers must have access to better pest management. Options based on training farmers in Integrated Pest Management are under-explored, even though a number of the Farmer Field School training projects in the region have successfully shown that pesticide use can be halved or more. Strategies show that training enables farmers to recognise pests and predators, identify when these pose a threat to production and yields, learn how to encourage beneficial insects, manage improvements to soil fertility, and adopt a range of other strategies. A number of small but highly successful organic cotton projects in Benin, Mali, Burkina Faso, and Senegal have shown that cotton can be grown without using pesticides, and that the savings on pesticides plus the premium paid bring economic benefits to farmers and eliminate health tragedies being replicated across the region.

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UZBEKISTAN

Of the major cotton producing countries, Uzbekistan is arguably the most severely affected by pesticides. Toxic agrochemicals first applied 50 years ago now pollute the country's land, air and water[15], causing substantial damage to human health and the environment. While many of these problems derive from the Soviet era, Uzbekistan's totalitarian dictatorship has done little to correct or redress the use of toxic pesticides since Independence in 1991. The country's state-controlled cotton sector continues to use many of the same toxic chemicals applied during the Soviet era – in some cases despite prohibitive legislation, sustainable practices are far from widespread, and the cotton sector is characterised by a near total lack of safety awareness relating to pesticide application. Chronic mismanagement of the environment relating to pesticides now poses a threat to communities living throughout Uzbekistan and Central Asia.

Uzbekistan's intensive use of toxic pesticides was initiated as a means of realising the Soviet ambition of cotton self-sufficiency. For 30 years pesticides, such as DDT, aldrin, dieldrin, and lindane, herbicides and defoliants were used in large quantities[16]. Estimates suggest applications of between 20kg and 90kg of pesticides per hectare[17] – almost 20 times the average level of pesticides currently applied to cotton in the US[18]. These chemicals have rendered almost 90% of land contaminated[19], and a cocktail of pesticides now pollutes the country's water resources. Even at a depth of 100-150m, groundwater is often contaminated[20]. In 2000, a study conducted in Karakalpakstan, the country's worst affected region, found traces of DDT and lindane in all samples of treated water analysed[21]. In the same part of the country around 85% of the population are said to suffer poor health as a result of exposure to agrochemicals and unsafe drinking water[22].

The abundance of pesticides present in Uzbekistan's soil and water systems has left the country's 25 million inhabitants[25] constantly exposed to the danger of diseases caused by chemical contamination of foodstuffs[26]. Precise statistics regarding the level of ill-health relating to pesticides is largely unavailable – in part because state doctors are often reluctant to diagnose illnesses caused by pesticides and intentionally provide alternate diagnoses[27]. However, numerous studies carried out in rural Uzbekistan reveal a catalogue of diseases potentially linked to environmental health problems and toxicology. These include elevated levels of developmental retardation, mal-absorption, hypothyroidism, immunodeficiency, and chronic renal and lung diseases among children[28]. In downstream regions the rate of DNA mutation is 3.5 times higher than normal – with the worst levels of deterioration observed in those most exposed to toxic agrochemicals[29]. According to one of the scientists, "This means not only that people are more likely to get cancer, but that their children and grandchildren are too."[30]

A second major health risk is the abundance of pesticide-laden dust particles. Since the 1960s, Uzbek cotton farmers have drained their fields into the Amu Darya and Syr Darya waterways. These giant rivers have for decades carried pesticides from the cotton fields, towards the Aral Sea where they accumulate in the soil. Strong winds then collect the pesticide contaminated dust particles

"When I was little, people used to tell me about a strange disease called 'chicken eye' which attacks people while they work in the cotton fields. They said when you catch it, everything in front of your eyes becomes white until eventually you temporarily lose all vision. I used to wonder what on earth could cause such an unusual condition. Years later someone explained that these symptoms were the effects of the pesticides applied to cotton"

EJF INTERVIEW WITH A RURAL UZBEK (2006)

and transport them throughout Central Asia[31]. According to Medecins Sans Frontieres, an estimated 43 million tonnes of pesticide-laden dust is blown into the air every year[32] – among the highest rate of dust deposition in the world[33]. It can be no co-incidence that the Aral Sea region suffers the highest rate of throat cancer in the world – with 80% of cancer victims suffering this form of the disease[34].

Carry on contaminating

The seriousness and extent of pollution relating to pesticides applied during the Soviet era supports an overwhelming case for reform of Uzbekistan's state-controlled cotton sector. However, despite the end of control from Moscow in 1991, Uzbekistan's totalitarian government has shown little interest in attempting to halt the damage caused by cotton pesticides. While the overall amount of pesticides applied has fallen due to decreased availability and increased costs[35], pesticides are still applied to cotton at two or three times the recommended amount[36]

Of particular concern is the continued application of the highly toxic cotton-pesticides that characterised Soviet cotton production. The authors are aware of 10 pesticides used during the Soviet era that were seen being applied to cotton growing in Uzbekistan as recently as 2004[37]. This list includes the defoliant butifos – a highly toxic organophosphate used widely between 1960 and the mid-1980s, but whose use was officially terminated in 1987[38]. Despite being known to affect the central nervous system, heart, liver and kidneys and female fertility[39], butifos is still manufactured at the Soviet built [redacted]) and applied to cotton grown in Uzbekistan[40]. Another banned pesticide is phosalone[41], whose continued application to cotton was highlighted in a recent communication from the Uzbek Ministry of Agriculture[42]. This hazardous broad-spectrum pesticide, manufactured at the same plant in Navoi[43], has now been identified as a contaminant present in the toxic dusts arising from the Aral Sea region[44].

The state's policy of seemingly ignoring Soviet-era prohibitions is compounded by its failure to provide safety training to those involved in cotton production. One expert interviewed by the authors explained, "No farmer I have met has been given any sort of safety training, and the application of integrated pest management and biological control remains fairly limited"[45]. In perhaps the most alarming development since Independence, schoolchildren have been witnessed applying cotton pesticides[46]. In June 2004, state authorities in the Rishtan district of the Ferghana Valley were reported to have excused local schoolchildren from their end of year exams, and instead sent them to work spraying pesticides in the cotton fields[47]. One student described how she and her friends were issued with plastic mineral-water bottles filled with chemicals. The bottles had holes drilled in the caps so that the children can go up and down the rows dowsing the plants. Although the children were unaware of the exact identity of the chemicals they were applying, it was noted that the contents of the bottles burnt the skin upon contact[48]. Further reports indicate that children involved in applying pesticides are not supplied with any protective clothing[49].

The Sick Man of Central Asia

The continued application of toxic pesticides to cotton growing in Uzbekistan, and the failure to rationalise either the infrastructure relating to cotton production or the manner in which cotton is produced, not only poses a serious problem for the population of Uzbekistan, but for all those living in Central Asia. For not only are the environmental impacts of Uzbek cotton production felt beyond the country's borders (the Aral Sea dust cloud pollutes the air in Turkmenistan, and water contaminated by Uzbek pesticides journeys through much of Kazakhstan), but the use of toxic pesticides undermines efforts by other Central Asian countries to regulate their own domestic use of pesticides. Perhaps the best example is that of Kyrgyzstan, whose Department of Plant Protection has drawn up a list of permitted pesticides to be imported from manufacturers in India, Switzerland and Russia, but where up to 80% of pesticides applied are smuggled illegally from Uzbekistan and are unlikely to comply with the Kyrgyz environmental standards[50].

Pesticides on a plate
In 2000, an international study consistently found traces of highly toxic cotton-related pesticides in beef, sheep fat, chicken, fish, eggs, dairy products, onions and carrots produced in Uzbekistan[51]. A separate study by the World Bank found that most of Uzbekistan's food products do not meet national food quality standards due to contamination by cotton pesticides[52].

INDIA

Of all the communities adversely affected by hazardous cotton pesticides, a substantial proportion are located in India: home to more cotton farmers than any other country in the world[51]. Indian cotton production is heavily associated with the intensive use of hazardous pesticides, and is responsible for over half of all agricultural pesticides applied nationally[52]. Within this figure Indian cotton is associated with some of the most hazardous pesticides used anywhere on earth[53]. Characterized by a near total lack of safety measures, low quality equipment, and with protective clothing often unavailable or prohibitively expensive, Indian cotton production represents a highly unsafe environment within which to work[54]. Observational studies reveal a heavy toll exerted on the health of those who work with cotton pesticides[55] and chemical analysis has revealed traces of pesticide residues in blood samples taken from Indian cotton labourers. Cotton undoubtedly represents one of India's most important economic, nutritive and cultural commodities, but its conventional cultivation has become deeply problematic, both for those who grow it and because of the external costs of its impact on health and the environment[56].

Covered in Cotton

With over 8.3 million hectares under cultivation, India has more land under cotton than any other country[57]. This cropland is tended by the world's biggest cotton farming community.

At 10 million strong, well over one third of the world's cotton farmers live and work in India[58]. The country's vast cotton belt covers much of its western side, reaching as far south as Tamil Nadu, and stretching upwards almost as far as the Himalayas. Key production zones are located in the north (Punjab, Haryana, northern Rajasthan, and part of Uttar Pradesh), the centre (Gujarat, Madhya Pradesh and Maharashtra) and the south (Andhra Pradesh, Tamil Nadu and Karnataka)[59].

Despite having more cropland, India trails both China and USA in terms of overall cotton output, accounting for just 13% of global production[60]. And while other major producers such as China, Greece, Brazil and Australia all harvest over 1000 kilos per hectare under cotton, India's yield stands at little more than 300 kilos per hectare – half the global average[61]. The causes of India's low yields are highly complex, but contemporary farming practices undoubtedly play a major role. Traditional methods of pest control, such as manual removal of pests, intercropping, crop rotation, and the burning or removal of cotton residues from the soil have been largely abandoned, and high yielding crop varieties which are significantly more susceptible to plant pests and diseases have been introduced into the farming system[62].

Splash and burn

In an attempt to limit the damage caused by pest infestations, Indian cotton farmers now apply an estimated US$ 344 million of pesticides annually. This represents 55% of the country's entire expenditure on agricultural pesticides; a truly disproportionate figure given that cotton accounts for just 5% of India's total cropland[63]. And within this figure a staggering US$ 235 million is spent trying to control bollworm alone[64].

The majority of pesticides that dominate applications to Indian cotton are classified as hazardous[65]. Among these perhaps the most significant is the 'Highly Hazardous' organophosphorus compound, monocrotophos, which accounts for 22% of the entire Indian cotton insecticides market[66]. Other insecticides included in the top 10 are endosulfan (WHO II), quinalphos (WHO II), fenvalerate (WHO II), chlorpyrifos (WHO II), dimethoate (WHO II), and imidacloprid (WHO II)[67]. In addition, surveys of pesticide use in specific regions reveal farmers applying even more hazardous chemicals to their cotton. A 2000 study of 3 villages in Andhra Pradesh documented cotton farmers applying pesticides classified as 'Extremely Hazardous': parathion, methyl parathion, and phosphamidon[68]. While cotton farmers in Karnataka are also known to use ethion (WHO II) and carbaryl (WHO II)[69].

In the blood

For the 10 million labourers directly involved in Indian cotton production, the dangers presented by the many hazardous pesticides used on cotton are exacerbated by the manner in which they are applied. Protective measures and equipment for safe handling and spraying of pesticides are far from being widely adopted[70]. Instead, cotton farmers have been documented working barefoot and barehanded, wearing only short-sleeved cotton T-shirts and traditional sarongs[71]. Not only is protective equipment expensive, unavailable, and cumbersome to use, but in extreme hot weather conditions of the tropics protective gear is rarely employed[72]. Working under such conditions farmers are liable to be directly exposed to pesticides for 3 to 4 hours per spraying session.

The consequences of occupational exposure to cotton pesticides are both extensive and severe. A 2005 study of 97 farmers working to grow cotton in 3 different villages in the southern state of Andhra Pradesh documented 323 separate incidents of ill health over a 5 month observation period[73]. Labourers reported symptoms including headaches, excessive sweating, burning eyes, running nose, breathlessness, excessive salivation, skin rashes, vomiting, nausea, dizziness, blurred vision, staggering gait, muscle cramp, twitching eyelids, tremors, loss of consciousness and seizures[74]. Of the total incidents reported, 39% were associated with symptoms of mild poisoning, 38% with moderate poisoning, and 6% with severe poisoning, and up to 10% of all spraying sessions were associated with three or more neurotoxic or systemic symptoms[75].

Meanwhile recent medical analyses of villagers from cotton farming regions in northern India has revealed a more subtle, yet equally disturbing health consequence of exposure to hazardous pesticides. Blood samples taken from residents to 4 villages in Punjab, – India's major cotton producing state – revealed traces of hazardous pesticides commonly

LEFT: *Two Indian women picking cotton*
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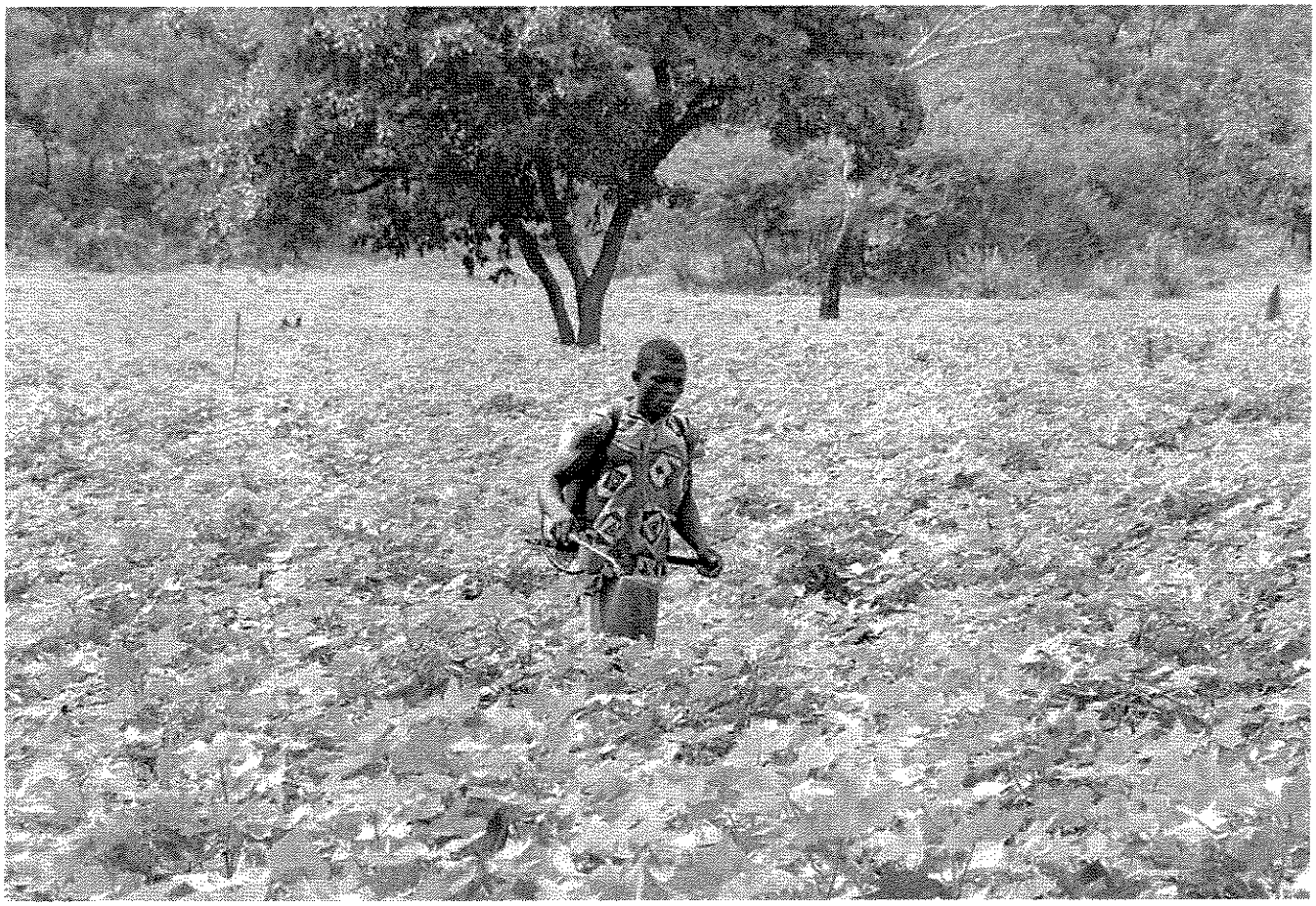
used in Indian cotton production: chlorpyrifos (WHO II) was detected in 85% of blood samples analysed, monocrotophos (WHO Ib) in 75%, and endosulfan (WHO II) in 25%[76].

Countrywide contamination

While the hazardous pesticides applied to cotton pose a clearly identifiable risk to those directly involved in Indian cotton production, the same chemicals may also endanger the well-being of innumerable people not directly associated with agriculture. Firstly, cotton pesticides may be present as contaminants in drinking water. In 2003, Indian researchers tested 16 brands of bottled drinking water for traces of pesticide residues. 14 brands tested positive for chlorpyrifos, and 1 for dimethoate – both chemicals commonly applied during Indian cotton production[77]. While this kind of exposure is not associated with the kinds of extreme symptoms incurred during agricultural work, the presence of pesticides in India's drinking water supplies carries potential health implications for a far larger group of people.

Communities in India may also be exposed to hazardous cotton pesticides through the contamination of cottonseed and cottonseed derivatives – an important source of edible oil. Because of the intensive use of hazardous pesticides in cotton production much of the cottonseed oil entering the Indian food chain may be heavily contaminated[78]. One analysis of cottonseeds collected from 5 locations in Punjab found detectable residues of the cotton pesticides ethion (WHO II), cypermethrin (WHO II), endosulfan (WHO II), chlorpyrifos (WHO II): the latter being 2 of the most common pesticides applied to cotton in India[79].



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TOWARDS CLEANER COTTON

Globally the world's cotton farmers use around US$ 2.0 billion of chemical pesticides each year, with around two thirds of these sales accounted for by insecticides (US$ 1.3 billion)[1]. The bulk of these chemicals are manufactured by a handful of multinational corporations, with just 7 companies accounting for over 60% of the world market[2]. While developed countries such as the USA are significant consumers of cotton insecticides, countries in the Far East and Latin America – which include many significant developing world cotton producers – together represent 60% of the global market[3].

In 2005, 33 cotton producing countries, which together account for 90% of global cotton production[4], responded to a survey organized by the International Cotton Advisory Committee[5]. Each country was asked to list the 10 most important agrochemicals that its farmers use to control cotton pests. EJF has analysed the responses they gave, and for each country has assessed the extent to which these commonly used agrochemicals are hazardous according to the WHO Recommended Classification of Pesticides. All 33 respondents listed at least one hazardous pesticide as being commonly applied by cotton farmers in their country[6]. Two thirds of countries, listed at least 5 hazardous chemicals in their top 10[7]. Of the many hazardous pesticides, herbicides, fungicides, and defoliants applied to cotton grown worldwide, EJF has identified 6 which pose a particular risk to human health and the environment (Annex I). These chemicals are used extensively by the world's cotton farming communities despite the dangers they present.

In response to the serious health and environmental risks posed by hazardous pesticides, some countries have either banned or restricted the application of specific agrochemicals in crop production. However, at present only 17 countries have imposed a ban on any of the top 10 hazardous pesticides used in global cotton production[8]. Of these, only 10 actually cultivate cotton, of which just 2 are major cotton producers[9].

In addition to the few unilateral decisions to ban the use of specific hazardous pesticides associated with cotton, there has also been agreement on non-legally binding

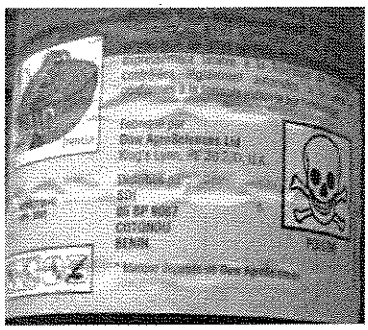
actions such as The International Code of Conduct on the Distribution and Use of Pesticides adopted by the United Nations Food and Agriculture Organisation, which *inter alia*, suggests that '*Prohibition of the importation, sale and purchase of highly toxic and hazardous products, such as those included in WHO classes Ia and Ib (34), may be desirable if other control measures or good marketing practices are insufficient to ensure that the product can be handled with acceptable risk to the user*'[11]. The Code also states that, '*Pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users in tropical climates*'[12]. In reality, such conditions tend to apply to the use of all class Ia and Ib pesticides and to most class II pesticides by farmers in most developing countries. As one analyst notes, "From this it is safe to assert that considering the current lack of appropriate protection measures in most developing countries, the FAO recommends not to use Class Ia and Ib, and possibly most of Class II"[13].

The World Bank has operational policies that prohibit the funding of formulated products that fall in WHO classes Ia and Ib, or formulations of products in Class II, '*if (a) the country (where they are to be used) lacks restrictions on their distribution and use; or (b) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly*'[14]. Such circumstances are prevalent across much of the developing world.

The Rotterdam Convention on the Prior Informed Consent (PIC) procedure for certain hazardous chemicals and pesticides in international trade is a legally-binding agreement that came into force in 2004[15]. Created as a joint initiative between the FAO and UNEP, and now backed by 106 countries worldwide – including most leading cotton producers – the treaty aims to promote shared responsibility and cooperative efforts in the international trade of hazardous chemicals[16]. Of the pesticides currently subject to the Convention, 7 are widely applied to cotton. Endosulfan (WHO II), an eighth hazardous pesticide – arguably the most widely applied in global cotton production – is also to be considered for inclusion under the Convention's protocols[17].

The inclusion of so many cotton pesticides under the Rotterdam Convention underlines the danger these chemicals pose to the world population. However, whilst the treaty aims to facilitate information exchange regarding the release of hazardous chemicals; to provide each party with a decision-making process on their import and export; and to ensure that chemicals are correctly labeled with information relating to potential health and environmental impacts; the treaty does not exist to promote an end to the sale and use of those chemicals it considers dangerous[18].

As a global commodity grown predominantly in developing countries, cotton undoubtedly has a great potential to provide a valuable income to some of the world's poorest communities. Yet because of the substantial use, and misuse, of hazardous pesticides, for many of those who live and work in close association with cotton, the impact of the crop is often severely negative. In seeking to end the damage caused by cotton, and to enable cotton farmers to realize the benefits of the crop they produce, a variety of international stakeholders are now acting to change the way in which cotton is produced.



ABOVE: *Made in the UK: Dursban B – containing chlorpyrifos – has been linked to many deaths and accidents in Benin.*

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10 Major hazardous pesticides applied to cotton and where they are banned

Hazardous pesticide	Rank	WHO	Banned in
Malathion	1	III	none
Aldicarb	2	Ia	Libya, Tanzania, Indonesia, Finland, Sweden, Saint Lucia, Kuwait
Parathion	3	Ia	Angola, Tanzania, Australia, India, Indonesia, Laos, Philippines, Sri Lanka, Thailand, Finland, Portugal, Sweden, Belize, Kuwait
Methamidophos	#4	Ib	Libya, Indonesia, Kuwait
Acephate	#4	III	Norway
Alpha-cypermethrin	6	II	none
Beta-cyfluthrin	7	II	none
Dimethoate	8	II	none
Deltamethrin	#9	II	none
Chlorpyrifos	#9	II	none

Data from Pesticide Database, Pesticide Action Network[10]

Cotton pesticides considered under the Rotterdam Convention

	WHO[19]	Usage in global cotton production[20]
Parathion	Ia	Third biggest selling cotton insecticide worldwide (US$ 60 million). Applied to cotton in Greece and China.
Methamidophos	Ib	Fourth biggest selling cotton insecticide worldwide (US$ 51 million). Dominant cotton pesticide in Argentina, Mexico. Also used in Brazil, China, Colombia, Ecuador, Greece, Spain, Thailand, USA and Vietnam.
Methyl-parathion	Ia	Dominant cotton pesticide in Brazil, Colombia, Mexico. Also used in Australia, Guatemala, Pakistan, Spain, Thailand, USA.
Monocrotophos	Ib	The major pesticide applied to cotton in India. Dominant in China, Madagascar and Zambia. Also applied to cotton in Bangladesh.
Thiram	III	Third biggest selling cotton fungicide worldwide. Applied to cotton in Argentina, Brazil, Cote d'Ivoire, Iran, Madagascar, South Africa, Togo, Turkey, Zimbabwe.
Lindane	II	A major pesticide applied to cotton grown in India. Also applied in Togo.
Carbofuran	Ib	Applied to cotton in China, Vietnam, Colombia, Brazil, Bangladesh and USA.
Endosulfan*	II	Dominant in Argentina, Australia, Benin, Brazil, Cameroon, Cote d'Ivoire, Ethiopia, Greece, India, Iran, Madagascar, Mali, Mozambique, Pakistan, South Africa, Sudan, Thailand, Turkey, and Zimbabwe. Also used in Bangladesh, Philippines, USA, and China.

** Endosulfan is to be considered for inclusion under the Rotterdam Convention, but is not currently subject to its protocols*

Integrated Pest Management

Integrated Pest Management (IPM) strategies reduce (but do not eradicate) the reliance on pesticides. IPM emphazises the growth of healthy crops and encourages natural pest control systems[22]. Actions commonly considered under the IPM framework include:

- Encouraging bird species which act as predators to cotton pest populations;
- Rotating cotton with crops less susceptible to the pests and diseases affecting cotton (i.e. wheat, pulses, legumes) in order to break the cotton/pest life cycle;
- Cultivating refuge crops which provide a habitat for beneficial animal species;
- Taking local ecology into account when selecting cotton varieties for cultivation;
- Planting border crops (i.e. maize, sorghum) around cotton fields to provide a physical barrier and which mask the odours given off by cotton plants;
- Planting intercrops (i.e. soybean, castor) among the cotton plants to encourage beneficial species into the cotton fields;
- Planting trap crops (marigold and sunflower) at low density around the outside of a cotton field to attract cotton pests away from the crop;
- Tolerating non-yield reducing early season crop damage rather than spraying crops with pesticides which may ultimately reduce the viability of beneficial species populations;
- Using chemical pheromones to discourage cotton pests from the field;
- Applying carefully selected narrow-spectrum pesticides designed to manage pest populations while having minimal impact on beneficial species.

Perhaps the most significant programme to engage developing world farmers in IPM cotton production is the 'FAO-EU IPM Programme for Cotton in Asia'[23]. Operating in six countries across the continent (Bangladesh, China, India, Pakistan, Philippines, Vietnam), the project has spread awareness by developing a cadre of local IPM cotton trainers who work directly with cotton farmers to develop appropriate strategies.

To date, 100,000 cotton farmers have graduated from IPM schools established under the scheme[24]. However, IPM does not entirely remove the use – and therefore the negative impacts – of chemical pesticides. It is a laudable aim, but a half-way house towards pesticide-free cotton fields.

Organic Cotton

Organic cotton production is the only farming system by which cotton is produced entirely free of chemical pesticides – and thereby without the risks that such chemicals pose to human health and the environment. Organic cotton production represents an alternative farming system within which natural predator populations are nurtured within cotton production zones, and measures such as intercropping and crop rotation are used to halt the development of cotton pest populations[27].

Over the last few decades organic cotton production has grown from just 30 farmers producing 113 tonnes of cotton fibre, to a global total of more than 31,000 tonnes[28]. While these figures represent only a small fraction (0.15%) of world cotton production, they represent an important proof of principle that contemporary cotton production can occur without the use of hazardous pesticides. In fact, so successful has organic production proved, that global production has increased 5-fold over the past four years[29].

Commercial organic cotton production is now underway in some 22 countries across Africa, Asia, the Mediterranean and the Americas. In sub-Saharan Africa, Uganda, Tanzania and Mali are the main producers, and production in Benin and Senegal are increasing rapidly. Production recently also started in Togo, Zambia, Malawi, and Kenya. As PAN-UK recently noted, *'Most small farmers are motivated to move to organic cotton to avoid corruption in the conventional sector, health risks, debt, and by the prospect of receiving organic premiums as well as prompt cash payments. For women, the prime motivations for organic farming are improved family health, and their children are not at daily risk of fatal poisonings. Their food supply is also safer, and more plentiful'*[31]. Women seem to benefit proportionately more from organic cotton production, particularly from the freedom to control their own incomes.

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

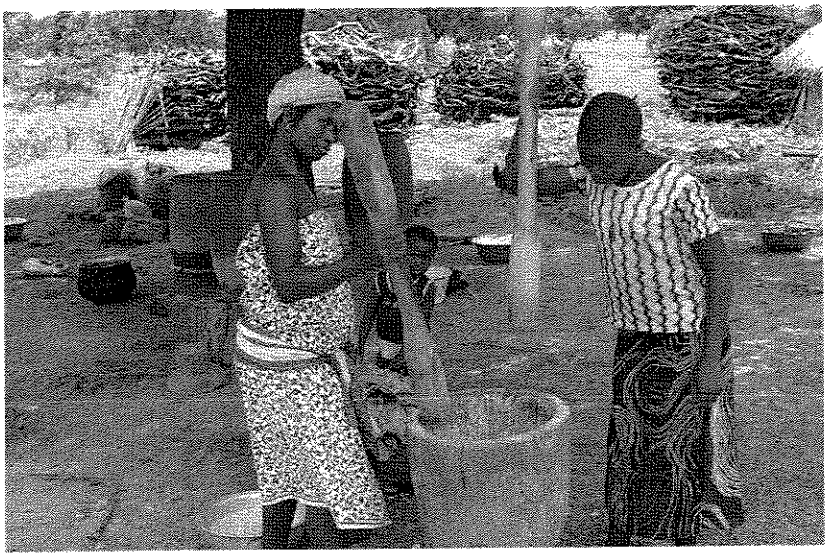
BÉNIN FARMER [redacted][26]

Major Organic Cotton Producers	Organic Cotton Harvest (MT)[30]
Turkey	10,700
India	9,835
China	2,531
USA	1,867
Tanzania	1,336
Uganda	1,100
Peru	1,000
Pakistan	1,000
Mali	722

Driving Change by Buying Organic

Demand for organic products among Western consumers is substantial, and growing. In a 2005 survey prepared by Ipsos MORI almost half of British consumers reported buying organic products, with many registering environmental concerns among those that shape the way they shop[32]. In 2003, UK market growth for organic cotton was estimated at 38% per year, and continues to grow at a steady rate[33]. To add to this, major clothing retailers, including [redacted][34], [redacted], and [redacted] are all now offering organic clothing ranges[35].

The growth in sales of organic cotton products is greatly enhanced by the existence of comprehensive labeling systems which enable consumers in the developed world to make informed choices about the type of cotton they wish to purchase. This vital connection, which endows the global cotton supply chain with a degree of transparency and traceability, may be our best hope to date of harnessing the concerns of those in the West as a powerful economic force for improving the lives of the million of people who work to grow cotton in the developing world.



LEFT: *Women organic cotton farmers prepare neem mixture, a natural pest repellent.*

CONCLUSIONS

For many millions of cotton farmers living and working in the developing world, hazardous pesticides form the root cause of substantial environmental and human suffering. Lacking the fundamental skills, knowledge and equipment necessary for the safe handling of pesticides, these agricultural labourers are causing substantial harm to themselves, their communities and their environment in their attempt to grow cotton – an enterprise that brings many into direct contact with some of the most toxic agrochemicals in the world. In many cotton growing regions, acute poisoning has become a common phenomenon, with entire families at risk of contamination through pesticide drift and contamination of drinking water and food sources.

While the dangers posed by hazardous cotton pesticides may seem remote to those who live and work in the developed world, the complexities of the global economy mean that consumers, retailers, and politicians around the world, are all in some small way linked to the suffering these chemicals cause. But crucially, each of these groups is endowed, by their connection with the global trade in cotton and cotton products, with the ability to change the manner in which global cotton production occurs.

Whether by purchasing organic cotton products or by establishing programmes aimed at eliminating hazardous pesticides from developing world countries, each one of these actors has the potential to secure positive change for the lives of developing world cotton farmers. Failure to act represents an attempt to benefit from the commodity these farmers produce, while ignoring their suffering. But with our existing understanding of organic cotton production, IPM and chemical safety procedures, the world's consumers, retailers and politicians are already well equipped with the tools necessary to end the human misery that cotton pesticides create.

RECOMMENDATIONS

General Recommendations

In the light of the information presented in this report, all relevant parties should:

- Call for a phase-out of pesticides classed by the World Health Organisation as being either 'Extremely Hazardous' (WHO 1a) or 'Highly Hazardous' (WHO 1b) as well as the organochlorine endosulfan (WHO II);
- Implement the recommendation issued in the FAO Code of Conduct, that formulated products that fall into WHO classes Ia and Ib, or formulations of products in Class II, are not sold to cotton farmers in developing world countries;
- Promote better agricultural practice based on reduced use of, reduced risk from, and reduced reliance on pesticides;
- Raise awareness of the problems linked to cotton pesticides, and how they can be avoided through well-funded, extensive education programmes;
- Promote organic cotton production and trade.

Consumers should:

- Buy organic cotton products;
- Ask clothing companies and retailers which pesticides were used in the production of cotton and cotton products they sell. Highlight their concern about the impact of cotton pesticides on the health of cotton producing communities and their environment and ask retailers to stock organic cotton products as a sustainable alternative.

International Clothing Retailers and Clothing Retail Associations should:

- Avoid sourcing textiles products manufactured from cotton grown in association with the use of formulated products that fall into WHO classes Ia and Ib, or formulations of products in Class II;
- Ensure that organic cotton products are available to consumers;
- Actively support the expansion of organic cotton production in the developing world and educate consumers as to the benefits of organic cotton.

World Health Organisation should:

- Conduct an urgent assessment of the global impact of cotton pesticides on the health of the world's cotton farming communities. This should include an analysis of (a) the extent to which agricultural labourers suffer from occupational poisoning; (b) the extent to which non-agricultural labourers living in cotton producing regions suffer from exposure to cotton pesticides; and (c) the extent to which cotton pesticides are present as contaminants in drinking water and in cotton derivates entering the human food chain;
- Establish regional health centres to monitor the occurrence of pathological exposures to pesticides.

The United Nations Environment Programme should

- Conduct an urgent assessment of the global impact of cotton pesticides on the global environment, and in particular the extent to which cotton pesticides contaminate global freshwater resources.

The United Nations Food and Agriculture Organisation should:

- Substantially expand IPM training programmes to include *all* cotton farmers in the developing world; especially those in West Africa, Asia, and South America.
- Actively promote the production and trade of organic cotton and devise new strategies to raise awareness of organic production techniques and benefits.

The Agrochemical Industry should:

- Phase out production of pesticides classed by the World Health Organisation as being either 'Extremely Hazardous' (WHO 1a) or 'Highly Hazardous' (WHO Ib);
- Take steps to implement the Recommendation issued in the FAO Code of Conduct, that formulated products that fall into WHO classes Ia and Ib, or formulations of products in Class II, are not sold to cotton farmers in developing world countries;
- Apply the same best practice standards in developing nations as are required in industrialised nations throughout pesticide products' entire lifespans;
- Improve transparency by disclosing *all* products and formulations stating the countries in which they are manufactured, formulated, stored and sold;
- Take a proactive role in setting up efficient disposal or recycling programmes for empty cotton pesticide containers.

The International Donor Community, Governments and International Financial Institutions should:

- Support the extension of IPM and organic cotton training programmes so that they may include all cotton farmers in the developing world, especially those in West Africa, Asia, and South America;
- Ensure that only organic cotton products may carry the EU textile Eco-label;
- Actively promote the production of organic cotton and facilitate fair trade to the West;
- Support research in non-chemical pest management, and research in seed varieties adapted to organic agriculture;
- Follow the World Bank in adopting policies in line with the FAO International Code of Conduct on the Distribution and Use of Pesticides, by denying finance for the use of formulated products that fall into WHO classes Ia and Ib, or formulations of products in Class II, if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly.

The National Governments of Cotton Producing Countries should:

- Take steps to ensure that formulated products that fall into WHO classes Ia and Ib, or formulations of products in Class II, are not distributed, or used by cotton farmers, lay personnel, and others, who lack training, equipment, and facilities to handle, store, and apply these products properly – in line with UN FAO guidelines;
- Sign and ratify The Rotterdam Convention on the Prior Informed Consent (PIC), and ILO Convention 184 regarding Safety and Health in Agriculture;
- Ensure that all agricultural workers involved in cotton production have adequate access to protective equipment, and receive training in the responsible use of hazardous cotton pesticides.

A Brief History of Pesticides in Cotton Production

1861 Cotton is the single most important crop traded in the world with over 80% of cotton being grown in the southern USA[1]. The American Civil War triggers the globalization of cotton production as US distribution networks are disrupted, prompting other countries to initiate cultivation.

WWII Until the end of World War II, cotton is predominantly grown without the use of chemical pesticides[2]. Farmers take pest cycles into account when cultivating cotton, and use methods such as crop rotation.

1948 Paul Müller wins the Nobel Prize for medicine for his discovery of organochlorine pesticides, including DDT (WHO II)[3]. These chemicals become widely adopted in agricultural pest control as they provide a cheap alternative to the use of labour and machinery. Between 1939 and 1954 pesticide sales climb from US$ 40 million to US$ 260 million[4].

1960s Growing concern regarding the safety of organochlorines, and the development of resistance among pest populations, prompts their replacement with less persistent, but often more toxic, second generation pesticides including aldicarb (WHO Ia), parathion (WHO Ia), and methamidophos (WHO Ib)[5]. These chemicals come to dominate global cotton production.

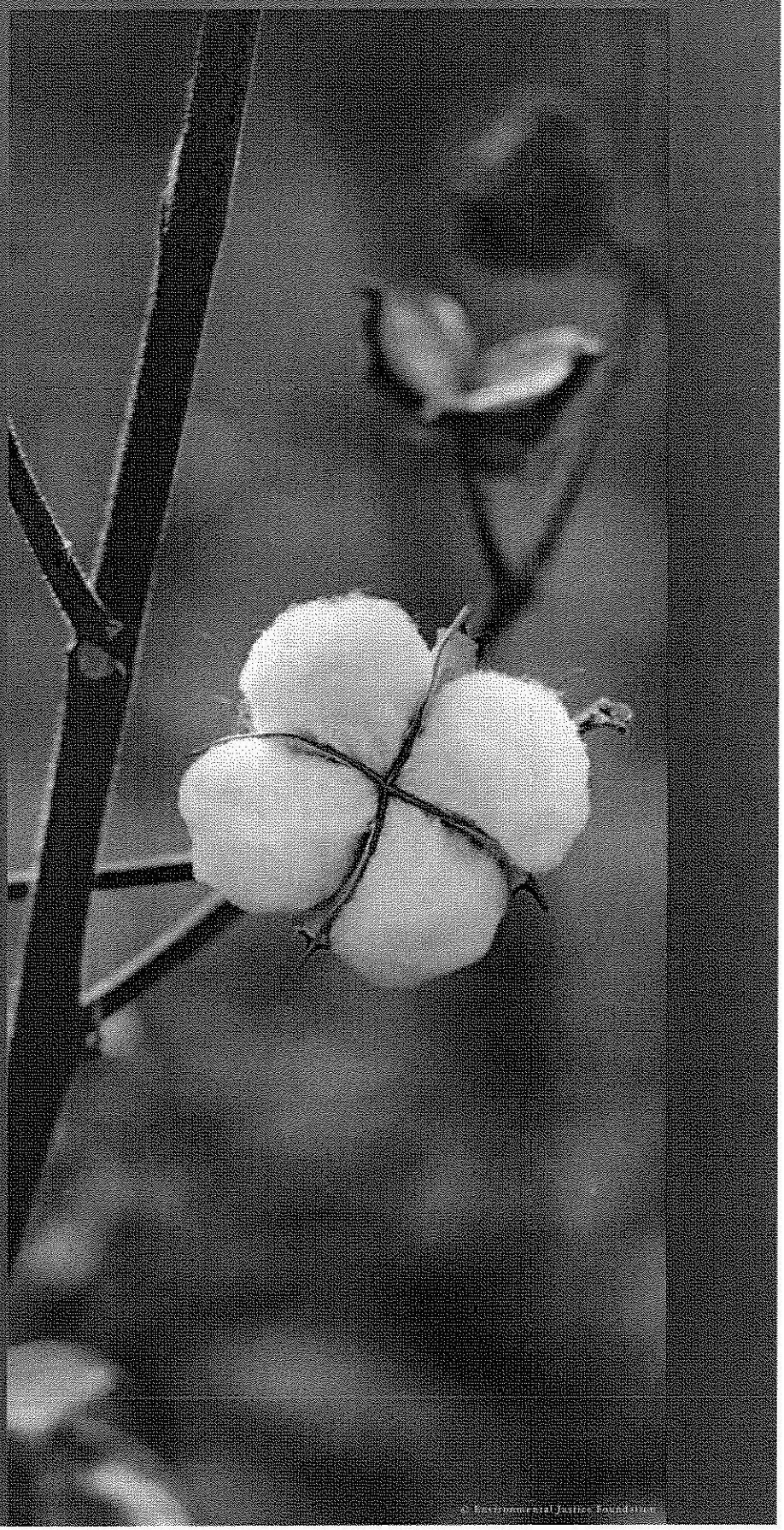
1984 The world's worst man-made chemical disaster occurs as a cloud of toxic gas leaks from a factory in Bhopal, manufacturing aldicarb (WHO Ia) and carbaryl (WHO II) for use in Indian cotton production. 20,000 people are killed. 120,000 people are injured[6].

1989 Fashion designer [redacted] raises awareness of the negative consequences of cotton pesticides by launching her Autumn/Winter 'Clean up or Die' collection[7]. Meanwhile farmers in Turkey make the first serious attempt at organic cotton production since the invention of chemical pesticides[8].

1997 Organic cotton production increases to 8150 tonnes as cotton farmers in 17 countries around the world attempt to meet rising consumer demand while themselves avoiding the risk of exposure to toxic pesticides[9].

2002 Aldicarb (WHO Ia) is listed as the world's 2nd biggest cotton pesticide with global sales standing at US$ 112 million[10]. Parathion (WHO Ia – US$ 60 million) and methamidophos (WHO Ib – US$ 51 million) are also among the top 10 global chemicals applied to cotton[11].

2005 While the global organic fibre market is now worth around US$ 800 million [12], conventional cotton farmers across the world continue to use some US$ 2 billion of chemicals per year, within which at least US$ 819 million are classified as hazardous[13], and cause substantial damage to the well-being of developing world communities and their environment.



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The Worst Chemicals in Cotton

Of the many hazardous pesticides, herbicides, fungicides, and defoliants applied to cotton grown worldwide, EJF has identified six which pose a particular risk to human health and the environment. These chemicals are used extensively by the world's cotton farming communities despite the dangers they present.

Aldicarb

Just one drop of aldicarb, absorbed through the skin, is enough to kill an adult[1]

Aldicarb, a powerful nerve agent[2]., is one of the most toxic pesticides applied to cotton worldwide. Despite its toxicity, US$ 112 million worth is applied to cotton every year[3]; making aldicarb the 2nd most used pesticide in global cotton production[4].

Aldicarb dominates cotton production in the USA, where it is more widely applied to cotton than any other insecticide[5]. In 2003 almost 1 million kilos of aldicarb were applied to cotton grown in the USA[6]. Its extensive use has led to the contamination of water groundwater in 16 states[7].

While application rates in the US average at 0.7 kg/Ha[8], in China the chemical is reportedly applied at between 12 and 15 kg/Ha in response to certain cotton crop diseases[9].

Symptoms of Poisoning Nausea, abdominal cramps, vomiting, diarrhea, difficulty breathing, seizures, hypertension, cardio-respiratory depression, dyspnea, bronchospasms and bronchorrhea with eventual pulmonary edema[10].

WHO Classification WHO Ia – Extremely Hazardous[11]

Chemical Group Carbamate[12]

Current restrictions Banned in seven countries[13]; Use restricted in seven countries (including USA and Argentina)[14]; Banned in EU from Dec 2007[15].

Other names Carbamic acid, Propionaldehyde, Temik[16]

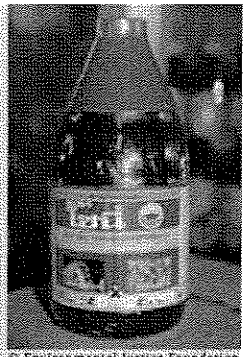
Dominant in cotton Argentina, USA[17]

Also used in cotton Australia, Bolivia, Brazil, China, Colombia, Costa Rica, Egypt, El Salvador, Ethiopia, Greece, Guatemala, Honduras, Israel, Malawi, Mexico, Morocco, Pakistan, Panama, Peru, South Africa, Spain, Turkey, Venezuela, Zimbabwe[18].

Aldicarb was one of the cotton pesticides being manufactured at the Union Carbide plant in Bhopal, India, when it became the site of the world's worst industrial disaster in 1984[20].

Environmental Impacts Aldicarb is acutely toxic to mammals, and very highly toxic to birds, aquatic invertebrates and fish[19].

Endosulfan



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Applied to cotton grown in 28 different countries, endosulfan is perhaps the most widely used cotton pesticide after deltamethrin: it 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[22]. A recent report suggests that endosulfan may be the most important source of fatal poisoning among cotton farmers in West Africa[23a]. In India, home to the world's largest cotton farming community, over 3,000 tonnes is applied to crops annually, making it the second most common pesticide in the country[23]. In 2004, analysis of Indian cottonseed found 22% to be contaminated with endosulfan[24]. Indian farmers feed almost 3 million tonnes of cottonseed and derivatives to cattle every year; and use around 500,000 tonnes of cottonseed oil in food preparation[25].

Symptoms of Poisoning Headaches, dizziness, nausea, vomiting, lack of co-ordination, mental confusion, convulsions, hyperactivity, seizures, coma and respiratory depression. In severe causes poisoning may lead to death. Long term exposure has been linked with damage to kidneys, liver and the developing foetus[26].

WHO Classification WHO II – Moderately Hazardous[27]

Chemical Group Organochlorine[28]

Current restrictions List II for inclusion in the EU Dangerous Substances Directive[29]; To be considered for inclusion under the UNEP Rotterdam Convention on Prior Informed Consent Chemical (PIC)[30]; Banned in five countries; Use restricted in four[31].

Other names Bromyx, Caiman, Callisulfan, Cyclodan, Cytophos, Endocel, Insectophene, Malix, Niagara, Phaser, Rocky, Thiodan, Thiofanex, Thionex[32]

Dominant in cotton Argentina, Australia, Benin, Brazil, Cameroon, Cote d'Ivoire, Ethiopia, Greece, India, Iran, Madagascar, Mali, Mozambique, Pakistan, South Africa, Sudan, Thailand, Turkey, Zimbabwe[33]

Also used in cotton Bangladesh, China, Colombia, Ecuador, Philippines, Spain, Thailand, USA, Uzbekistan[34]

In a single province of Benin, at least 37 people died from endosulfan poisoning in just one cotton season[21].

Environmental Impacts Endosulfan has adverse effects on aquatic systems, and is highly toxic to fish, birds, bees and other wildlife[35].

In 1997, Paraguay's Ministry of Health and Welfare identified monocrotophos as being responsible for causing paralysis in children living in cotton growing areas[36].

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Monocrotophos

In 1989, monocrotophos was voluntarily withdrawn from the US market[37] but remains on sale in many developing world countries; 30,000 tonnes are used annually, mainly in Asia (58%) and South America (26%)[38]. The chemical is particularly dominant in India where 3,500 tonnes are applied to crops annually[39] – making it the most heavily used pesticide in the country. Monocrotophos represents 22% of the Indian market in cotton pesticides[40], a share worth US$ 76 million annually[41].

Symptoms of Poisoning Muscular weakness, blurred vision, profuse perspiration, confusion, vomiting, pain, and small pupils[42]. Respiratory failure can lead to death.

WHO Classification WHO Ib – Highly Hazardous[43]

Chemical Group Organophosphorus compound[44]

Current restrictions Subject to the UNEP Rotterdam Convention on Prior Informed Consent (PIC)[45]; Banned in seven countries[46]; Use restricted in 12 countries (including China, USA and Brazil) and the EU.[47]

Dominant in cotton China, India, Madagascar, Zambia[48]

Also used in cotton Australia, Bangladesh, Pakistan, Thailand[49]

Other names Azodrin, Dimethyl ester, Fenom, Monocron, Nuvacron, Phosphoric acid[50]

Environmental Impacts Monocrotophos is extremely toxic to birds and is used as a bird poison[51]. It is also very poisonous to mammals, and highly toxic to bees.

Methyl parathion

Methyl parathion is applied to cotton in at least 10 countries, including five of the top 10 cotton producers. Once commonly applied to cotton grown in the USSR, methyl parathion is now more closely linked with the Americas, being dominant in Brazil, Colombia and Mexico[52]. Despite US EPA regulations which forbid labourers from entering a field within 48 hours of being sprayed with the chemical[53], over 66 tonnes of methyl parathion are applied annually across several southern US states[54].

Symptoms of poisoning Vomiting, diarrhea, abdominal cramps, blurred vision, involuntary muscle contractions, and eventually paralysis of the body extremities and the respiratory muscles[55]. In severe cases there may also be involuntary defecation or urination, psychosis, irregular heart beats, unconsciousness, convulsions and coma. Death may be caused by respiratory failure or cardiac arrest.

WHO Classification WHO Ia – Extremely Hazardous[56]

Chemical Group Organophosphorus compound[57]

Current restrictions Subject to the UNEP Rotterdam Convention on Prior Informed Consent (PIC)[58]; Banned in five countries[59]; Use restricted in 13 countries (including Brazil, China and USA) and the European Union[60].

Other names Folidol, Metacide, Metafos, Phosphorothioic acid[61]

Dominant in cotton Brazil, Colombia, Mexico[62]

Also used in cotton Australia, Guatemala, Pakistan, India, Spain, Thailand, USA[63].

Environmental Impacts Methyl parathion is highly toxic for aquatic invertebrates[64], and moderately toxic to mammals such as rats, dogs and rabbits[65]. The chemical has been implicated in the deaths of waterfowl and the acute poisoning of fish, birds, cattle and wild animals. In 1995 a mixture of methyl parathion and endosulfan led to the death of over 240,000 fish in Alabama, when heavy rain washed the pesticides washed from the cotton fields and into rivers[66].

In a separate case a colony of laughing gulls in Texas was devastated when methyl parathion was applied to cotton three miles away. More than 100 dead adults were found and 25% of the colony's chicks were killed[67].

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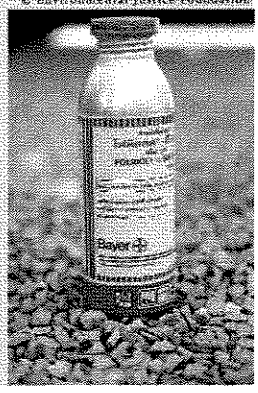

Methamidophos

With US$ 51 million applied to cotton each year, methamidophos – a neurotoxin that impairs the activity of key enzymes essential for the normal transmission of nerve impulses[69] – is the fourth most significant pesticide applied to cotton worldwide[70]. Cotton accounts for over 40% of global use[71]. Methamidophos residues have been detected in cottonseed and derivatives and may pose a particular hazard to those who consume cottonseed oil, or who feed derivatives to livestock[72]. In laboratory experiments, hens and goats reared with food containing methamidophos showed traces of the pesticide in their eggs and milk[73].

Symptoms of Poisoning Shakiness, blurred vision, tightness in the chest, confusion, changes in heart rate, convulsions, coma, cessation of breathing and paralysis[74].

WHO Classification WHO Ib – Highly Hazardous[75]

Chemical Group Organophosphorus compound[76]

Current restrictions Subject to the UNEP Rotterdam Convention on Prior Informed Consent (PIC)[77]; Banned in three countries[78]; Use restricted in nine countries and the European Union[79].

Other names Amidophos, Cypercal, Cyperthion, Filitox, Monitor, Patrole, Tamaron[80]

Dominant in Cotton Argentina, Mexico, Pakistan[81]

Also used in cotton Brazil, China, Colombia, Ecuador, Greece, Spain, Thailand, USA and Vietnam[82]

Environmental Impacts Methamidophos is toxic to birds, aquatic organisms, and insects, and has a half life in water of up to 309 days[83].

In Sri Lanka patients suffering with methamidophos poisoning experienced paralysis of the limb, neck, and respiratory muscles up to 4 days after exposure[68].

Deltamethrin

Applied to cotton in 43 out of 81 cotton producing countries, the nerve agent deltamethrin, is probably the most extensively applied cotton pesticide in the world. Global sales on cotton applications amount to some US$ 40 million, placing deltamethrin among the top 10 pesticides applied to cotton globally. These sales account for over one quarter of deltamethrin applications within the global crop sector.

Symptoms of Poisoning Convulsions leading to paralysis, dermatitis, edema, peripheral vascular collapse, tremors, vomiting, and death due to respiratory failure[85].

WHO Classification WHO II – Moderately Hazardous[86]

Chemical Group Pyrethroid[87]

Medical analysis of a community living in Jozini, a South African village located on the edge of major cotton production area, found traces of deltamethrin in human breast milk[84].

Current restrictions none[88]

Other names Butoflin, Butox, Deltaphos, Decis[89]

Dominant in cotton Australia, Bangladesh, Brazil, Cote d'Ivoire, Ethiopia, Greece, Pakistan, Sudan, Mozambique, South Africa, Syria, Tanzania, Uganda, Zambia[90]

Also used in cotton Argentina, Bolivia, Burma, China, Colombia, Costa Rica, Dominican Republic, Ecuador, India, Indonesia, Iraq, Italy, Kazakhstan, Kenya, Mali, Mauritania, Mexico, Namibia, Nigeria, Paraguay, Peru, Philippines, Senegal, Spain, Thailand, Turkey, USA, Venezuela, Zimbabwe[91]

Environmental Impacts Deltamethrin is highly toxic to insects, including non-target species[92].

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