PAN Germany
Pestizid Aktions-Netzwerk e.V.

# Pesticides and health hazards

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**Acknowledgements**
We thank Bread for the World for funds used in producing this publication.

**We appreciate donations to**
Pestizid Aktions-Netzwerk e.V. (PAN Germany)
GLS Gemeinschaftsbank eG, PO Box 10 08 29, 44708 Bochum
Account 203 209 6800, bank code 430 609 67
IBAN DE91430609672032096800, BIC (SWIFT) GENODEM1GLS

Impressum: © Pestizid Aktions-Netzwerk (PAN) e. V. Nernstweg 32, 22765 Hamburg,
phone: +49 (0)40 - 3991910 - 0, info@pan-germany.org, www.pan-germany.org, Hamburg, 2012
Text: Vanessa Laumann; Editing: Carina Weber; Translation from German: Paula Bradish
Layout: grafik:sommer; printed on recycled paper. Photo credits – cover: Rainer-Sturm_pixelio.de (top left), ©M. Eddleston (top right), ©Carina Weber (bottom)

This is a translation of the German publication “Pestizide und Gesundheitsgefahren: Daten und Fakten”, PAN Germany 2012

# The focus of this publication

Around the globe, chemical-synthetic pesticides have been used increasingly since the 1940s. Their use leads to considerable health hazards for people, due for example to direct contact during application, pesticide drift from fields, or contamination of food or drinking water. Data from research literature shows that the effects of the dispersal and negligent handling of pesticides are a significant global health problem.

## This publication addresses the following issues:

- Who is affected by the health hazards posed by pesticides?
- What is known about the frequency of acute pesticide poisonings and the extent of long-term adverse health effects due to pesticides?
- To what extent do suicides and attempted suicides contribute to the total numbers of pesticide poisonings?
- In view of ongoing increases in global pesticide use, has documentation of pesticide poisonings been improved?
- On the basis of available data on pesticide poisonings, what action should be taken?

# Pesticides

Data and facts

## Pesticide use worldwide

In recent decades, there has been a steady increase in the amount of pesticides marketed for argicultural use. In the European Union alone, more than 200,000 tonnes of pesticides (active ingredients) are used annually.[1] Between 2005 and 2010, the total volume of global sales rose from US$ 31 billion to US$ 38 billion.[2][3][4] The amount of pesticides used internationally has risen fifty-fold since 1950.[5][6] China is now the country that both uses and produces the largest amounts of pesticides.[7]

## Pesticides are everywhere

Presumably, all populations worldwide are exposed to pesticides. The ubiquitous dispersal of these substances is revealed by data on contamination of food as well as surface, ground, and drinking water.

In almost all parts of the world, low-level poisoning of human beings due to pesticide contamination of food poses a risk of chronic illness and adverse health effects. In Germany, the Federal Office of Consumer Protection and Food Safety [Bundesamt für Verbraucherschutz und Lebensmittelsicherheit] publishes an annual monitoring report on undesirable substances that constitute health risks in food. These reports show that pesticides can be found in all foodstuffs of plant origin. Two percent of all agricultural products of plant origin examined in Germany, including plums and lettuce, for example, showed signs of inadmissible application of pesticides. The levels of contamination detected in eleven samples of pineapple, tomatoes, peaches, nectarines, lettuce, and zucchini were considered to be sufficiently high to possibly pose acute health hazards.[8]

Infobox 1 **What are pesticides?**

Pesticides are substances that are used intentionally in agriculture, forestry, and horticulture and on public lands and in gardens to increase crop yields, improve the appearance of plant products, or to facilitate the care of open spaces. They are also referred to as plant protection products. In Europe, pesticides used outside of agriculture are called biocides.[9] Biocides are used, for example in private households, to repell or destroy unwanted or detrimental organisms and are also applied in large quantities in many developing countries to combat pathogenic organisms or species that serve as vectors (carriers) for pathogens (e.g. mosquitoes that are carriers of pathogens that cause malaria).

In developing countries, the effects of acute poisoning due to exposure to dangerous levels of pesticides in food are apparently more severe than in industrialized countries. Two examples from Africa: in 2008 Nigeria reported that 112 people had been poisoned by pesticide-contaminated food. Two children died as a result. Another report from Nigeria recorded 120 cases of poisoning of students who had eaten beans contaminated with lindane.[10][11]

In some regions, direct contact with pesticides used in agriculture is a widespread problem. Mixing and applying pesticides can result in acute poisoning due to uptake via the respiratory organs or through direct contact with the skin or eyes.[12] Pesticide drift poses a further hazard for the residents of rural areas.

Moreover, pesticides are not only used outdoors; they are also applied inside buildings to combat insects and other undesirable organisms such as mice. In many developing countries, spraying pesticides indoors is one of the main measures undertaken against certain mosquitoes to roll back malaria.

The effects of accidents in production facilities can be especially dramatic. In a pesticide plant in Bhopal, India, run by an Indian subsidiary of the US company Union Carbide Corporation, a defective tank lead to the release of about forty tons of isocyanate gas. Thousands of people were exposed and died or incurred serious injuries. Even today, more than twenty-five years later, the region remains contaminated, and people are still suffering from the long-term effects of exposure.

## Availability of highly hazardous pesticides

Many organisations such as the World Health Organisation (WHO), the US Environmental Protection Agency (EPA), or the European Union classify pesticides according to their hazards. The WHO, for example, classifies pesticides in five groups, ranging from extremely hazardous (class Ia) to slightly hazardous (class III) to unlikely to present acute hazard (Class U). PAN International has published a list of highly hazardous pesticides that takes into account such international classification systems. About four hundred highly hazardous pesticide active substances are on the market worldwide.[13] Research conducted by PAN Germany shows that BASF, Bayer, and Syngenta, who together control nearly half of the global pesticide market, each offer more than fifty highly hazardous pesticide active ingredients on their websites.[13a]

Most of the pesticides in WHO class I are banned or subject to strict regulations in the industrial countries. A teaspoonful (5 ml) of one of these pesticides would be enough to kill an adult.[14][15] In Indonesia, for example, 44% of the registered pesticides (265 different products) belong to the WHO classes Ia, Ib, or II (moderately to extremely hazardous).[16] PAN Asia and the Pacific has conducted research that shows that 82 of the 150 pesticides used in Asia, including seven of the ten most used ones, are on the list of highly hazardous pesticides published by PAN.[7]

Among the pesticides that are frequently associated with documented cases of poisoning are carbamates and organophosphates, which are in WHO class I, endosulfan, which the Stockholm Convention has earmarked to be phased out worldwide, and paraquate.[17][18] These pesticides are often freely available on the markets in developing countries or smuggled in for use or sale.[19]

Illegal trade in pesticides is a significant global problem. In developing countries, as much as 30% of the pesticides do not meet internationally recognized safety standards.[19] In India, for example, the Ministry of Agriculture has determined that one-third of the pesticide samples examined do not comply with official standards.[20]

Infobox 2 **Hazardous pesticide contacts occur due to:**

- pesticide use in agriculture
- pesticide use indoors against undesirable organisms and disease vectors
- pesticide drift in rural areas
- accidents during production, storage, and handling of pesticides or due to mix-ups in private households
- contaminated food / drinking water / consumer products / building materials

In Germany, 17% of the pesticides on the market also fail to meet official standards.[19] According to the government's monitoring report for 2010, 38.9% of the open spaces examined were found to have been treated with pesticides without permission – in other words, illegally.[21]

# Health hazards due to pesticides

The many chemical substances that are collectively referred to as pesticides intervene in different vital metabolic processes in various organisms. The effects of insecticides range from damage to the transmission of nerve impulses and inhibition of blood clotting to paralysis of the respiratory and circulatory centers. Besides the target organisms such as insects, fungi, or weeds, non-targeted organisms are also always affected by pesticide use. These include wild animals and plants, domestic animals and crops, and human beings. In humans, exposure to pesticides can lead to unspecific adverse health effects that will be referred to here as poisonings.

The following sections offer a survey of acute illnesses that result from contact with pesticides as well as reviewing chronic illnesses that can occur due to long-term contact with pesticides. The text also describes population groups that are especially at risk with respect to acute and / or chronic pesticide poisoning. Based on estimates by the WHO, we then offer an impression of the global extent of pesticide poisonings. Pesticide poisonings are classified here as either suicidal or intentional poisonings, on the one hand, and unintentional poisonings that result from accidents on the job or accidents outside of occupational contexts, on the other.

## Acute illnesses

Among the typical symptoms of poisoning in humans that are relatively easy to diagnose as acute pesticide poisoning are fatigue, headaches and body aches, skin discomfort, skin rashes, poor concentration, feelings of weakness, circulatory problems, dizziness, nausea, vomiting, excessive sweating, impaired vision, tremors, panic attacks, cramps, etc., and in severe cases coma and death.[22][23]

Diagnosis of acute pesticide poisoning generally occurs when one or more of these symptoms, which appear a short time after contact with pesticides, are detected, so that patients or physicians can link them to pesticide exposure. However, these symptoms can also frequently be attributed to other illnesses. Analysis of blood, urine, or stomach content to detect pesticide residues can lead to an unequivocal diagnosis. But clearcut proof will only be forthcoming if a sufficiently high concentration of the poison is present and there is reason to suspect that a specific agent among the hundreds of substances available might potentially be responsible for the symptoms. Appropriate analytical methods are often very expensive or lacking altogether.

The severity of symptoms is frequently classified on a scale ranging from mild to moderate to severe or lethal.[24] However, a standardized definition of what constitutes poisoning does not exist, so that comparing and summarizing different statistics on poisoning is difficult. The WHO proposed guidelines for identifying acute poisonings in 2008.[25]

## Chronic illnesses

Besides causing acute poisoning, pesticides can also cause chronic illnesses if they are incorporated over a longer period, even if the amounts taken up are relatively small. Symptoms are often diffuse or do not become apparent for a long time, which then leads to late effects. Farm workers are especially at risk, but the general population is also affected, for example due to contaminated food or consumer goods or pesticide drift from fields. Knowledge about the effects of long-term pesticide exposure is limited to date but numerous late effects are described in the literature.

Many pesticides that are commonly used today have been classified on the basis of animal testing as possibly or probably carcinogenic for humans.[13] Although the results of various epidemiological studies are inconsistent, these findings leave no doubt that agricultural workers exposed to pesticides have a significant risk of contracting non-Hodgkin lymphomas and leukaemia. Other studies have revealed a correlation between pesticide use and sarcomas, multiple myelomas, cancer of the prostate, pancreas, lungs, ovaries, the breasts, testicles, liver, kidneys, and intestines as well as brain tumors.[22][23][26][27]

Furthermore, pesticides can damage the human nervous system. There are indications that there is a connection between pesticide exposure and reduced sensitive faculties, distruptions in cognitive and psychomotoric functions, and depression. Various studies have also shown that the risk of developing Parkinson's disease can increase by as much as factor seven if there has been contact with specific pesticides.[23][28] Today various experts and organisations such as the Berufsgenossenschaften (employee occupational health compensation boards) in Germany have acknowledged that farmers who have used certain pesticides later suffered from this degenerative illness of the nervous system as a result.[29]

The disruption of children's neurological development due to exposure to a number of pesticides has hardly been investigated to date. However, laboratory studies indicate that there may be correlations.[30] Among the most frequent neurological disorders that may result from pesticide exposure are learning deficits in children, attention deficits, sensoric deficits, or retarded development.[31]

It has been known for many years that specific pesticides can disrupt the hormone system, but so far state authorities have not determined exactly which pesticides have such effects. To date no agreement has been reached in the EU on how hormone-disrupting pesticides should be identified and evaluated. Presentation of a concrete proposal is planned for 2013; until then, interim regulations are in effect. Hormonal effects can appear at extremely low dosages that sometimes cannot be observed at higher dose levels.[32] In one study, 37 pesticides out of a group of 134 that appear, for example, as contaminants in food in the EU were tested for their hormonal effects. Of these 37, 23 pesticides were categorised as anti-androgenic and 7 others as androgenic substances. If fetuses are exposed to these substances they may suffer developmental disorders and malformations of their sexual organs.[33][34]

Other late effects due to pesticide use or to long-term ingestion of small amounts of these substances include weakening of the immune system and effects on the reproductive system, which can lead to miscarriage, still birth, and premature birth or to low birth weight. [9][14][22][35]

## At-risk groups

Not all groups within the entire population face the same level of health hazards due to pesticide exposure. Because of various risk factors (e.g. larger body surface in relation to body weight, differences in metabolism, higher growth rate, and the ongoing development of the body's organs) children are frequently more susceptible to the effects of pesticides than adults. Children also tend to be in more intense contact with their immediate environment than adults; for example, they put things into their mouth more often. Lack of experience or judgment, the inability to read, and deficits in their capacity to assess risks also mean that children unintentionally ingest pesticides and are poisoned more often than grownups.[9][14]

In developing countries malnutrition and infectious diseases often intensify the negative effects of pesticide poisoning.[9] Moreover, many people are poisoned while applying pesticides to fields, because protective clothing is too expensive, not available, damaged, or impractical in hot and humid climates. Safety precautions are often provided in foreign languages or are not understood for other reasons, especially by analphabets but also by those who can read.[36] Pictograms are often used on pesticide containers to inform people about risks and avoid health hazards. But a study in South Africa has shown that many people who handle pesticides do not understand and misinterpret the pictograms on pesticide labels.[37] A further study in west Africa demonstrated that only an estimated 2% of farmers there wear protective clothing when handling pesticides.[38] In Burkina Faso only 1% of farmers used the recommended protective measures. Even if pesticide users there are informed about risks, protective equipment is rarely used – because of the costs involved, for practical reasons, or out of carelessness.[18]

Further risk factors that should not be underestimated are inappropriate disposal and storage of pesticides. In developing countries there is often a lack of opportunities for careful management, storage, and disposal that reduces hazards and risks of pesticides and pesticide handling. [39] Pesticides may be mistaken for food due to storage in homes. Pesticide containers are thrown away along fields or in irrigation channels.

It has been estimated that global stockpiles of obsolete pesticides in developing countries and economies in transition amount to something in the order of 400,000 – 500,000 tonnes.[40] These pesticides can contaminate the soil and surface water.

As a result of the frequently problematic handling of pesticides in developing countries, 70% of all pesticide poisonings and 99% of resulting deaths occur in these countries, despite the fact that of all pesticides used globally, only 25% are applied there.[41]

## More suicides where hazardous pesticides are available

On a global scale, pesticide poisoning plays a significant role as a method for committing suicide; at 31%, it is the most frequently used method. The proportion of pesticide-related suicides within the total number of suicides varies regionally from 4% in Europe to as much as 50% in the western Pacific region. This distribution does not correlate with the distribution of pesticide use. In Europe (where 2% of pesticide suicides occur), sales of pesticide products amount to 29% of world sales; in Asia (where 91% of pesticide suicides are reported), 25% of the global sales of pesticides are made.[42]

It has been suggested that more people poison themselves with pesticides when products with a high acute toxicity are readily available.[23][42] Documented cases often involve various substances that belong to the class of organophosphates and the herbicide paraquat. In Korea, 85% of pesticide poisonings are the result of suicides; every year, 2,000 people poison themselves with paraquat and 60 to 70% of these cases end in death.[43][44] In China, an estimated 175,000 people poisoned themselves intentionally each year between 1996 and 2000. Organophosphates are freely available there.[45]

Some studies show a significant correlation between contact with pesticides and depression and other psychological disorders. Moreover, some reports point to a connection between thoughts of suicide and increased suicide rates and chronic pesticide exposure.[45][46] However, the results of various studies with respect to this issue are inconsistent.[47][48]

Since suicides are frequently appellative, we can assume that many of these lethal poisonings might have been prevented if access to highly hazardous pesticides had been limited, pesticides in rural areas were stored under more secure conditions, and availablity and quality of medical care were improved in these regions. In most hospital records, the number of intentional pesticide poisonings (suicides and attempted suicides) is higher than the number of unintentional poisonings. In the statistics evaluated for this publication, the percentages of intentional poisonings range from 36% to 85% of all pesticide poisonings reported (Table 1). According to WHO estimates, there are two million cases of intentional pesticide poisoning globally each year (two-thirds of all severe pesticide poisonings). The number of suicidal deaths through pesticides was estimated as being as many as 370,000 in 2007. In Asia alone, more than 300,000 people die this way each year.[42] The numbers reported from Sri Lanka are especially alarming. In several rural areas there, pesticide suicides are the most frequent cause of death in hospitals.[36]

Table 1 **Percentage of suicidal, accidental occupational, and accidental non-occupational poisonings in various clinical records**

| Year | Country / extent of study | Suicidal poisonings | Occupation-related poisonings | Accidental poisonings | Reference |
|---|---|---|---|---|---|
| 1999 – 2000 | India: 20 hospitals 1,531 poisonings | 85,2% | 5,4% | 4,7% | WHO (2002)[20] |
| 1999 – 2000 | Indonesia: 125 poisonings | 43% | 37% | 16% | WHO (2002)[20] |
| 1999 | Thailand: 10 hospitals, 130 poisonings | 62% | 28% | not specified | WHO (2002)[20] |
| 1983 | Indonesia, Malaysia, Sri Lanka, Thailand: 273 poisonings | 36 – 68% | 2 – 32% | 9 – 29% | Jeyaratnam et al. (1987)[49] |
| not specified | Southeast Asia | 68% | 18% | 14% | WHO (2009)[50] |
| 1998 – 2002 | Japan: 65 hospitals, 346 poisonings by agrochemicals | 70% | 16% | 8% | Nagami et al. (2005)[51] |

## Global statistics on unintentional acute pesticide poisonings

In 1990 the WHO estimated that one million unintentional acute pesticide poisonings occurred worldwide annually. However, only the most severe cases registered in hospitals were included in this figure. WHO later reported that the extent of poisonings was significantly underestimated at the time. Despite this admission and the fact that, after more than twenty years, this figure is now without a doubt outdated, it is still cited. What is more, funding for a WHO project on the epidemiology of pesticide poisoning was discontinued several years ago.[52]

The number of people who died worldwide as a result of unintentional poisonings was estimated at 20,000 in 1990.[53] More current statistics have become available since 2008. According to this WHO data, 346,000 people die annually worldwide as a result of unintentional poisonings, two-thirds of them in developing countries.[54][55] Here, too, the WHO admits that this figure may be too low.[52] The substances involved are not specified, but presumably most of these poisonings are caused by toxic chemicals such as pesticides.[56] Researchers have noted that probably 71% of these fatalities might have been prevented by improving chemical safety measures.[55]

## Global statistics on chronic pesticide poisonings

Statistics on chronic poisonings are very limited, since registration systems and regional studies only include poisoning cases that can be proven without any doubt to have been caused by pesticide exposure. According to a 1990 WHO estimate, it was expected that 735,000 cases of specific chronic effects and 37,000 unspecific health effects such as forms of cancer would occur annually.[41]

# Inadequate documentation and high numbers of non-reported cases

**In order to estimate the frequency of pesticide poisonings, the WHO uses hospital records, population surveys, and data registered by governmental authorities. However, global documentation and data transfer is inadequate.** One case in point is Germany. In 1990, Germany introduced mandatory documentation of poisoning; all cases must be reported to the Bundesinstitut für Risikobewertung [Federal Institute for Risk Assessment, BfR]. BfR receives reports from Giftinformationszentren [Poison Information Centers, GIZ], from Berufsgenossenschaften (employee occupational health compensation boards), or directly from physicians who have provided treatment. The GIZ provide toxicological advice for physicians and private individuals and register, according to their own assessment, a large portion of non-occupational poisoning incidents. Work-related incidents are usually reported to BfR by the respective Berufsgenossenschaften.

In 2009, six of the nine GIZ reported a total of 2,954 cases of pesticide exposure. Only a few of the GIZ supplied data on the severity of these incidents in their statistics. When this information was included, 15% to 43% of these pesticide exposures were cases of mild to fatal poisoning; 57 to 85% of the cases involved exposure to pesticides that resulted in only minimal or no adverse health affects (Table 2). According to the GIZ, for technical reasons, only the most severe cases are reported to BfR.

Table 2 **Number of pesticide exposures and poisonings registered by the GIZ in Germany in 2009**

| (GIZ) | Registered pesticide exposures | Registered pesticide poisonings (mild to fatal) |
|---|---|---|
| Göttingen | 614[24] | 251[24] |
| Bonn | 360[58] | not specified |
| Berlin | 791[59] | 121[59] |
| Erfurt | not specified | not specified |
| Freiburg | 416[60] | 182[60] |
| Homburg | 51 (children only[61] | not specified |
| Mainz | 722[62] | not specified |
| Munich | not specified | not specified |
| Nuremberg | not specified | not specified |
| **Total** | **2,934** | **554** |

Table 3 **Number of acute pesticide poisonings and deaths per year for specific countries (registered and estimated)**

| Year | Country/region | Pesticide poisonings anually | of these, fatal incidents | Reference |
|---|---|---|---|---|
| 1982 | Sri Lanka | 10,000[2,3,4,5] (2/3 of these suicides) | 1,000 | Jeyaratnam (1990)[41] |
| 1998 – 2000 | Sri Lanka | 15,000 – 20,000[4,5] | 500 – 2,200[4,5] | WHO (2002)[20] |
| 1995 | Sri Lanka | 15.730[7] | 1,571[7] | Eddleston (2002)[36] |
| 1989 | Africa | 11 million[5,6] | | Jeyaratnam (1990)[41] |
| n.s.[1] | Africa (ten countries) | 2.212,200 | | Jeyaratnam (1990)[41] |
| 1989 | Indonesia | 30,000[5,6] | | Jeyaratnam (1990)[41] |
| 2003 | Indonesia | 317[7] | | WHO (2004)[63] |
| 1985 | Thailand | 4,046[7] | 289 | Jeyaratnam (1990)[41] |
| 2008 | Asia | | 300,000[5] (only pesticide suicides) | Eddleston et al. (2008)[64] |
| 1995 | USA | 10,000 – 20,000[5,2] (only farm workers) | | Calvert et al. (2008)[65] |
| 1998 – 2005 | USA | 0,07% of farm workers suffer poisonings | | Calvert et al. (2008)[65] |
| 1996 – 2000 | China | | 175,000[5,3] | Zhang et al. (2009)[45] |
| n.s.[1] | China | 53,300 – 123,000[5] | 300 – 500[2,5] | Organic Consumer Association (2003)[66] |
| 2008 | Vietnam | 5,000[2,5] (in agriculture) | 300 – 1,200[2,5] (in agriculture) | Ministry of Health Vietnam (2008)[67] |
| 2002 | Vietnam | 7,170[7] | | WHO (2005)[68] |
| 2000 | Nicaragua | 66,000[5] (52% of these during spraying) | | Corriols (2009)[69] |
| 2002 | Central America (Belize, Costa Rica, Guatemala, Honduras, El Salvador, Nicaragua, Panama) | 400,000[5] (76% of these work-related; only 7,000 were registered) | | Murray et al. (2002)[70][27] |
| 2000 | Central America | 6,934[7] | 748[7] | PAHO (2002)[71] |
| 2009 | Korea | 2,000[3,5] (only paraquat) | 1,200 – 1,400[3,5] (only paraquat) | Seok et al. (2009)[43] |
| 1996 – 2005 | Republic of Korea | | about 2,500[3,5] | Lee, Cha (2009)[44] |
| 2010 | Germany | | 39 | Statistisches Bundesamt (2011)[72a] |
| 2005 | Germany | 150,000 – 200,000 (all poisonings; mostly pharmaceuticals and alcohol, pesticide poisonings account for 1%) | | Weilemann (2005)[72] |
| 1993 | Federal Republic of Germany (western part) | 20,000[5] | 220[5] | Bödeker (1993)[22] |
| n.s.[1] | Mali | 110,200[5] | | PAN UK (2007)[73] |
| 2003 | Togo | 500[2,7] (only endosulfan) | | Kodjo (2003)[74] |
| 2008 | Bangladesh | | 7,438[7] | Ministry of Health, Bangladesh (2009)[75] |
| 1997 | Bangladesh | 309,409[7] (all poisonings) | | Bangladesh (2007)[76] |
| 07/1999 – 06/2000 | India | 1,531[7] | 347[7] | WHO (2001)[77] |
| 1997 – 2002 | Andhra Pradesh | | > 5,000[5] | Rao et al. (2005)[50][78] |
| 2006 – 2008 | Malaysia | 490 – 841[7] | | National Poison Center Malaysia (2010)[7] |
| n.s.[1] | Costa Rica | 600 – 1,000[7] (estimated 83 – 98% non-registered) | | Ministry of Health, Costa Rica (2003)[52] |
| n.s.[1] | Canada | 6,000[5] (more than 2,800 of these are children) | | Canwest News Service (2007)[79] |
| 1993 – 1997 | Myanmar | 2.28% of the population | 240[5] | WHO (2002)[20] |
| n.s.[1] | Nepal | 300 – 500[4,7] | | WHO (2002)[20] |
| 1992 – 2007 | Morocco | yearly average 163[7] | | Rhalem et al. (2009)[80] |
| 2000 | Brazil | 300,000[6] (due to agrochemicals) | 5,000 | Bensusan (2000)[81] |
| 1998 – 2001 | Japan | | 860 – 1,070[7] | Nagami et al. (2005)[51] |

**Legend:** 1. not specified, 2. unintentional cases, 3. intentional cases, 4. only cases in treated in hospitals, 5. estimate, 6. severe and mild poisonings, 7. only registered cases

In 2009 only 84 cases of pesticide poisonings were reported to the BfR, of which 75 cases came from the Berufsgenossenschaften.[57] In comparing and evaluating the statistics documented by GIZ and BfR one of the key issues is that the various degrees of severity of poisoning are not always defined using the same criteria. Further problems result from variations in the definition of terms that refer to pesticides, i.e., pest protection substances, biocides, wood preservatives, agricultural chemicals, etc. International comparisons are even more difficult.

With respect to nation-wide documentation in Germany, it should be noted that there is no institution that registers and reports on all poisonings, their severity, and causes nationwide. Chronic poisoning incidents that do not lead to acute treatment by a physician or that do not show symptoms that are attributed to pesticide poisoning are presumably not registered with any of the agencies mentioned here. For this reason, it is difficult to ascertain the total number of pesticide poisoning incidents in Germany and to estimate the number of unreported cases.

**Estimating the extent of non-reported cases globally is even more difficult. Especially in developing countries,** often only the most serious poisonings that are treated in hospitals are documented; these represent only a fraction of the total number. Even if the frequency of poisonings are well documented in some regions, using this data to draw conclusions about other regions is problematic, since the number of people exposed to pesticides can vary greatly nationally and regionally. Furthermore, the amounts and the toxicity of the pesticides used and the protective measures implemented also vary.

Table 3 summarizes the data on pesticide poisonings in specific countries reviewed for this publication (cases registered in hospitals and estimates that also reflect non-reported cases). The assumption that these figures represent the tip of the iceberg is substantiated by interviews with farmers from various regions. Although suicidal poisonings represent the largest group in hospital statistics (Table 1), work-related poisonings are especially widespread in developing countries, usually are associated with milder symptoms, and are registered much less often than suicidal poisonings. Besides impairing personal wellbeing, they cause the loss of many years of human life. The WHO reports that more than 7.4 million years of life annually are lost due to poisoning with chemical substances.[55] Furthermore, considerable costs result for the health care system.[73]

**A study conducted in Nicaragua showed that less than 5% of the people who suffered from poisoning and received medical treatment** were officially registered.[69] In Central America, the percentage of unregistered poisonings was even higher, namely 98%. Another study estimated that the proportion of work-related poisonings in Central America was 76%.[69][70] In India 83.6% of the women who worked in cotton farming and were interviewed in one study had experienced poisoning symptoms.[84] In a further investigation, 55% of tobacco farmers tested in Pakistan showed reduced levels of cholinesterase activity, an indication of specific pesticide poisonings.[85] PAN International conducted comprehensive investigations in Africa, Asia, and Latin America, based on which it was able to show in 2010 that in many regions more than half of the people interviewed suffered from poisoning symptoms due to application of pesticides.[7] Table 4 shows results from selected studies that indicate the percentage of farmers poisoned in connection with pesticide use.

Infobox 3 **Causes of a high level of unreported cases in statistics on pesticide poisoning**

- inadequate or non-existent monitoring and registration system
- lack of medical facilities for diagnosis and treatment
- lack of willingness to seek treatment by a physician (costs, time, fear of job loss)
- late effects are not recognized as caused by pesticide poisoning
- false diagnosis

Infobox 4 **Cholinesterase activity**

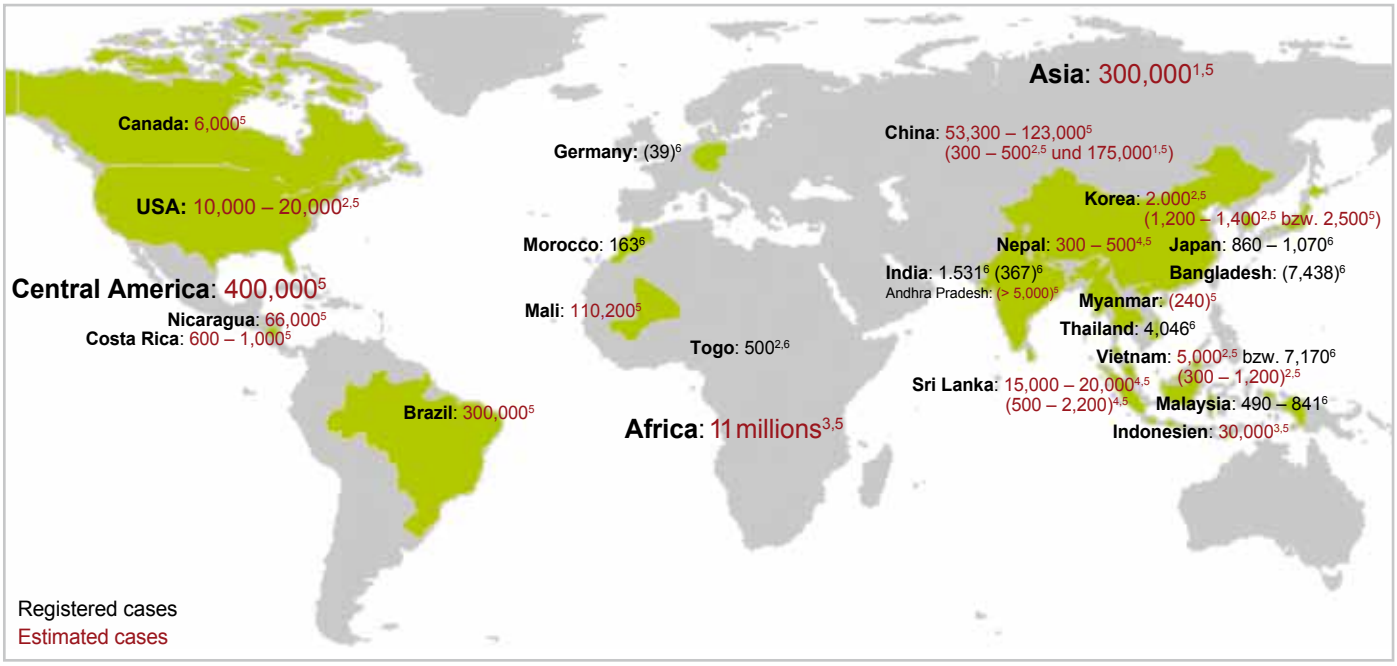
Pesticides such as organophosphates or carbamates inhibit the activity of cholinesterase, a class of enzymes involved in transmitting signals in the nervous system. This inhibition disrupts functions in glands, muscles, and in the brain. Poisoning with organophosphates or carbamates can therefore be measured by testing the level of cholinesterase activity in the blood. Cholinesterase activity that is reduced by more than 25% indicates an acute case of poisoning; more than 33% is a sign of severe acute poisoning,and more than 66% reflects severe chronic poisoning.[22][87]

Table 4 **Percentage of farmers poisoned during pesticide application (selected studies)**

| Year | Segment of the population | Country / region | Percentage of poisoned farmers | Reference |
|---|---|---|---|---|
| 2004 | 190 rice farmers | Vietnam (Mecong Delta) | 35% pesticide poisonings (21% chronic poisonings) through blood tests | Dasgupta et al. (2007)[87] |
| 1999 | 123 women exposed to pesticides (application and handling) | Myanmar | 40% chronic poisoning | WHO (2002)[20] |
| n.s.[1] | 5,025 farmers | Indonesia (Java) | 21% of pesticide applications were linked to 3 or more symptoms (direct oberservation), 9% reported severe poisoning | Kishi et al. (1995)[16] |
| 1985 | 5,317 farmers who had been exposed to pesticides | Malaysia and Sri Lanka | 2 – 7% reported they had suffered poisoning within the past year | Jeyaratnam et al. (1987)[49] |
| 2001 | Families in 2 rural districts | China (Sichuan) | 20% reported pesticide poisonings | Organic Consumer Association (2003)[66] |
| n.s.[1] | 210 farmers | Cambodia | 35% reported moderate poisoning symptoms e.g. nausea); 1 – 5% reported serious symptoms such as loss of consciousness | Sodavy et al. (2000)[88] |
| 2000/ 2001 | 50 farmers | Vietnam | 61% of the pesticide applications are associated with mild symptoms of illness; 31% are associated with at least one definite poisoning symptom (self-reported) | Murphy et al. (2002)[89] |
| n.s.[1] | 85 vegetable growers (most do not wear protective clothing) | Ivory Coast | 55% report symptoms of illness such as stomach pain or headaches after applications | Doumbia, Kwadjo (2009)[90] |
| 2007 – 2009 | 2,220 people exposed to pesticides | Africa, Asia and Latin America | 21 – 59% of those interviewed who have been exposed to pesticides subsequently suffer from symptoms such as headaches, dizziness, impaired vision, increased sweating | PAN (2011)[7] |
| 2003/ 2004 | female cotton farmers in 3 villages | India | 83,6% of pesticide exposures (application, mixing, or work in the fields) were linked to poisoning symptoms; of these 10% were linked to 3 or more symptoms that typically occur with organophosphates; 6% with extremely severe poisonings; no one consulted a physician | Mancini et al. (2005)[84] |
| 2009 | 105 tobacco farmers | Pakistan | The majority reported headaches, dizziness, nausea, shortness of breath, muscle weakness, skin rashes in connection with pesticide use; reduction of cholinesterase activity was measured for 55% | Khan et al. (2009)[85] |

**Legend:** 1. not specified

Number of cases of acute pesticide poisoning (deaths) per year for countries and regions*




**Notes:** 1. only intentional poisonings, 2. only unintentional poisonings, 3. severe and mild cases, 4. only poisonings treated in hospitals, 5. estimate, 6. only registered cases, * data collected for this publication, incomplete; for references see Table 3

# Summary

Since the 1940s, the amount of synthetic chemical pesticides used annually worldwide has increased, resulting in considerable human health hazards. Due to contamination of the environment, presumably all populations worldwide are effected by pesticide contamination and face the threat of chronic health disorders. Particularly at-risk are people employed in agriculture because they are directly exposed to pesticides and frequently suffer from acute as well as chronic poisoning symptoms. Moreover, especially in developing countries, a large number of highly hazardous pesticides are easily available, many of which are used in agriculture, often even without appropriate protective clothing. Because of their availability, intake of these pesticides is a frequent suicide method.

Many hospital records show that a high proportion of severe acute pesticide poisonings are in fact suicides, especially in Asia. The WHO estimates that there are about 2 million pesticide suicides and suicide attempts worldwide every year. However, these statistics do not reflect the fact that cases of non-suicidal pesticide poisoning among farm workers are generally poorly documented, in particular in developing countries. Poisonings with milder symptoms that generally subside rather quickly are often not registered, so that such cases are presumably underestimated. In 1990, the WHO assumed that one million severe cases of unintentional pesticide poisoning occurred annnually. What is remarkable is another, much higher WHO estimate from the same year that is rarely cited in the relevant literature. This figure refers to 25 million unintentional poisonings annually of farm workers in developing countries alone, with on average 3% of agricultural workers in developing countries suffering an episode of pesticide poisoning per year.[41] Since the sales volume of pesticides worldwide has increased and the rate of poisonings in regions is much higher than 3%, it is probable that the number of unintentional poisoning incidents

is much higher and that the rates have increased. Thus, the previous estimates can quite rightly be considered to be outdated. A recent study by PAN International assumes that currently, of the total 1.3 billion farm workers worldwide, about 41 million suffer pesticide poisoning each year, with average poisoning rates at 32%.[91][92]

Statistics on illnesses due to chronic poisoning as a result of pesticide use or pesticide contamination of food are very limited. But there is reliable evidence that the increasing incidence of cancer, hormonal effects, and neurological disorders such as Parkinson's disease is linked to the use of certain pesticides in agricultural production.

Although a large quantity of data and studies on pesticide poisoning is now available, it is not possible to present a clear and comprehensive survey of the global dimensions. Most statistics are probably incomplete because systems for registering and documenting pesticide poisonings are inadequate or completely missing, even in a country like Germany. Furthermore, the terms for pesticides as well as the classification and severity of symptoms are not standardised so that compiling and comparing existing statistics is difficult. Despite these deficits in documenting pesticide poisonings, available data from research conducted to date clearly demonstate that the consequences of handling pesticides are a significant global health problem that is especially serious in developing countries.

## The need for action

We can only deal with the global problem of pesticide poisonings if the nature and scope of pesticide poisonings (e.g. number of incidents, geographic distribution, frequently affected groups of people) are carefully monitored and documented. So far, registration and documentation is inadequate. **There is an urgent need to implement the following three key measures:**

- raise the awareness of physicians and oblige them to consistently diagnose, document, and register cases of pesticide poisonings,
- improve the registration systems, and
- harmonize the documentation of data.

On the basis of improved data collection, risk areas, at-risk groups, and risk factors (e.g. the availability of highly hazardous pesticides and the implementation of protective measures) could be determined. Measures to mitigate, reduce, or eliminate risk factors in risk areas could then be applied.

**More generally, it is essential that the use of highly hazardous pesticides be abandoned; they should be phased out of use step-by-step and taken off the market.** Since the early 1980s, various programs have been introduced that aim to ensure the "safe" use of highly hazardous pesticides (e.g. by training people in application methods), but they have proven to be unsuccessful. Consequently, the only effective strategy to reduce the health risks associated with pesticides is to end their use (see PAN Germany, 2011[93]).

It is also essential that the methods employed to study health hazards associated with pesticides be improved. Epidemiological studies offer evidence that many of the pesticides approved for sale and use are linked to adverse health effects. In keeping with the precautionary principle, this evidence should be the basis for implementing improvements in international and national laws, in the test regimes required before pesticide products are licensed for sale, and in procedures for monitoring and controlling pesticide use.

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