

Maine becomes last state to allow genetically altered corn

July 28, 2007

WATERVILLE, Maine --Maine is joining the rest of the country in allowing farmers to grow a type of genetically altered corn.

The Board of Pesticides Control voted to let farmers grow the crop that's resistant to insects. It'll be used only for animal feed as it is in other states, and the seed companies will have to provide sales data to the state.

Organic growers have been concerned their that crops will be contaminated by cross-pollination with the genetically modified corn.

But the Board of Pesticides Control said Friday that its mandate of reducing pesticide use and its concern about state farmers being at a competitive disadvantage without the genetically altered feed trumped those concerns.

"If we don't take advantage of this technology, these farmers may not be here in five or 10 years down the road," board member Richard Stevenson said.

Critics urged the board not to cave to pressure for Maine to follow the rest of the nation in adopting the use of *Bacillus thuringiensis*, or Bt, corn. They said the modified corn poses a potential threat to wildlife and plants, as well as people.

"This technology has been out there about a generation," said Peggy Gannon of Stetson, "and there have been no long-term tests on humans."

Organic growers have their own concerns: contamination of their crops and possible revocation of their organic certification.

But Pittsfield farmer Tom Cote argued that eliminating use of some pesticides by growing Bt corn will be a net gain for the environment. Farmers like Cote say they'll be able to reduce the use of expensive pesticides.

"I believe Bt crops are a bit better for the environment and the people who have to handle them," Cote said.

The board voted to mitigate the possible risks by developing rules for how the modified corn is grown to address some of the concerns of organic farmers.

The three companies that petitioned to sell the corn -- Dow AgroSciences, Pioneer Hi-Bred International and Monsanto -- also will be required to provide sales data to the state so it can track the use of the seed.

"We have to weigh that risk against pretty clearly defined benefits," said board member Daniel Simonds, a forestry consultant. "I'm having a hard time seeing the net adverse effect as being unreasonable." ■



Several opponents at a hearing to allow a genetically-altered corn to be sold in Maine showed their opposition by coming to the Waterville hearing dressed as honeybees. Many organic farmers testified that the corn could pose a threat to humans, the environment and other species, such as pollinating honeybees.
(Bangor Daily News Photo/Sharon Mack)

Modified corn OK'd for Maine farmers

By [Sharon Kiley Mack](#)

Saturday, July 28, 2007 - Bangor Daily News

WATERVILLE, Maine - After pleas from farmers on both sides of the issue, Maine's Bureau of Pesticides Control on Friday approved the registration of corn that is genetically engineered with a natural pesticide. Maine is the last state in the country to allow the modified corn to be sold or grown.

While dairy farmers said they needed the greater-yielding corn to maintain a competitive edge, organic growers said they feared for the health of Maine's residents.

"This technology has been out there about a generation," testified Peggy Gannon of Stetson, "and there have been no long-term tests on humans." Gannon and others asked the Bureau of Pesticides Control to wait for approval until next spring to give the Legislature time to review new liability rules for planting genetically engineered crops.

"Maine doesn't have this [engineered corn]. We are the only state because we're smarter," said Andrea DeFrancesca of Franklin.

Dairy farmers, however, asked the bureau to allow them the same tools that other farmers across the country are using, saying they could save money and environmental costs by eliminating pesticide spraying and growing a bigger, disease-free crop.

The genetically engineered corn approved Friday is Bt, or *Bacillus thuringiensis*, corn.

Bt corn — which is used only for cow feed, not for human consumption — is genetically engineered to produce pesticidal proteins from the naturally occurring soil-borne Bt bacteria that kill certain insects. As such, the corn seed is considered a pesticide, which is why it requires BPC approval.

Members of the BPC said they recognized that Bt corn may require special management because of concerns the pollen may drift to organic corn.

"This is not Kansas," said BPC member Daniel Simonds. Referring to the different geography in Maine and how varying farms abut each other, he said, "The spatial management of this is quite complex and may be hard to monitor."

To deal with those concerns, the BPC approved the corn with two conditions: that an educational program be offered by the chemical companies, and that sales records be provided to the BPC to allow monitoring of how much and where the corn is planted.

The BPC held the hearing after a request filed in March by three biotech companies — Dow AgroSciences, Pioneer Hi-Bred International and Monsanto — on behalf of dozens of Maine farmers. The companies submitted applications to register seven Bt field corn products, all used as feed for animals.

Organic farmers at Friday's hearing testified that drift from Bt corn could contaminate their certified organic crops and possibly open them up to copyright infringement lawsuits from the chemical companies that manufacture the seeds.

Jody Spear of Co-Op Voices Unite said Bt corn poses unacceptable risks, including liver and kidney damage, allergies and asthma, as well as posing risks to other plants and animals.

"Consider that one out of every three bites of food has been pollinated by honeybees. You need to tread carefully," she said.

Logan Perkins of Protect Maine Farmers said the issue was not just about organic certification. "It is about the market, about consumer confidence and the farmers' ability to save seed."

But conventional dairy farmers argued that organic farms represent a small percentage of Maine agriculture and the "tail shouldn't wag the dog."

Dairy farmers from Knox, Pittsfield and Exeter testified Friday that using Bt corn will give them a competitive edge and allow them to stop spraying their fields with pesticides, which sometimes is done three times a season.

James Crane, an Exeter dairy farmer, raises 2,400 acres of crops with nearly 1,000 acres in corn, and pays \$13 an acre to spray with pesticides.

He said Bt corn already is being imported into the state as cattle feed. "It is coming into the state by rail cars. Allow me to compete," he said.

The BPC began investigating Bt corn in 1994, conducting technical reviews to look for adverse effects on human health and for potential development of insect resistance.

According to Dr. John Jemison, an agronomist at the University of Maine in Orono, these reviews were conducted in 1997 after applications were filed to register three Bt corn products. The human health review concluded there were no concerns, and a process was established to identify any development of insect resistance. The registrations were denied, however, because Maine's pesticide statute requires that a need or benefit be demonstrated for the products. No such information was available at that time.

At Friday's hearing, the BPC members concluded that Maine farmers needed the edge provided by planting Bt corn.

"If we don't take advantage of this technology, these farmers may not be here in five or 10 years down the road," BPC member Richard Stevenson said.

The BPC will draft a new rule which then will be advertised by the Secretary of State's Office and a formal public hearing will be held in the future.

Morning Sentinel

Genetically modified corn gains approval

By CRAIG CROSBY
Staff Writer

Saturday, July 28, 2007



Staff photo by Jim Evans

AGAINST: Jeff Black, of Thorndike, demonstrates against a proposal to allow genetically modified corn to be grown in Maine during a hearing Friday in Waterville.



Staff photo by Jim Evans

FOR: Carol A. Eckert, M.D., chairwoman of the Maine Board of Pesticides Control, votes to allow genetically modified corn to be grown in the state during a hearing Friday in Waterville.

WATERVILLE -- Maine joined the rest of the nation Friday when the Board of Pesticides Control approved the use of a genetically modified corn that is resistant to insects.

Citing a mandate to try to reduce the use of pesticides, the board approved applications by Dow AgroSciences, Pioneer Hi-Bred International and Monsanto to register seven Bt corn products to be grown for animal feed.

While allowing the corn to be grown in Maine for the first time, the board plans to develop rules for the crops use to alleviate

organic farmers' fears of contamination.

"I'm only going to be able to say there aren't unreasonable risks if we add some conditions (for use)," said Chairwoman Carol A. Eckert, M.D.

The board voted 6-0 in favor of both the motion to approve the applications under the conditions the three companies report sales data to the board and support education and training. The board also agreed 6-0 -- John Jemison Jr. abstained from both votes for unstated reasons -- to develop rules for use.

Those rules, and how they are enforced, will be key to many of the roughly 60 people who filled the room at the Hampton Inn for Friday's meeting. While conventional farmers argued that the Bt corn will help make them competitive with corn growers around the country, organic farmers raised concerns of genetic drift, the creation of super-resistant bugs, and also the health and welfare of people and animals.

"We should not be endangering our food supplies with dangerous, biotech gambles," said Jody Spear of the Sierra Club.

The board considered the applications in two primary areas -- whether the Bt corn would have an adverse affect on the environment and if farmers had shown a need to use the crop.

Genetic drift, the cross pollination of a genetically modified crop with a non-modified crop, may occur, said Jemison, a water quality and soil specialist for the University of Maine Cooperative Extension in Orono. European markets allow products to be labeled organic with up to 5 percent genetic modification.

"If zero is the intended goal, it's really always going to be difficult," Jemison said.

But Pittsfield farmer Tom Cote argued that eliminating use of some pesticides by growing Bt corn will be a net gain for the environment.

"I believe Bt crops are a bit better for the environment and the people who have to handle them," Cote said.

While acknowledging the risks, the board ultimately decided it could mitigate the dangers by educating users and encouraging conventional farmers and organic growers to work together to help reduce the chance of genetic drift.

"We have to weigh that risk against pretty clearly defined benefits," said board member Daniel Simonds, a forestry consultant. "I'm having a hard time seeing the net adverse affect as being unreasonable."

Board member Lee Humphreys, a market gardener, said there were too many unknowns about the genetically modified corn, such as its long-term effect on the soil and in creating resistant bugs.

"I think it might very well be a short-term solution and farmers will be forced to use more pesticides in the future," she said.

Humphreys also mentioned 108 letters the board received opposing use of the corn.

"We represent them as well," she said. Many of the organic growers who spoke against approving the corn suggested there was not a real need. Logan Perkins of Protect Maine Farmers noted the number of organic dairy farmers that survive without pesticides or Bt corn.

"If they can do it, why can't everyone else?" Perkins asked.

Using Bt corn will increase harvests an estimated 10 percent, which will help give farmers an important economic edge, said board member Richard Stevenson Jr., a commercial applicator for Modern Pest Services.

"It may not run a farm out of business today, but if they don't take advantage of these technologies, they may not be there 5 or 10 years down the road," Stevenson said.

Craig Crosby--861-9253

ccrosby@centralmaine.com


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Will Maine embrace genetically modified foods?

By [Megan Richardson](#)

(Created: Friday, July 20, 2007 12:27 PM EDT)

AUGUSTA — The controversy over genetically modified (GM) foods heats up as the Maine Board of Pesticide Control (BPC) prepares to consider allowing a genetically modified type of corn that contains a pesticide to be grown and sold in Maine.

Bacillus thuringiensis (BT) corn can be sold or grown in every state in the country except Maine. This corn has been genetically altered to produce the pesticidal proteins that are present in the soil-born Bt bacteria. Because corn containing Bt is considered a pesticide, it must be registered and approved by the BPC.

This is not the first time the BPC has looked at allowing Bt corn in the state. According to a press release regarding the coming BPC meeting, the board first considered Bt corn a decade ago, when companies first applied to register Bt corn. Research conducted by the BPC found no health concerns associated with Bt corn, but the applications were ultimately denied because the board did not find that there was any real demonstrated need for Bt corn in the state.

Board member John Jemison says that interest is now coming from large herd dairy farmers who want to be able to use Bt corn. He says that Maine has a small corn market, but Bt corn companies have been willing to resubmit applications because farmers have expressed interest.

Maine farmers, however, are split on the issue. While there are large dairy farms that are interested in growing Bt corn (to be used as feed for their animals), there are also smaller farms that are very much opposed.

Spencer Aitel, an organic dairy farmer in China, is one of the farmers who oppose Bt corn, and he is vocal about it. He and his wife Paige Tyson have been running their organic farm since 1997. They have between 130 and 140 cows, and grow about 25 acres of feed corn, in addition to other oats and grains.

Aitel opposes Bt corn for several reasons. First, organic farmers commonly use Bt in a spray form as a pesticide, as it is one of the only pesticides available that is not a poison. Aitel and other organic farmers are concerned that insects will develop a tolerance to Bt if the corn is commonly used, making Bt as a pesticide ineffective.

He is also worried about genetic pollution. He points out that it is not possible to control pollen and where it travels. He worries that if Bt corn is grown at other farms, the pollen could drift and contaminate his and other farmers' conventional or organic corn.

Aitel says he has already seen signs of pollution with other genetically modified corns in Maine. Herbicide resistant corns, such as the brand Roundup Ready, are allowed in the state, because they are not considered a pesticide. Aitel says that he has tested



Spencer Aitel stands among the rows of corn on his farm. He grows about 25 acres of feed corn in addition to oats and grains. [MEGAN RICHARDSON](#)

bags of supposedly regular corn and has found some of the plants to be Roundup Ready.

"It's pretty easy to test for Roundup Ready corn," said Aitel. "If you spray it with Roundup and it doesn't die, it's pretty obvious what you've got."

More than anything, Aitel just doesn't think Bt corn is necessary. He says the pests that Bt protects against are not usually a problem in Maine, as they are common to more southern parts of the country. He says that when the insects do make their way up to Maine, pesticides (such as the spray form of Bt) can be used as needed rather than across the board, which would be better for the environment. He says that supporters of Bt corn often cite a reduction in the use of pesticides as one of its bonuses. Aitel disagrees.



Spencer Aitel shows some of the regular corn seed used at his farm. [MEGAN RICHARDSON](#)

"Bt corn doesn't reduce the amount of pesticides used, it applies them in a different way," Aitel said.

He says Bt corn actually increases the amount of pesticides put into the environment because the corn produces the pesticide constantly, regardless of whether or not it is needed.

Aitel says that if farmers would properly rotate their crops, there wouldn't be a need for all those pesticides anyway. He says that soil is healthier when crops are commonly rotated, and has fewer pests as a result. He also says that scientists in Maine are looking at ways to rotate crops so that they leave a slight insecticidal residue, which would be a more natural way to keep pests away.

Aitel says that in addition to charging for corn seed, Bt companies charge a hefty technology fee as well, making Bt corn far more expensive to grow than organic or conventional corn.

According to dairy farmer Tom Cote, this is not necessarily true. Cote owns a farm in Pittsfield, where he milks about 350 cows and grows around 400 acres of feed corn. To Cote, one of the best things about Bt corn is that the pesticide is there when he needs it — and he doesn't have to keep applying it. He'd rather be safe than sorry.

"The problem with farming is you don't know you have a problem until you already have it," Cote said.

Cote says he travels a lot, and has seen a lot of Bt crops in other parts of the country.

"They have better yields," he said.

Cote is also concerned with safety. He likes the idea of having the plant produce its own pesticide, because that means people working on his farm — which includes family members — have to handle fewer chemicals and pesticides. He also believes Bt corn would be quite a cost savings. He says that a bag of top-of-the-line corn seed sells in the \$85 - \$100 range, while a bag of Bt corn sells for between \$100 and \$130 per bag. Cote says the savings in labor and additional pesticides that he has to use to grow non-Bt corn would offset the slightly higher cost of the Bt seed. He thinks he should be able to use Bt technology at his farm.

"Every farm is different. We want the option out there," Cote said.

But to Aitel, it isn't that simple. He thinks Bt corn is risky, but he is willing to compromise.

"Organic farmers are just looking for cooperation," Aitel said.

By cooperation, he means regulation. If Bt corn is approved in the state, Aitel wants it to be regulated. He wants things to be recorded, inspected, and monitored. Aitel says that everything else in farming is regulated, from spreading manure and fertilizer to keeping a pesticide log. He doesn't think Bt corn — which is considered a pesticide — should be any different.

Nationwide, though, Bt corn has not been faced with many regulations, and that's how Cote wants it.

"I'm the kind of person who thinks the fewer regulations, the better," said Cote.

He does not think it would be fair to put regulations on Bt corn in Maine, because it isn't regulated anywhere else in the states. Cote does think it would be wise to hold regular informatory meetings on the proper ways to grow Bt corn, but he does not think they should be mandatory. He is also opposed to regulations that would cause him to change his labeling, as this would increase costs for the farm.

What about the food you eat?

Most people probably consume genetically modified foods without realizing it.

GM foods in the United States are not heavily regulated, especially when it comes to labeling. GM foods are sold and consumed all the time, and many people have no idea.

According to the U.S. Department of Energy's genomics Web site, the most common GM crops are soybeans, corn, cotton, and canola. These include both herbicide-resistant plants and those containing pesticides. According to Jemison, herbicide-resistant corn, soybeans, and canola are allowed in Maine. He also said that Bt potatoes were approved in the state, but that potato farmers did not embrace the technology.

The Center for Food Safety reports that 85% of soybeans and 45% of corn grown in the United States is genetically modified. Because of the prevalence of corn and soy products in processed foods (such as breakfast cereals, crackers, and soups), many people are consuming GM foods everyday. The Center for Food Safety also reports estimates that 70 to 75 percent of all processed foods in the United States contain some form of a GM ingredient.

There are plenty of new GM foods in the works. The genomics Web site lists rice that has an increased vitamin content, bananas that produce a vaccine against hepatitis B, fish that mature more quickly and fruit trees that produce years earlier among them.

The pros and cons of GM foods are often debated, and the genomics Web site lists some of the benefits and controversies associated with GM foods. On the positive side are increased nutrients and yields, faster maturation time, more environmentally friendly insecticides (such as Bt), and an increase in food production for growing populations. On the negative side are potential unknown health problems, ethical questions about mixing genes from different species, and the lack of a labeling requirement in some countries (like the United States).

Even though companies are not required to label their GM products in the United States, GM foods are monitored by the government. Groups such as the USDA and the FDA determine whether or not plants are safe to grow and eat, so GM foods are not completely regulation-free.

Still, farmers like Aitel want to keep Maine growers and consumers informed about GM products, and he thinks changes need to be made. While he does not want Bt corn to be approved in Maine, he hopes that if it is, farmers and Bt companies will be cooperative in regulation and keeping people informed.

The BPC is scheduled to meet Friday, July 27, to consider whether or not they should approve Bt corn. The meeting is open to the public and will take place at the Hampton Inn in Waterville at 9:30 a.m.

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Maine says yes to Bt corn

By [Megan Richardson](#)

(Created: Tuesday, July 31, 2007 2:57 PM EDT)

AUGUSTA — The Maine Board of Pesticide Control (BPC) voted Friday to allow *Bacillus thuringiensis* (Bt) corn to be grown and sold in the [state of Maine](#). Maine is the last state in the United States to approve Bt corn, which has been genetically modified to produce its own pesticide.

The BPC voted to approve the registration of Bt corn in the state, but will do so only under specific conditions, which as yet have not been completely worked out. According to Paul Schlein, Public Information Officer of the BPC, once the conditions are worked out they will be made into law. Schlein said the board will require seed companies to supply sales information. He said farmers will also be required to receive education and training on the use of Bt corn.

Bt corn has been a controversial issue in Maine, especially between small organic farms and larger traditional dairy farms. Organic farmers have raised concerns about crop contamination and increased insect resistance to pesticides. Traditional farmers have said that the new corn will allow them to use fewer chemicals and pesticides overall and will improve crop turnout.

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Editorial, Page C4
July 15, 2007

Before Maine gets Bt corn, protect organic farmers' crops protection

The genetically modified product has built-in advantages, but it shouldn't take over by default.

Maine, the only state not to have approved the use of genetically modified "Bt corn," may soon grant that permission to farmers.

When and if it does, the policies and procedures under which it is planted and grown have to be strictly controlled to prevent other types of the crop from being contaminated with the new strain. Only stringent measures will protect those growers who boast of raising truly organic foods.

The genetic structure of the modified corn has been altered scientifically to be more resistant to insect pests by producing an organic toxin called Bt, for "Bacillus thuringiensis," a naturally occurring type of soil bacteria.

Three producers of the GM grain, Dow AgroSciences, Pioneer Hi-Bred International and Monsanto, have applied to the state Board of Pesticides Control to reconsider its ban, which it could do at its July 27 meeting.

The corn has long been opposed by Maine's large number of organic growers, who worry that Bt corn, which is pollinated by the wind, will cross-pollinate their organic varieties.

They are also concerned that it will produce bugs that evolve over time to be more resistant to Bt, which they spray on their crops to kill the pests.

The pesticides board turned down the last application to grow GM corn here 10 years ago, but the grain has been modified to protect against a wider variety of pests, including cutworms, rootworms and caterpillars.

And GM varieties of canola, corn and soybeans modified to survive weed-killing herbicides have been grown in Maine for years.

Nevertheless, if the board approves Bt corn, it should provide for adequate buffer zones and other precautions to prevent cross-pollination and allow pests to feed on unprotected crops so that their vulnerability can be preserved.

That's how the balance of nature can be worked into the GM equation.

GENETICALLY MODIFIED CORN

Next step: Do no harm

Editorial—Thursday, August 2, 2007

The sky fell a long time ago for those who feared the introduction of genetically modified crops into Maine. For at least a decade, the state's farmers have grown Roundup Ready canola, corn and soybeans as well as LibertyLink corn -- all plants that have been bred through biotechnology to be resistant to herbicides.

Last week, another significant barrier finally fell when the state's Board of Pesticides Control, or BPC, approved the use of *Bacillus thuringiensis*, or Bt, corn. That approval was hotly contested by organic farming advocates and came a decade after the first effort by biotechnology companies to gain approval of the corn's use in the state. (A small experiment in growing Bt potatoes here in the last decade failed when the market for them didn't materialize.)

Bt corn is grown as feed for animals and contains normally soil-borne bacteria that kill insects that can decimate a corn crop; insects try to eat the corn and die, instead. Conventional farmers argued that growing it could cut their pesticide use and costs, increase yields and thus give them a competitive edge at a time when farming in Maine is more challenged than ever.

Organic farmers have maintained for years that use of Bt corn would lead to the evolution of pesticide-resistant insects. Equally worrisome was the issue of so-called "genetic drift" -- unlike the earlier experiment with Bt potatoes, which self-pollinate, one corn plant pollinates another. And that raises the specter of Bt corn pollinating organic and non-Bt corn -- a kind of genetic trespass and pollution that scared organic growers who make a living on the certified purity of their crops.

The state needs to do everything it can to help both agricultural sectors, conventional and organic, thrive. The use of Bt corn may well help conventional farmers but it can also harm a robust and growing segment of our state's farming community, organic growers. Conflicts between adjacent farms that grow both kinds of corn are bound to happen; those conflicts could easily escalate into lawsuits. Farmers are more likely to be able to handle a plague of grasshoppers than a plague of lawyers, and time spent in a courtroom is time not spent in the field.

That elevates the importance of ensuring that proper rules are in place to control the interactions between Bt corn crops and organic crops and that rules regarding the safe and ecologically appropriate management of the corn are promulgated and enforced.

The Board of Pesticides Control should ensure that all farmers using the corn are trained in its safe management. Buffer zones will need to be established between the crop and adjacent farms growing organic corn; that will likely entail direct discussions between farmers that should be facilitated and overseen by the board. Federal requirements that 20 percent of a farm's acreage be planted to conventional corn as a "refuge" for insects must be followed. Compliance with these rules will require that farmers file annual reports.

All this will necessitate strong enforcement and oversight by the board, which will be a challenge, given that it's part of an underfunded and understaffed state Department of Agriculture. Yet if there's one place where that kind of state oversight is positively essential, it's in the aftermath of approval for a crop that's never been grown in this state before and whose potential, and perils, are equally great.

Beyond Pesticides Daily News Blog

Maine Withdraws Opposition to Bt Corn

(*Beyond Pesticides*, August 3, 2007) Maine is no longer the only state to prohibit the use of genetically altered corn. Despite concern from the organic farming community, Maine joined the rest of the nation last Friday when the Board of Pesticide Control (BPC) ruled to allow *Bacillus thuringiensis* (Bt) corn to be grown and sold in the state of Maine.

With the aim of reducing the use of hazardous pesticides, the BPC registered Bt corn products from Dow AgroSciences, Pioneer Hi-Bred International and Monsanto to be grown for animal feed. Bt corn is genetically modified to produce its own pesticide, a naturally occurring toxin that protects against a combination of insects.

Organic growers caution that overuse of the crop will lead to insect resistance to the Bt toxin, which is widely sprayed on organic crops.

“I think it might very well be a short-term solution and farmers will be forced to use more pesticides in the future,” said Board member Lee Humphreys, a market gardener. She warned that there are too many unknowns about the genetically modified corn, such as its long-term effect on the soil and in creating resistant bugs.

In addition, the safety of consuming milk and beef products from animals fed with Bt corn has not been fully probed. A 2000 report of the National Academy of Sciences on Bt crops concluded that “there is the potential for...adverse health effects” and recommended that “priority should be given to the development of improved methods for identifying potential allergens” in these crops.

“This technology has been out there about a generation,” testified Peggy Gannon, “and there have been no long-term tests on humans.” Ms. Gannon and others asked the Board to wait for approval until next spring to give the Legislature time to review new liability rules for planting genetically engineered crops.

Another concern is that the pollen from Bt corn will contaminate crops that are not bioengineered, possibly resulting in copyright infringement lawsuits from the chemical companies that manufacture the Bt corn seeds.

While allowing the corn to be grown in Maine for the first time, the Board plans to develop rules for the crops use to alleviate organic farmers’ fears of contamination.

“I’m only going to be able to say there aren’t unreasonable risks if we add some conditions (for use),” said Chairwoman Dr. Carol A. Eckert, M.D.

The applications were approved under the conditions that the three companies report sales data to the Board and support education and training. Just as important is the need to develop a strategy to prevent pollen drift, according to Russell Libby, executive director of the Maine Organic Farmers and Gardeners Association.

He said farmers must also follow a U.S. Environmental Protection Agency (EPA) requirement to use non-Bt corn on 20 percent of their corn acres, so insects have a refuge from the toxin.

“If the refuge is planted on the edge of cornfields then it would make a great buffer” with nearby farms, Mr. Libby said.

Although EPA asks farmers to set aside refuges of non-Bt crops, a biotechnology industry survey published in January 2001 showed that nearly 30% of farmers who grew Bt corn in 2000 did not follow the resistance management guidelines.

Along with considering the potential adverse effect on the environment of Bt corn, the Board required that farmers had shown a need to use the Bt corn.

“If we don’t take advantage of this technology, these farmers may not be here in five or 10 years down the road,” said Board member Richard Stevenson.

However, *When Does It Pay to Plant Bt Corn?*, a 2001 report, found that American farmers suffered a net loss of \$92 million, or about \$1.31 per acre, from planting Bt corn between 1996-2001.

Bt corn has been a controversial issue in Maine, especially between small organic farms and larger traditional dairy farms, but it would not be the first genetically engineered crop grown in Maine. The Roundup Ready line of canola, corn and soybeans, which has been modified to survive herbicides, has been legally grown in Maine for at least 10 years, the Board said.

But the fact that Bt corn can not be grown in Maine had been a point of pride for some environmental and agricultural groups, whose members worry that the rise of bioengineered crops will hurt wildlife and humans and give corporations too much control over farming.

The Board's decision bows to the pressure of industrialized dairy farmers and underscores the difficulties that organic agriculture faces.

Sources: [The Boston Globe](#), [Portland Press Herald](#), [North Kennebec Valley Morning Sentinel](#), [Keep Maine Free From Genetically Engineered Crops](#)

Posted in [Alternatives/Organics](#), [Genetic Engineering](#), [Bt](#), [Maine](#) by: Beyond Pesticides

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We oppose genetically modified crops

(Created: Wednesday, August 1, 2007 9:51 AM EDT)

The Maine Board of Pesticide Control (BPC) voted Friday to allow *Bacillus thuringiensis* (Bt) corn to be grown and sold in the [state of Maine](#). Maine is the last state in the United States to approve Bt corn, which has been genetically modified to produce its own pesticide.

We admit we may just be superstitious or old-fashioned, but we disagree with this decision.

Whether the world and its life forms were created by God or are the result of millions of years of evolution (or both), we believe that the process that got us here is superior to a process we can create.

To put it another way, we do not feel humans have attained the wisdom or the moral judgment to handle the awesome responsibility of altering nature at the DNA level.

It's a dangerous road we're on when taking a piece of bacteria DNA and splicing it with that of corn. And that's exactly what's happening here.

It's not a matter of something taking place in a controlled laboratory environment. Cornfields are out in the open and they could affect plant life in the environment for years to come. What's worse is we really don't know the long-term consequences of this genetic tinkering.

There's a difference between "can we do this" and "should we do this." Science and industry have too often forgotten to ask the second question.

People got by for thousands of years without this method of altering their natural world.

Perhaps we are splitting hairs between this form of genetic modification and the kinds of breeding practices that changed the wolf into the domesticated dog. Certainly medical science has made good use of genetic research.

However, when it comes to farming, the only real reason to engage in this process is greed, and that's not good enough for us.

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OpEd—John Jemison: Between a rock and a hard place

Monday, August 06, 2007 - Bangor Daily News

After listening to Maine farmers express why they wanted Bt corn and to the opponents about why they opposed it, I found myself between a rock and a hard place. I have studied and researched genetically modified crops for more than a decade. I have heard how biotechnology will reduce pesticide inputs, save growers money, and feed a growing population through increased yields etc.

Some of that is true. For example, insect resistant cotton has greatly reduced insecticide inputs. However, use of another GM crop technology (herbicide tolerant crops like Roundup-Ready corn and soybeans) has actually led to more herbicides being applied to crops. The reason is that no herbicide controls all weeds. Over time, weeds not controlled well by a specific herbicide tend to populate crop fields leading to higher application rates to maintain control.

If an herbicide is used for too many years, weeds can develop complete resistance to the herbicide. Opponents of Bt corn think the same thing will happen with the insects controlled by Bt. University scientists have worked with industry to develop an insect resistance management plan to prevent this. Growers will have to understand and follow this plan carefully to prevent insect resistance.

I have the unique opportunity to serve on both the Maine Organic Farmers and Gardeners board of directors and the Maine Board of Pesticides Control. As the university representative on the BPC, I try to provide the board with research-based information so that we can make technically sound decisions. My interest in serving on the MOFGA board is similar. I bring a larger farm perspective than many to the discussions, but I am extremely supportive of their goals of sustainable agriculture, a strong local food network, and farming with minimal pesticide inputs. While it might seem to many that the two boards are grossly different, both are concerned about the long-term sustainability of Maine agriculture.

The BPC's decision to approve Bt corn was based on farmer need and acceptable human/environmental risk. MOFGA director Russ Libby stated that he didn't think the BPC had made a case for need. Yet, need is a variable term. Yes, we could continue producing corn in Maine without Bt as we have done for the last nine years.

But as our farms grow larger, and production costs increase, farmers see a greater need to use available tools to prevent major loss. I stated at the meeting that I wish we still had 1,200 dairy farms in Maine, each milking 50 to 100 cows, and that those producers could make a comfortable living on that. But the USDA food policy and farm supports have favored increased farm size, efficiency, and low-cost food. Most of our dairy farmers have taken that road, and they are an effective economic engine. They steward the land, create jobs and produce a local healthy product for Maine families. It is hard not to support their wish to have the tools they believe they need to be effective.

In the end, I doubt the BPC's decision will radically change Maine's corn production. I don't think we'll see significantly higher yields or radically improved feed quality. But, I think this will be a positive decision if our growers learn how to use the crop, manage Bt corn well, and follow the protocols that will reduce the potential for insect resistance.

If we can help growers reduce personal and public exposure to pesticides that we know are hazardous, I am willing to accept some degree of uncertainty associated with newer technologies.

It's not particularly comfortable being between a rock and a hard place, but shades of gray are reality and agriculture is no different. Regardless of how you feel about the BPC decision, I hope you will continue to see and value what agriculture does for our state.

John Jemison is an extension professor of water quality and social science at the University of Maine Cooperative Extension

Planting the seed

Controversy swirls around genetically modified veggies. But will Bt corn help Maine's farmers?

BY KERRY ELSON

On July 27, the state reversed its 10-year ban on a kind of genetically modified corn that makes its own pesticide. Maine was the last state in the nation to approve the controversial variety, called Bt corn, which is implanted with the bacteria *Bacillus thuringiensis* to resist pests like cutworm, maggots and grubs.

The decision from the Board of Pesticides Control was unanimous. It voted 6-0 to approve applications from three major seed suppliers — Monsanto, Pioneer Hi-Bred International and Dow AgroSciences — to sell a total of seven varieties of Bt corn in Maine.

The BPC hopes allowing Bt corn will reduce the use of toxic spray pesticide, which can drain from farm soil into waterways.

Continued on page 6

ALSO INSIDE

Smart spending Scott Tompkins on the cost of aging infrastructure, in From



They have different jobs in different industries, but these five Maine workers have one thing in common:

THEY'RE ALL WORKING THE NIGHT SHIFT



PHOTO/DAVID A. RODGERS

On patrol: Sgt. Patrick Lally of the Westbrook Police Department

dustry is being squeezed by out-of-state pressures, too: Peter Lammert, utilization and marketing forester for

70%, according to a press release. Verizon committed to completing the expansion, including installing all neces-

s ballot, according to the Associated Press. The first question of five will ask voters whether they want to

on Aug. 2. Blitz would replace Charles Summers, who vacated the post in June to serve in Iraq and run for Congress.

Planting the seed

Continued from cover

The board members hope it will give a leg up to Maine's conventional corn growers, who've said they find it hard to compete with their peers in the rest of the country, nearly 50% of whom use Bt corn, according to the U.S. Department of Agriculture.

The decision isn't final. Organic growers worry that Bt pollen will contaminate their crop, so the BPC is drafting rules for how farmers can use the corn. The three companies, too, have to agree to tell the state how much Bt corn they sell here. But if companies agree to those conditions, the seed could be available this fall, giving farmers here a chance to catch up with farmers elsewhere.

These days, some farmers say they can't afford not to use Bt corn. The corn can boost yield by as much as 10%, says Lauchlin Titus, an agronomist in Vassalboro whom the state hired this year to research

"Farmers are losing access to newer, higher-yielding varieties," Titus says.

Pesticide roundup

In 1997, when the state denied companies' applications to sell Bt here, the variety wasn't as widespread. The technology was new and only protected against a bug that wasn't a problem here, the European corn borer. Since then, however, companies have tweaked Bt corn to resist several kinds of bugs — including rootworm and caterpillars — making it more attractive to Maine growers. As Bt corn became more powerful, farmers in Maine began asking for it, and the three companies eventually brought their proposals to the state a second time, in March 2007.

Bt corn wouldn't be the first genetically modified crop in Maine. About 30% of

PHOTO/COURTESY JIM CRANE



Ready for Bt: Jim Crane, co-owner of Crane Brothers Farm in Exeter, says he'll purchase Bt corn seeds when they come to Maine

Bt corn's benefits. (Titus also consults for Monsanto, the St. Louis, Mo.-based firm that applied to sell Bt corn here.) For the last three years, almost all seed companies' highest yielding corn — the kind that will produce the most product per acre — has been genetically implanted with pesticide.

But because of the Bt corn ban, those kinds aren't available here. Of the 108 varieties from Pioneer that could grow in Maine, for example, about 60 are banned because they contain Bt, according to Titus.

Maine farmers use another kind of genetically modified corn, Roundup Ready, which can resist herbicides that farmers spray to kill weeds in their fields.

But Bt corn sparked controversy partly because, according to organic growers, it could make bugs resistant to Bt, which they can use in spray form because it's a natural substance. If conventional farmers begin planting Bt corn, bugs could develop resistance to it, making the spray ineffective. Organic farmers also say that if Bt

corn pollen travels to nearby organic plots, those crops would be contaminated and lose value.

Russell Libby, executive director of the Maine Organic Farmers and Gardeners Association in Unity, says possible contamination concerns him most.

For now, the state has no laws on who's responsible for contaminated crops — a bill that would put the blame on GM seed manufacturers, LD 1650, was introduced in the Legislature this spring but put off until next year. "That's all pretty challenging, figuring out what the rules are," Libby says. "As these engineered crops become more prevalent in Maine agriculture, that's the question."

One regulation the BPC hopes to implement will require farmers to plant Bt corn refuge areas, or acres that contain non-Bt corn. Those tracts of land would help prevent bugs from developing resistance to Bt, according to Gary Fish, director of pesticide programs at the BPC. Meanwhile, the BPC, which is working to limit pesticide use in Maine, hopes that using Bt corn will reduce the amount of toxic pesticides that farmers spray. About 40% of Maine's 24,000 acres of field corn is sprayed with insecticide each year, according to Titus.

Jim Crane, co-owner of Crane Brothers Farm in Exeter, is certain he'll purchase about 350 bushels of Bt corn seed if it's sold in Maine. Crane, who grows potatoes and corn on 2,400 acres, isn't sure how much money he'll save using Bt instead of spraying insecticide, which costs about \$13 an acre, but he's looking forward to cutting down on his pesticide use. "There's a reason there's a skull-and-crossbones on it," he says. "If I can get rid of that, that's what I'd like to do. I don't like to be around it, and I don't like my workers to be around it."

Crane says he couldn't forgo toxic sprays altogether and go organic. "The weeds and insects would eat us alive," he says. For a 25-acre farm, abstaining might be possible, he says, but not for a farm the size of his own.

Not all farmers may be willing to try Bt corn. Titus predicts that if the state gives it final approval, a few will use it this year, and the figure will climb over the next three to four years until the state reaches the national average, 50%.

"It's one thing for the government to say, 'You can't use this,'" he says, referring to Bt corn. "It's another thing for people to be able to decide whether or not to use it."

Kerry Elson, *Mainebiz* staff reporter, can be reached at kelson@mainebiz.biz.



The benefits of pesticides to mankind and the environment

Jerry Cooper*, Hans Dobson

Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent ME4 4TB, UK

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Abstract

Most published material relating to pesticides focuses on negative attributes and outcomes. This fact probably partly explains the public's inaccurate perception of the hazard they represent, and the low level of appreciation of the benefits they bring. This paper explores and analyses the many benefits of using pesticides, in order to inform a more balanced view. It does not attempt to quantify or rank these benefits, nor to weigh them against any negative consequences of pesticide use. Twenty-six primary benefits are identified that are immediate and incontrovertible, and 31 secondary benefits that are longer term, less intuitive and for which it is harder to establish causality. These benefits include increased crop and livestock yields, improved food safety, human health, quality of life and longevity, and reduced drudgery, energy use and environmental degradation. A complex matrix of benefit interactions are explored for a range of beneficiaries at three main levels—local, national and global, and in three main domains—social, economic and environmental.

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1. Introduction

The hazards of pesticides are well documented, but their benefits are largely ignored in published literature and the mass media. A recent brief poll of pesticide-related articles in published literature, conducted by the authors, revealed a ratio of over 40 negative articles for each one that took a more positive view. Many point to health or environmental problems from accidental or deliberate exposure to pesticides, particularly pesticides with high mammalian toxicity or those that persist in the environment. These risks should not be ignored, and efforts must be made to minimise them through rigorous regulation and proper training for users, but we should not overlook the positive impacts of pesticide use. When pesticides are used rationally and carefully, in conjunction with other technologies in integrated pest management systems, it is more likely that their use will be justifiable.

Part of the explanation for the scarcity of articles highlighting the benefits of pesticides may be that when a

product does exactly what the manufacturer says it does, it is not 'newsworthy'. We do not read about the wonders of gloss paint, but it remains a good way to protect exterior woodwork. Sometimes, it takes an accident or evidence of harm to stir the popular media into action and this applies to some extent to scientific literature too.

There are some exceptions to the predominantly negative view of pesticides—**Lomborg and Bjorn (2001)** wrote "If pesticides were abolished, the lives saved would be outnumbered by a factor of around 1000 by the lives lost due to poorer diets. Secondary penalties would be massive environmental damage due to the land needs of less productive farming, and a financial cost of around 20 billion US Dollars".

This paper does not attempt to quantify or rank the benefits, nor to balance the benefits from pesticide use against any negative consequences. Rather it focuses on the positive outcomes delivered by judiciously used pesticides, in order to inform a more objective assessment of costs and benefits. It arises from an extensive literature search, the preparation of a comprehensive review report and the compilation of an electronic database of pesticide benefits for CropLife International. The key 100 or so articles will be available in the database, which will be publicly

*Corresponding author. Tel.: +44 1634 880088 (switchboard), +44 1634 883729 (direct); fax: +44 1634 883379.

E-mail address: j.f.cooper@gre.ac.uk (J. Cooper).

accessible via the CropLife website, as well as the full review report and bibliography of all 360 references (<http://www.croplife.org/>).

2. Perceived versus real risk

Like many technological developments that improve the quality of our lives, pesticides can pose risks if they are not used judiciously. In this they are not unique. Cars kill over 40,000 people each year in the US alone (Anon, 2003a). Their emissions contribute to greenhouse gases (Anon, 2006a) and they are inefficient users of energy compared with alternatives, such as buses or trains (Anon, 2006c). However, the convenience of being able to go from place to place independently is compelling, so many of us buy and drive cars. To reduce the risks and negative impact of car ownership, we legislate to make them safer (Likanen, 2001), and less polluting (EPA, 2000) and require drivers to pass a proficiency test to drive them. Likewise mains electricity brings irresistible benefits but there are some negatives too. Its production pollutes the atmosphere and causes 33% of greenhouse gases (Anon, 2006b) and there were 411 deaths in the US from accidental electrocution in 2001 according to the Product Safety Commission (2006). Similarly, few people would deny that medicines can reduce disease and preserve life, but if they are used without care they can be extremely hazardous. Berry (1991) pointed out that we accept the risks associated with selling the analgesic drug paracetamol over the counter in packets of five lethal doses, due to the benefits of easy access to pain relief and the improvement in life quality that it brings. These examples provide parallels with pesticides, being technologies that make our lives better, provided they are regulated and used in such a way that the benefits significantly outweigh the risks.

The potential benefits are particularly important in developing countries, where pests cost billions of dollars in national income (Anon, 2004b) and farm and post-harvest losses contribute to hunger and malnutrition, which kills between 12 million (UNICEF undated) and 15 million children annually (Anon, 2005a). According to the United Nations Children's Fund (UNICEF) malnutrition is: "largely a silent and invisible emergency, exacting a terrible toll on children and their families" (Bellamy, 1998).

Weighing the risks against the benefits of pesticide use is not only hampered by the paucity of information on benefits, but also by the fact that most people are poor judges of the relative hazard that pesticides represent. Based on earlier US data by Upton (1982), Hibbitt (1990) ranked 30 hazards on the criterion of number of deaths per year, with number 1 being the largest number of deaths and number 30 being the smallest. Pesticides were ranked very low at number 28 behind food preservatives (ranked 27), home appliances (ranked 15), swimming (ranked 7) and smoking and alcohol (ranked 1 and 2, respectively). But public perceptions were very different. Women voters thought that pesticides ranked number 9 in the list, and

college students put them at number 4. Both groups performed poorly at estimating the relative risks posed by a list of hazards, perhaps due to the predominantly negative publicity that pesticides receive.

Moreover, food safety and health concerns in the general public have increased in Europe following serious incidents such as Salmonella poisoning, Bovine Spongiform Encephalopathy (BSE), Foot and Mouth and *Escherichia coli* infections. Pesticide residues in food, detected at ever-lower levels due to increasingly sensitive laboratory equipment, are perceived to be associated with these issues and are lumped together with them as another of the evils of agricultural intensification. However, the evidence does not support the popular view that pesticide residues represent a significant health risk in Europe and the US.

Statutory maximum residue levels (MRLs) are the highest concentration of pesticide (expressed in mg/kg) legally permitted in or on food commodities and animal feed. They are set by measuring the residue levels on harvested produce after it has been grown using Good Agricultural Practice and in accordance with pesticide label instructions, provided this level does not constitute a hazard to consumers. In fact, contrary to public perception, MRLs are far below any level that would be hazardous to consumers—they are usually not approved unless they are a factor of at least 100 below the no observable adverse effect level (NOAEL). The UK Pesticide Residue Committee annual report (2002) found that over 70% of the food in the UK contained no detectable pesticide residues and only 1.09% contained residues above the statutory MRLs. It concluded that "none of these residues caused concern for people's health". This is backed up by Brown (2004) and by Bell (2005), Head of the UK Food Standards Agency, who said "There are no safety concerns or we would take action immediately".

3. Types of positive outcome from pesticide use

There is a large range of positive outcomes from different types of pesticide use. Reduced crop loss resulting from spraying fungicides is an obvious benefit, but some are less obvious either because they occur in the medium or long term, or are subtle or small incremental benefits distributed over a large area. To facilitate a systematic analysis capable of unravelling the many potential benefits of pesticide use, a hierarchical model of outcomes was adopted, comprising effects, primary benefits and secondary benefits.

3.1. Effects

Effects are the immediate outcomes of pesticide use—for example killing caterpillars on a cabbage. These are not classed as benefits because the consequences of the effects have not manifested themselves yet. The three main effects of pesticides are:

- (1) controlling agricultural pests (including diseases and weeds) and vectors of plant disease;

- (2) controlling human and livestock disease vectors and nuisance organisms;
- (3) preventing or controlling organisms that harm other human activities and structures.

3.2. Primary benefits

These are the consequences of the pesticides' effects—the direct gains expected from their use. For example, the effect of killing caterpillars prevents them feeding on the crop and brings the primary benefit of higher yields and better quality of cabbage. From the three main effects listed above, 26 primary benefits have been identified ranging from protection of recreational turf to saved human lives.

3.3. Secondary benefits

These are the less immediate, less intuitively obvious, or longer term consequences. It follows that for secondary benefits, it is more difficult to establish cause and effect, but nevertheless they can be powerful justifications for pesticide use. For example, higher cabbage yield might bring additional revenue that could be put towards children's education or medical care, leading to a healthier, better educated population. There are 31 secondary benefits identified here, ranging from fitter people to conserved biodiversity.

Fig. 1 summarises effects, primary and secondary benefits and their interactions. The interplay between the effects and benefits is complex and not easy to follow in this diagram. However, the detail of the linkages is less important at this stage than the recognition that there are many and varied positive downstream implications arising from pesticide use—some more obvious, and some less so.

4. Beneficiaries and the domains and dimensions of benefit

The number and type of people who benefit (or suffer) due to a technology influence our attitudes to it. A common public misconception is that the only benefit of pesticides is to increase the profits of wealthy farmers. In fact, beneficiaries of pesticide use include consumers, retailers, drivers, researchers, politicians and individuals from many other groups. Poor people are as likely to benefit as wealthier ones. However, a detailed analysis of the beneficiaries and the distribution of benefits among them is beyond the scope of this paper.

There are three main benefit domains: the social domain concerns issues such as the health, life quality and well-being of people; the economic domain concerns issues such as farm revenues, costs and profits; and the environmental domain covers issues of the aquatic, terrestrial and airborne environment, including global warming. Benefits in these domains can operate at community, national or global scales. For example, the use of herbicides saves

money or effort on mechanical weed control at the community level, brings medium term social benefits of reduced drudgery, improvement of the living environment on public and personal-use amenity or sports-use land at national levels, and longer term environmental benefits of reduced fossil fuel use, soil disturbance and moisture loss from tillage—a global scale benefit to us all. These domains and dimensions are mentioned where relevant in the exploration of benefits that follows, and the benefits are categorised according to them later in Fig. 5.

4.1. The benefits of effect 1—controlling pests and plant disease vectors

Over the last 60 years, farmers and growers have changed the way they produce food in order to meet the expectations of consumers, governments and more recently, food processors and retailers. In doing so, they have made many changes to the way they farm, including the extensive use of pesticides. They have done this principally to prevent or reduce agricultural losses to pests, resulting in improved yield and greater availability of food, at a reasonable price, all year round. Pimentel (1997) suggests there is a four-fold return on investments in pest control and Pimentel et al. (1992) estimated an economic return of around \$16 billion from pesticide use in the USA. India, a former country of famine has quadrupled grain production since 1951 (Jha and Chand, 1999) and now not only feeds itself but exports produce. Similarly outputs and productivity have increased dramatically in most countries, for example, wheat yields in the United Kingdom rose from 2.5 t/ha in 1948 to 7.5 t/ha in 1997 (Austin, 1998). Corn yields in the USA went from 30 bushels per acre to over a hundred per acre over the period from 1920 to 1980 (Kucharik and Ramankutty, 2005). Warren (1998) also drew attention to the spectacular increases in crop yields in the United States in the twentieth century, reporting that average US yields for 10-year periods during this century for nine crops show that increases were from two to seven-fold, starting in the 1940s and continuing during the rest of the century. While a significant proportion of the gains are due to better soil and water management, improved plant varieties and application of fertiliser, the use of pesticides has undoubtedly played a very significant role. Webster et al. (1999) stated that “considerable economic losses” would be suffered without pesticide use and quantified the yield increases and 50% increase in gross margin that result from pesticide use in British wheat production. Webster and Bowles (1996) concluded that without pesticides, apple production would not be commercially viable and farmers would have to use their land for other purposes. In Russia, Petrusheva (1975) attributed orchard yield increases of 1.5–2 times to the use of pesticides. Damage done to fruits by the apple worm went down to 1–2%, and marketable percentage was 80–90% of produce when pesticides were adopted. In the same country, Zakharenko (1975), Keiserukhsky and Kashirsky (1975) and Chenkin (1975)

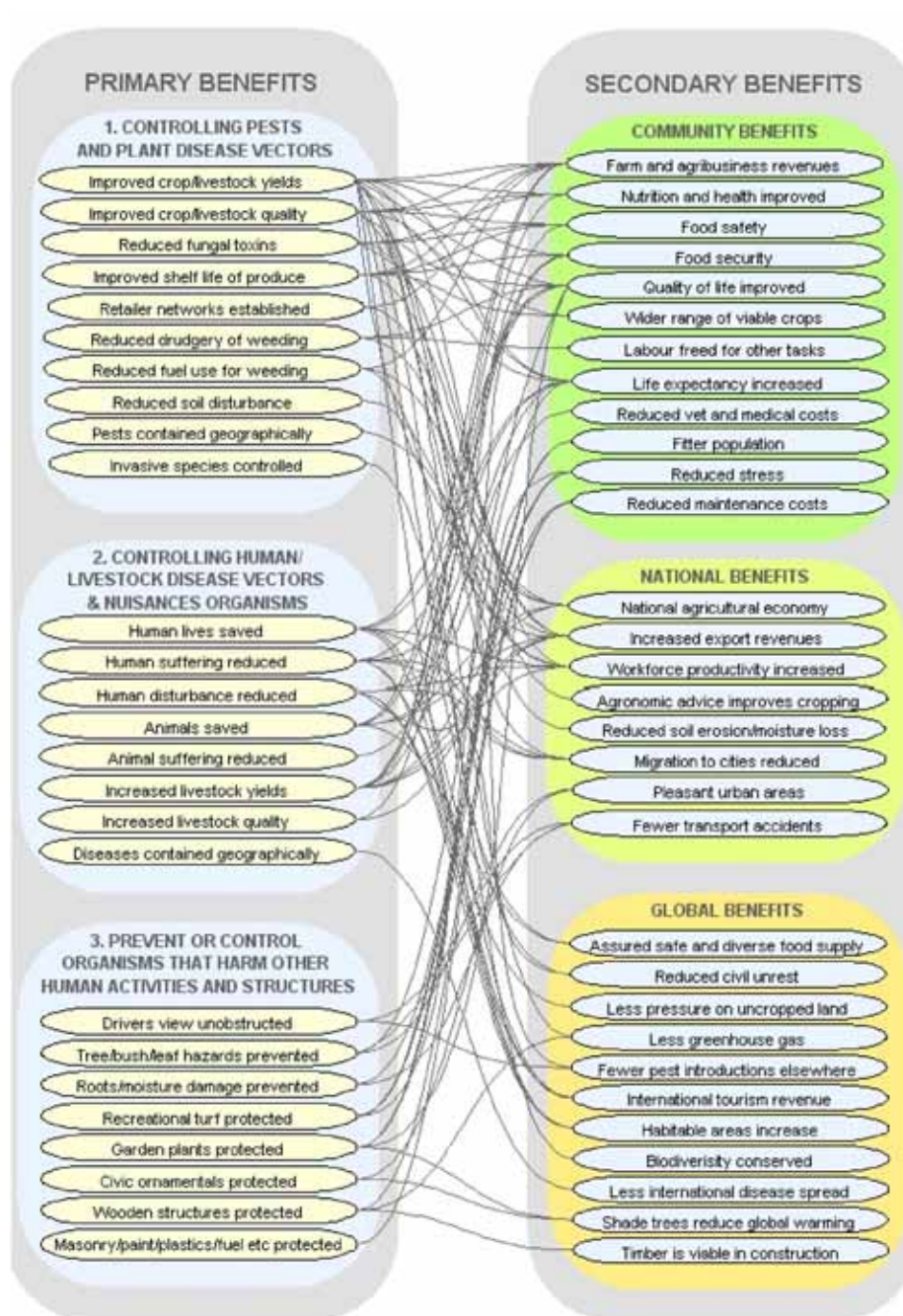


Fig. 1. Effects, primary and secondary benefits. The linkages are not easy to follow, but serve to illustrate the complexity of the interactions between them.

all claimed that the financial outlay on pesticides was repaid four to six times in increased yields.

Not only do pesticides prevent losses on existing crops, they broaden the range of viable crop options that a farmer can grow at particular times of year. For example, tomatoes can only be grown in the rainy season in Zimbabwe by using fungicide to prevent late blight—without them, there is usually total crop failure. This rainy season production is also extremely lucrative; tomatoes have a highly elastic price response to demand, with rainy season prices being 10 times dry season prices (Mapurisa, 1998, personal communication).

Controlling pests of pasture can also bring significant livestock productivity benefits. By using a single carefully timed insecticidal spray costing US\$10/ha to control red legged earth mite in clover, Australian sheep farmers have increased the value of their wool yield by US\$50/ha (Ridsill-Smith and Pavri, 2000).

Herbicides are the most widely used type of pesticide since weeds are the major constraint that limit yield in many crops. Herbicides represent around 50% of all crop protection chemicals used throughout the world, compared with insecticides and fungicides that are around 17% each (CropLife, 2004, personal communication). Without

herbicides there would be an estimated US \$13.3 billion loss in farm income in the US (Anon, 2003b). Yancy and Cecil (2005) put the figure for benefits of herbicide use even higher at \$21 billion annually, against a cost of \$6.6 billion for the product and application that reduced losses to weeds by 23% and avoided a loss of farm income valued at \$8 billion. Bridges (1992) reported that US losses due to weeds of \$4 billion would be \$20 billion without use of herbicides. Miller Stanley (1982) analysed the primary and secondary productivity and labour impacts of improved weed control, as achieved with herbicides, on farmers and rural communities. He concluded that increased agricultural productivity creates direct economic benefits for farming families in terms of increased income.

There are knock-on benefits of these primary benefits. If marketable yields and quality are increasing, farm revenues are also likely to increase. This results in wealthier farmers with more disposable income to stimulate the local economy. Higher yields mean less pressure to cultivate un-cropped land—a wider benefit to biodiversity and the environment as highlighted by McNeely Jeffrey and Scherr Sara (2003). In turn, regional and national agricultural economies become more buoyant and revenues from exports of high quality produce bring in much needed foreign exchange. This last factor is particularly important in some developing countries that export fruit and vegetables to the US and Europe, where the unintended presence of certain flora and fauna in the produce can be a major barrier to international trade (IPPC, 1997). Consumers in developed countries gain too from the wider range of imported crops that is available for a greater proportion of the year.

More food in communities also allows better nutrition, which carries over into healthier lives. Healthier people are by and large also happier people, who are more productive and able to contribute better to their society. This contrasts with the situation where poor nutrition resulting from limited food supplies increases the susceptibility to diseases, reducing people's energy and productivity in a vicious circle of deprivation. Pesticides can help break this cycle that threatens security of personal livelihoods and quality of life.

Reliability of production is economically important to any producer, and to resource-poor communities with no financial or food reserves, it is critically important. It is no good having an adequate harvest for 3 years if there are large losses in the fourth year. By reducing risk of catastrophic loss to pests and diseases, pesticides are a tool to help deliver food security and dependable livelihoods from farming.

Many people now expect and enjoy a healthier and longer life than in the past. Average life expectancy in the US, which was only 47 years in 1900 has now risen to 78 (Anon, 2005b). In France, life expectancies have increased by 3 months every year for the past 50 years (Atreya, 2006). Many lives are also more comfortable in the 21st century than those experienced by our ancestors who tended to

work hard and die young. There are some unfortunate exceptions to this trend. For example, Zimbabweans now have a life expectancy of less than 40 due to HIV/Aids and failing medical and agricultural systems. In many other parts of the world, improved medical care and drug treatments with better living conditions and improved hygiene have played a significant role in extending lives, but the value of nutritious, safe and affordable food should not be underestimated as a health promoter that increases life expectancy (US Dietary Guidelines, 2005, European Food Information Council, 2006; Atreya, 2006; Eat 5 to 9 a day (US) and 5 a day campaign, UK, 2003).

Gattuso (2000) wrote that banning some pesticides would reduce the availability, affordability and overall consumption of fruit and vegetables—a vital protection against cancer. Lewis and Ruud (2004, 2005) discussed the nutritional properties of apples and blueberries in the US diet and concluded that their high concentrations of antioxidants act as protectants against cancer, heart disease, and other chronic diseases associated with oxidative stress and ageing. Lewis attributed doubling in wild blueberry production and subsequent increases in consumption chiefly to herbicide use that improved weed control. Gianessi and Leonard (1999) attributed all year round availability of inexpensive and good quality fresh fruit and vegetables largely to the use of pesticides.

Herbicides replace the back-breaking work of manual weeding, and reduce the fossil-fuel requirements for mechanical cultivation. The reduction in the need for manual weeding is particularly significant in sub-Saharan Africa where HIV/AIDS has resulted in shortages of labour and many adults being too ill to work (Hainsworth et al., 2000). When herbicides are used, what little labour there is available can be freed for other productive activities.

Improved nutrition and reduced drudgery clearly both improve the quality of life of rural communities, and while 'quality of life' is imprecise and difficult to define, it is surely what most people are seeking to improve—whether it be through money, work satisfaction, home life or more time for recreation. An improved quality of rural life can contribute to a slowing down of the dramatic rural to urban exodus, as people try to escape the poverty and suffering of agricultural communities, only to find themselves in deeper poverty in town with no viable livelihood options.

The opportunities afforded by herbicides to reduce mechanical cultivation in larger scale agriculture clearly have wider national and international benefits in reduced production of greenhouse gases, as well as slowing down soil erosion on sloping land, and reducing moisture loss from soil surfaces (Bates and Denton, 2007, undated; Anon, 2005c).

Pesticides can also improve the quality of the produce (Kolbe, 1982) including its safety. When stressed or attacked by diseases, many plants, or the pathogenic organisms causing the diseases, produce chemicals that are

acutely toxic. An extreme example is the cereal disease ergot (*Claviceps purpurea*) that produces highly toxic and sometimes lethal alkaloids in the grain under certain conditions unless protected by a fungicide. One family of mycotoxins, the aflatoxins, are potently carcinogenic and immunotoxic and can cause growth retardation when consumed. Fumonism (a toxin associated with *Fusarium*, that causes brain and kidney damage) can also affect both humans and animals. These mycotoxins proliferate in maize grain and other crops either in the field or in storage when temperature and humidity conditions are favourable for them (Bruns and Arnold, 2003). The use of fungicides can reduce the incidence of such fungal contaminants (Joshi, 2001). Etcheverry et al. (1987) studied the influence of 10 commercial fungicides and insecticides on growth and formation of aflatoxin B1 by *Aspergillus parasiticus*. Four of the five fungicides investigated in concentrations corresponding to commercial practice inhibited growth and toxin production in the laboratory media.

Pesticides used in stored products can prolong the viable life of the produce and prevent huge post-harvest losses from pests and diseases. Dales and Golob (1997) reported that insecticides can protect stored grain in bags or bins from insect spoilage. Their trials in Tanzania showed that the larger grain borer *Prostephanus truncatus* and *Sitophilus* species can be controlled for at least 9 months by applications of insecticide mixtures used in small quantities as protectants of shelled maize. Zettler and Arthur (2000) also reported on chemical control of stored product insects with fumigants and residual treatments, and wrote that pesticides are often the cheapest and most efficient control strategy available.

Effective control of pests can have consequences beyond the geographic or chronological range of the initial intervention. If pest levels are suppressed by many farmers at once, it can have an area-wide effect—in other words, the source population for infection or infestation of future crops is reduced. In many cases, the threat to subsequent crops is therefore much lower, even without future interventions.

For more mobile pests such as locusts, if populations can be controlled before they become too numerous in one country, it can prevent massive population expansion and migration to other countries (Anon, 2001). Non-pesticidal approaches such as egg bed destruction, digging trenches and burying the nymphs or beating them with branches are all too slow and act on too small a scale to have any significant impact on the overall locust populations in the area. The early interventions over large areas that are possible with aerially applied insecticides can be more cost-effective and environmentally safe than the later 'fire brigade' treatments over much larger areas and longer time periods that would otherwise be required.

Pests controlled effectively on export crops can prevent pest introductions in other countries—a phenomenon that often has devastating effects due to the fact that the new pest has left behind all of its natural enemies, i.e. its

predators and parasitoids that were exerting a natural regulatory pressure on the pest in its native region (Neuenschwander and Peter, 2001). Moreover, pesticides are a powerful tool against invasive species that constitute an enormous threat to indigenous ecologies. For example, when rats are introduced onto islands previously free of them, they have a devastating effect on local fauna—in particular, on ground-nesting birds, but also other mammals, molluscs, insects, spiders, amphibians and reptiles. In this way, pesticides can be a tool to conserve biodiversity (Fig. 2).

4.2. Benefits of effect 2—controlling human/livestock disease vectors and nuisance organisms

In warmer climates especially, insects can spread devastating human diseases such as malaria, sleeping sickness, river blindness and a range of serious fevers and disfiguring or debilitating illnesses. Ross (2005) reported that malaria kills more than 5000 people every day. Lindblade et al. (2004) argue that this figure urgently needs to be reduced by use of insecticide-treated bed nets—particularly the high levels of infant mortality. Field trials by Yadav and Sampath (2001) showed that bed nets treated with deltamethrin significantly reduced indoor resting density, biting, light trap catches, human sourced engorgement rate and parous rate of malaria infection in *Anopheles* mosquitoes. Malaria incidence was reduced 59% in the treated net village, 35% in the untreated net village, and 9% in the no-net village. Curtis et al. (2003) reported that use of treated bed nets reduced the number of infective bites per person per year by 75%. Half of this effect is attributable to an area-wide effect of reducing mosquito populations due to the nets killing those attracted to the human 'bait'. The other half of the effect is due to the personal protection afforded by the treated nets. Lindblade et al. (2004) pointed out that insecticide treated bed nets significantly reduced infant mortality in western Kenya with no increased mortality in older children through delayed acquisition of immunity to malaria (an argument sometimes voiced against use of nets).

Gratz (1994) asserted that vector-borne diseases are most effectively tackled by killing the vector. Insecticides are often the only practical way to control vectors, but are being under-exploited (Townson et al., 2005). The World Health Organization (Anon, 2004c) claims that without access to chemical control methods, life will continue to be unacceptably dangerous for a large proportion of mankind. Recognising this, nearly 30 years after phasing out the widespread use of indoor spraying with DDT and other insecticides to control malaria, the World Health Organization (WHO) announced that this intervention will once again play a major role in its efforts to fight the disease. WHO is now recommending the use of indoor residual spraying (IRS) not only in epidemic areas but also in areas with constant and high malaria transmission, including

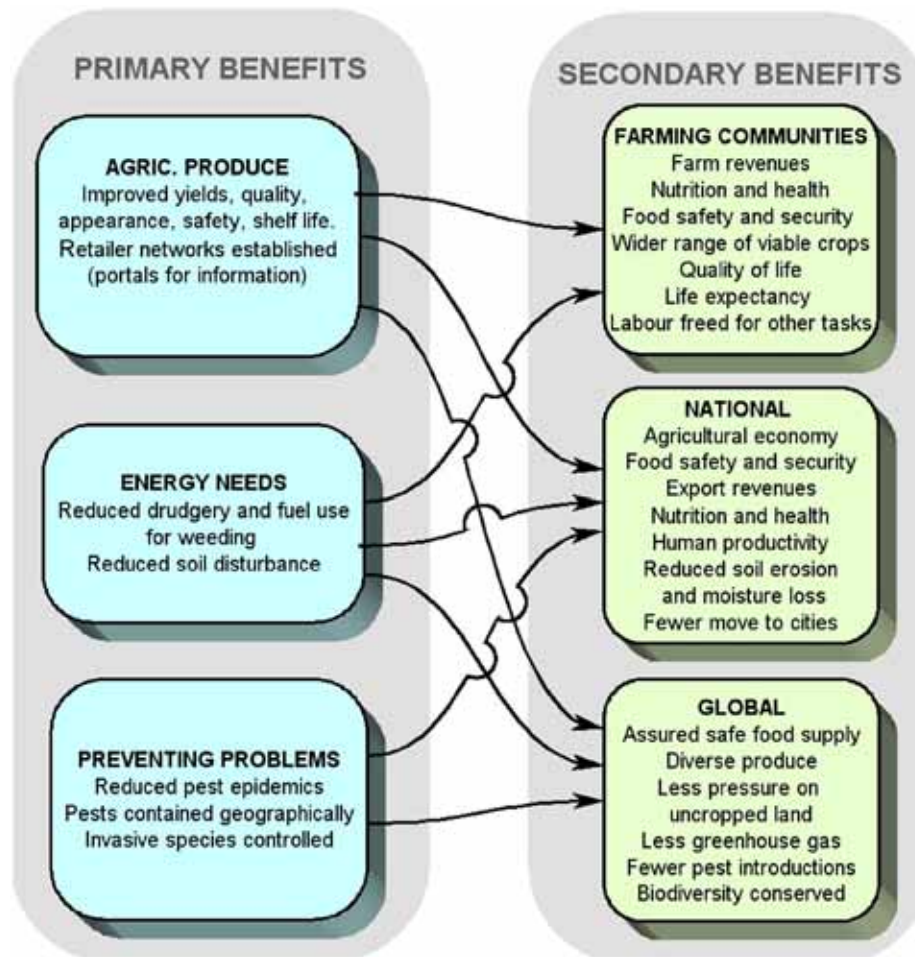


Fig. 2. Benefits of pesticide effect 1. Using pesticides to control pests (including diseases and weeds) and vectors of plant diseases.

throughout Africa (<http://www.who.int/mediacentre/news/releases/2006/pr50/en/index.html>).

Insects such as cockroaches and houseflies are mechanical vectors for various micro-organisms that cause diarrhoeal diseases, which are rated by UNICEF as the number one killer of children under 5.

The most obvious benefit of controlling the wide range of human and livestock disease vectors is reduced suffering and lives saved that would otherwise have been lost, but reducing the likelihood of international spread of disease is not insignificant. With regard to livestock, controlling disease vectors translates to secondary benefits of additional livestock revenue and reduced veterinary and medicine costs. Kamuanga (2001) in Burkina Faso reported that tackling trypanosomiasis through tsetse control programs using insecticide-impregnated targets and pour-on treatments of all cattle with deltamethrin 1% resulted in benefits which included; a 25% increase in herd size and an increase in the number of oxen from 0.1 to 1.1 per household; a reduction in mortality from 63.1% to 7.1% and reductions in the rates of abortions and stillbirth of 55.9% and 51.3%, respectively; and an increase in the rate of live births of 57.6%, as well as increases in the milk

yield from 0.2 to 2.21/cow/day in the dry season. In Ethiopia where the main vector of malaria (*Anopheles arabiensis*) feeds on cattle as well as on humans, when cattle were treated to control tsetse fly, intriguingly, local people told him that not only were their cattle healthier but they also noticed that the incidence of malaria was reduced. It seems probable that insecticide-treated cattle could reduce malaria transmission too (Torr, personal communication). The higher livestock yields and quality provide a boost to the national economy and may allow access to meat export markets, generating valuable foreign exchange (Fig. 3).

In the case of humans, lower vector-borne disease incidence increases life expectancy and leads to a happier society, more confident in its future. Most fatalities from malaria are in young children and pregnant women. A reduction in infant mortality is usually correlated with a decrease in family size—people have fewer children if they think they are more likely to survive. Children in these smaller families are better cared for and have better nutrition and life quality. Ensuring the survival of pregnant women ensures there is a carer for her children and has a knock on effect on the well-being of communities. When serious vectors and nuisance insects are controlled,

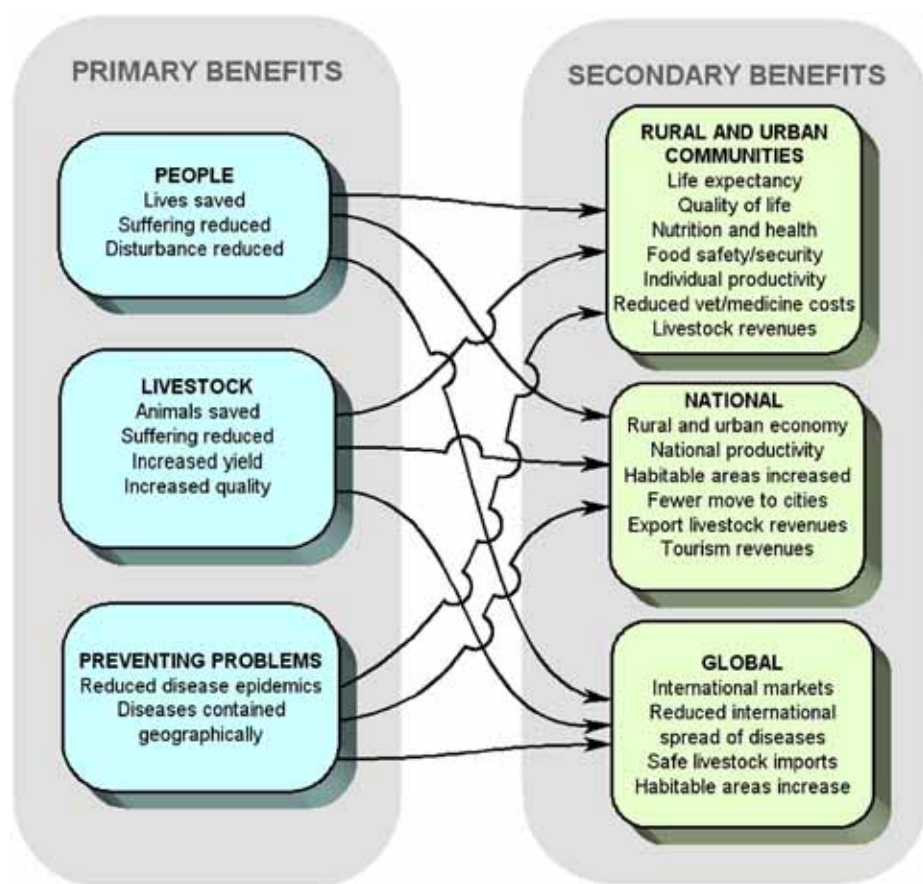


Fig. 3. Benefits of pesticide effect 2. Controlling human and livestock disease vectors and nuisance organisms.

previously uninhabitable areas become habitable and quality of life increases in both rural and urban environments.

There are also substantial benefits to reducing the number of people suffering sub-lethal effects of vector-borne diseases. The misery caused by frequent bouts of malaria or the insidious effects of river blindness on eyesight has a debilitating effect on the morale and productivity of communities, not to mention the cash cost of medicines to treat these diseases. Moreover, studies by Hoffman et al. (1999) have shown that acute malaria infection increases HIV viral load, and that this increased viral load was reversed by effective malaria treatment. This malaria-associated increase in viral load could lead to increased transmission of HIV and more rapid disease progression, with substantial public health implications.

A less obvious, but still significant benefit is the prevention of misery and disturbance caused by various biting insects, whether they transmit disease or not. This group includes mosquitoes, blackflies, midges, other biting flies, fleas, lice and bedbugs. Studies in Cameroon have found people in some areas being bitten up to 2000 times per day by *Simuliid* blackflies, effectively preventing them doing any useful agricultural or other outdoor work due to the nuisance and constant irritation. An additional non-lethal but nonetheless disfiguring effect of these bites is

depigmentation of the skin, which causes social stigmatisation and inability to find life partners. The whining noise of mosquitoes flying—especially *Culex* species—disturbs people and prevents them sleeping properly.

The impact of biting flies is not confined to the developing world. America, Canada and many other countries use pesticides to control ticks, mosquitoes, blackflies and other insects so that people can live more comfortably and enjoy their recreation undisturbed. If such insects were not controlled, there would be a severe impact on life quality, tourism levels and revenue. Recent arthropod-borne disease episodes in the developed world, particularly West Nile virus and Lyme disease in the US and Ross River virus in Australia, have drawn attention to the potential for biting insects to transmit serious diseases even in the developed world.

4.3. Benefits of effect 3—preventing or controlling organisms that harm other activities or damage structures

In the same way that pests in agriculture and public health cause undesirable effects such as losses, spoilage and damage, various organisms have a negative impact on human activities, infrastructure and the materials of everyday life unless controlled. Pesticides play an important, if often unseen role in preventing this negative impact.

The transport sector makes extensive use of pesticides, particularly herbicides, to ensure that roads, railways and waterways are kept free of vegetation that might otherwise cause a hazard or nuisance. For example, if vegetation is allowed to grow too tall on roadsides, it reduces the drivers' view at junctions, and deposits branches or vegetation onto the road that might be an obstruction or make it very slippery. The use of pesticides to manage this vegetation brings secondary benefits of safer transport systems with fewer accidents and less stress for users.

An invasive species that can obstruct waterways is the water hyacinth. It was introduced from South America in the 1950s into many countries as an ornamental plant and it can also provide livestock food and can control pollution by absorbing heavy metals. Unfortunately, the species reproduced rapidly and spread over many countries, out-competing other plants for space and water and clogging rivers, lakes and dams. Due to their great thirst for water, arid countries in Africa have recently spent an estimated US\$60 million annually to control alien weeds such as water hyacinth (Anon, 2004a). The Worldwide Fund for Nature programme clears alien plants from 200,000 ha per annum. Some biological control programmes are in place, but they are insufficient to deal with the problem exhaustively. The programme is now using herbicides,

which have proved to be very useful in dealing with invasive species (Anon, 2004a).

Pesticides are also used on water craft to prevent the build up of algae, molluscs, and weeds, and deliver secondary benefits of reduced costs of manual cleaning, and increased fuel efficiency from the reduced drag of a smooth hull.

The destructive power of vegetation is also enormous; above ground growth around metal structures harbours moisture and can accelerate corrosion, and below ground, the roots of growing plants can crack pipes, open up potholes in the road or dislodge railway lines. Most people living in towns take for granted that roads, gutters and pavements stay clear and weed-free, and are not aware that it is due to the regular use of herbicides. Thus, pesticides bring primary benefits associated with preventing these problems, leading to secondary benefits of reduced maintenance costs and increased transport safety.

In an age of increasingly sedentary jobs, sport and recreation are very important for people's physical and mental health. Herbicides and insecticides are used to maintain the turf on sports pitches, cricket grounds and golf courses and so help to bring secondary benefits of improved health and fitness, reduced stress, and greater quality of life.

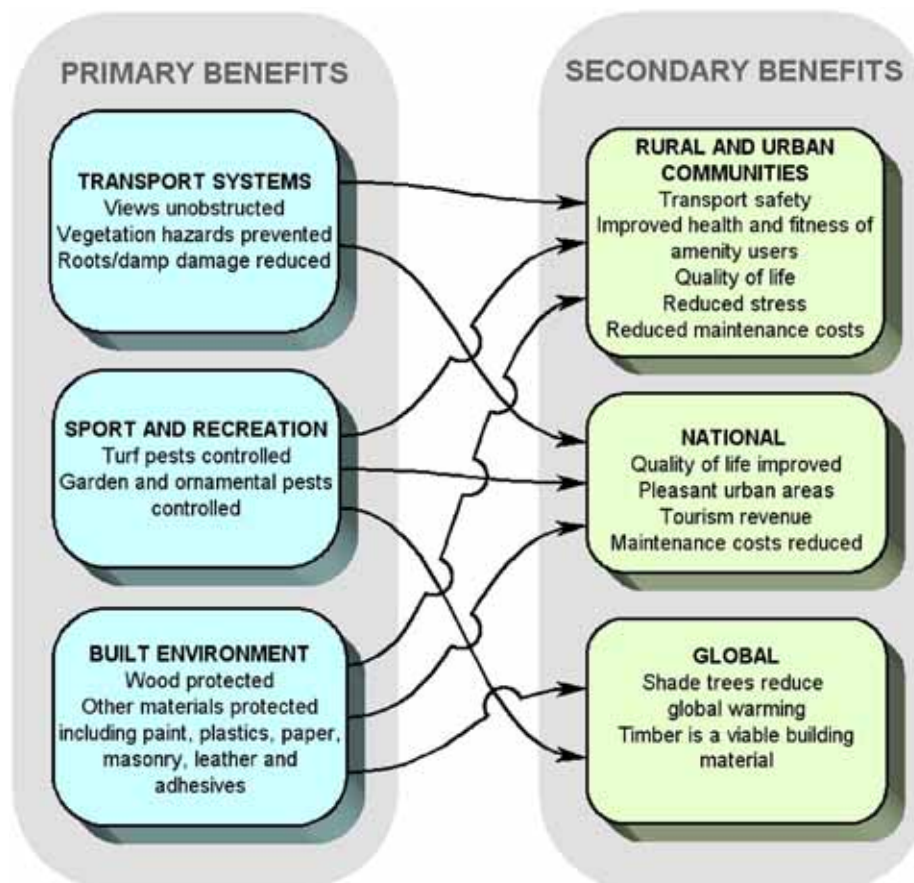


Fig. 4. Benefits of pesticide effect 3. Prevent or control organisms that harm other human activities or structures.

Similarly, the pesticides used in domestic gardens enable householders to maintain their plants—edible or ornamental—and protect them from pests and diseases. Gardening is the most popular leisure activity in the United Kingdom and pesticides are helping to facilitate a hugely popular pastime that provides fresh air and exercise for millions of people around the world, contributing to their health, fitness and quality of life. The result of their efforts is reflected economically in several ways. Exercise promotes health and reduces medical needs, and pleasant gardens add significantly to the value of properties (Ravlin and Robinson, 1985; Henry and Environ, 1994). Ornamental plants and trees in public spaces are also protected from pests and diseases by the use of pesticides where necessary, and such civic vegetation makes urban landscapes more pleasant to live in, thus improving life quality and reducing stress. Plants—particularly trees—provide shade in hot countries, which can reduce cooling energy costs (Templeton et al, 1998), and trees are used as windbreaks in exposed sites to protect crops from damage (Fig. 4).

Insecticides protect buildings and other wooden structures from damage by termites and wood boring insects, thus decreasing maintenance costs and increasing longevity of buildings and their safety. This use also has wider environmental benefits in that timber—a renewable resource that can be produced in an environmentally beneficial way—becomes a more viable construction material.

Antimicrobial pesticides, sometimes known as biocides, are substances used to destroy or suppress the growth of harmful micro-organisms such as bacteria, viruses, or fungi

that can cause spoilage, deterioration or fouling of materials in applications such as cooling towers, jet fuel, paints, textiles and paper products. Secondary benefits are greater shelf life and longevity of products and reduced maintenance costs.

5. Categorisation of benefits by domain and dimension

When the many benefits are laid out in a matrix (Fig. 5), the linkages are easier to follow than in Fig. 1. The colour coding also allows them to be categorised by domain—social, economic and environmental—and by dimension—local, national or global. The construction of this matrix was informed by the large body of literature reviewed, but also by experience, deduction and extrapolation—particularly the secondary benefits where direct evidence linking use to benefit is harder to find.

The results suggest that at community level, most of the benefits are social, with some compelling economic benefits too. At the national level, the benefits are principally economic, with some social benefits and one or two environmental benefits. It is only at the global level that the environmental benefits appear to come into play. To some extent, this is an over-simplification as a result of trying to categorise the benefits and avoid repetition, for example, the benefit of reduced soil erosion and moisture loss that currently sits in the national benefits area, applies equally to communities. And of course global environmental benefits are eventually felt at every level.

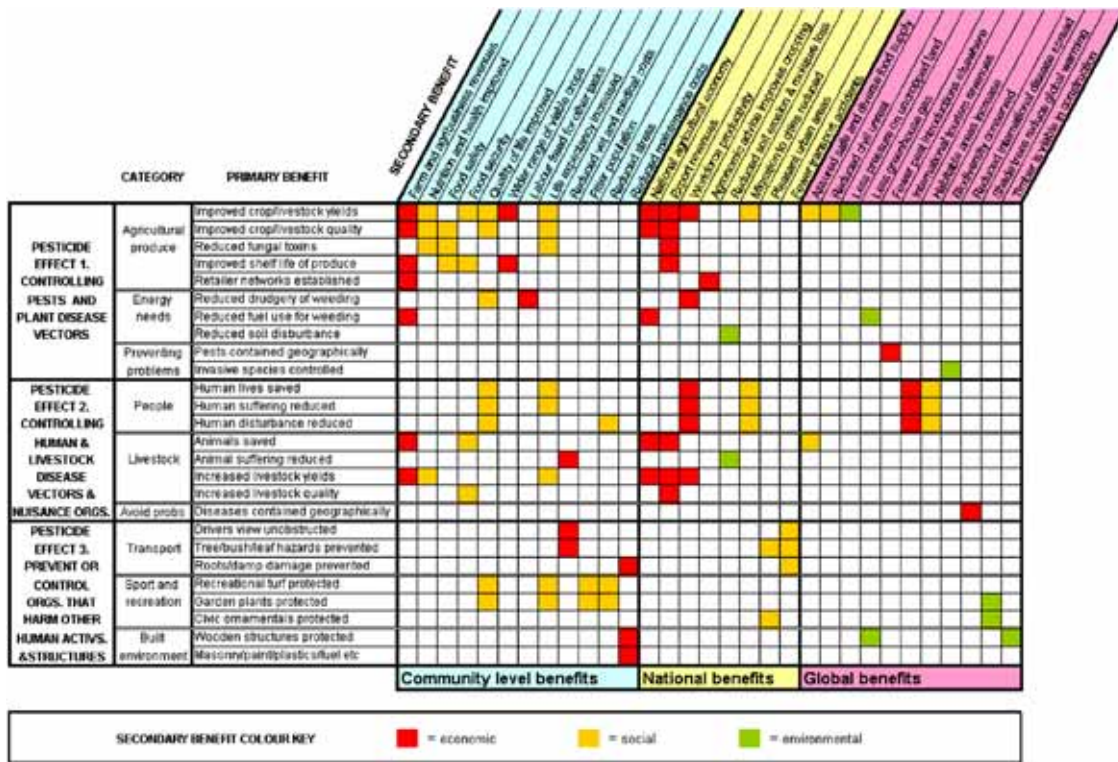


Fig. 5. Matrix of pesticide effects, and primary and secondary benefits.

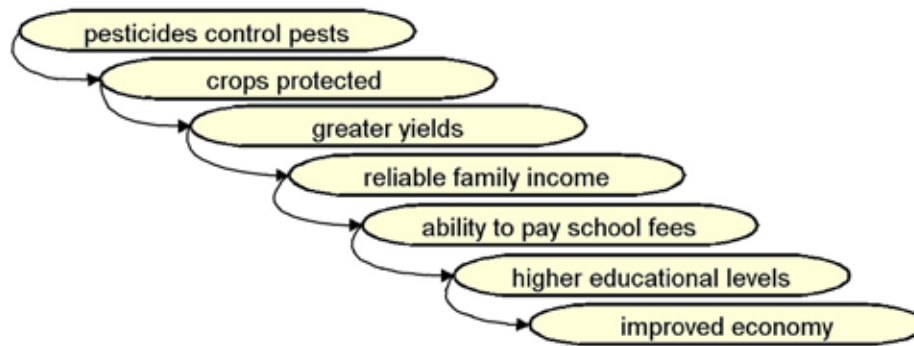


Fig. 6. Example of a chain of benefits.

6. Discussion and conclusions

The risks associated with pesticide use have been set aside in order to focus on the benefits of pesticides and redress the balance of information available for a more objective assessment of costs and benefits. In addition, there has been no attempt to quantify or rank the benefits.

In considering ways to categorise and summarise the beneficial outcomes of pesticide use, it became clear that while the initial effects are usually obvious, and primary benefits follow on reasonably logically, there are secondary (and subsequent) benefits that are sometimes quite subtle and more difficult to substantiate. One such pathway illustrated below in Fig. 6 proposes some indirect but important consequences of pesticide use for resource-poor families and ultimately the economy.

However, as we try to track these events, many other factors come into play in an increasingly complicated series of interactions in which it is difficult to be sure there is cause and effect. And indeed, while the example cited above is a plausible chain of benefits, we are unlikely to find documentary evidence in individual publications that follow them right through because the chain spans such a wide range of disciplines—chemistry, economics, sociology, education. Where would it be published? So while there is plentiful evidence linking pesticide effects to primary benefits, in order to link the primary benefits to the secondary and subsequent ones and validate the complete chain of benefits, it would be necessary to review literature outside the body of publications related to pesticides, or to carry out extensive multi-disciplinary field research.

The hierarchical model of effects, primary benefits and secondary benefits helped in the unravelling and categorisation of potential benefits of using pesticides. Although there was inevitable simplification in the categorisation process, it is clear that the benefits are many and diverse and can operate in all domains and dimensions, and across all countries rich and poor.

There are many other technologies that parallel pesticides, such as vehicular transport and the mains electricity supply, in that they bring us enormous net benefits provided the associated risks are properly managed. However, to maximise the benefits of pesticide use at minimum human,

environmental and economic cost, pesticides must be strictly regulated and used judiciously by properly trained and appropriately equipped personnel, ideally in tight integration with other complementary technologies.

References

- Anon, 2001. FAO Desert Locust Control Guidelines—Control, second ed. Food and Agriculture Organization, Rome, Italy.
- Anon, 2003a. Drive and Stay Alive Inc. At: <http://www.driveandstayalive.com/info%20section/statistics/stats-usa.htm>.
- Anon, 2003b. Herbicide use essential to crop production. Chem. Market Rep. 263 (18), 4.
- Anon, 2004a. Water Matters for Sustainable Agriculture—A Collection of Case Studies. CropLife International, Brussels, April 2004.
- Anon, 2004b. The State of Food Insecurity in the World: 2004. FAO/Economic and Social Department. Food and Agriculture Organization, Rome, Italy.
- Anon, 2004c. The World Health Organization. <http://www.who.int/mediacentre/news/releases/2006/pr50/en/index.html>.
- Anon, 2005a. <http://library.thinkquest.org/C002291/high/present/stats.htm>. An End to World Hunger: Hope for the Future.
- Anon, 2005b. Population and Vital Statistics Report, Series: A, No. 236/237, vol. LVIII, No. 1.
- Anon, 2005c. Conservation Technologies and the Plant Science Industry: Managing Natural Resources Sustainably. CropLife International, Belgium, 42pp.
- Anon, 2006a. World Energy Council Report. At: http://www.worldenergy.org/wec-geis/publications/default/tech_papers/17th_congress/4_2_30.asp.
- Anon, 2006b. World Resources Institute, 2006. EarthTrends: The Environmental Information Portal. Available at: <http://earthtrends.wri.org>. World Resources Institute, Washington, DC.
- Anon, 2006c. The role of public transport to reduce green house gas emissions and improve energy efficiency. European Union Position on the European Climate Change Programme and the Green Paper on Energy Efficiency. March 2006.
- Atreya, N., 2006. Chemophobia—pesticide residues in food. Outlooks on Pest Management, vol. 17. December 2006, p. 242.
- Austin, R.B., 1998. Yield of wheat in the UK: recent advances and prospects. In: Annual Meeting of the Crop Science Society of America.
- Bates, G., Denton, H.P., 2007. No-Till Establishment of Forage Crops Agricultural Extension Service. The University of Tennessee at: <http://www.utextension.utk.edu/publications/spfiles/sp435c.pdf>.
- Bell, J., 2005. CropSaver, Summer 2005. Crop Protection Association, UK, p. 4.
- Bellamy, C., 1998. The State of the World's Children. Oxford University Press, UNICEF, Oxford and New York.
- Berry, C.L., 1991. Assessing environmental health risks from chemicals. Trans. Med. Soc. Lond. 108 (1991/1992), 72–78.

- Bridges, D. (Ed.), 1992. Crop Losses Due to Weeds in the United States. Weed Sci. Soc. Am., Champaign, IL, 403pp.
- Brown, Ian UK Pesticides Residue Committee Report, 2004 (available online: <http://www.pesticides.gov.uk/uploadedfiles/Web_Assets/PRC/PRCAnnualreport2004.pdf>, also available on request).
- Bruns, A., 2003. Controlling Aflatoxin and Fumonisin in maize by crop management. *J. Toxicol. Toxin Rev.* 22 (2), 153–173.
- Chenkin, A.F., 1975. Economic effects of plant protection in the Russian Federated Republic. In: Papers at Sessions, VIII International Congress of Plant Protection, Moscow, USSR, vol. 2, p. 27.
- Curtis, C., Jana-Kara, B., Maxwell, C.A., 2003. Insecticide treated nets: impact on vector populations and relevance of initial intensity of transmission and pyrethroid resistance. *J. Vector Borne Dis.* 40 (1/2), 1–8.
- Dales, M.J., Golob, P., 1997. The protection of maize against *Prostephanus truncatus* (Horn), using insecticide sprays in Tanzania. *Int. J. Pest Manage.* 43 (1), 39–43.
- EPA, 2000. Emission Facts. Office of Transportation and Air Quality Average Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks EPA420-F-00-013.
- Etcheverry, M., Chulze, S., Dalcero, A., Varsavsky, E., Rodriguez, M., Moschetti, E., Ferrero, S., 1987. Aflatoxins in sunflower seeds. Influence of fungicides and insecticides. *Int. J. Food Microbiol.* 5, 103–109.
- European Food Information Council, 2006. At: <<http://www.eufic.org/page/en/health-lifestyle/healthy-eating/>>.
- Gattuso, D., 2000. Understanding the benefits of pesticides. *Consum. Res. Mag.* 83 (2), 34.
- Gianessi, L., 1999. Beneficial impacts of pesticide use for consumers. In: Ragsdale, N., Seiber, J. (Eds.), *Pesticides: Managing Risks and Optimizing Benefits*. American Chemical Society Symposium Series #734. American Chemical Society, Washington, DC, United States of America, p. 207.
- Gratz, N.G., 1994. What role for insecticides in vector control programs? *Am. J. Trop. Med. Hyg.*, US 50 (6), 11–20.
- Hainsworth, S.D., Eden-Green, S.J. (Eds.), 2000. In: *Sustaining Change: Proceedings of a Workshop on the Factors Affecting Uptake and Adoption of Department for International Development (DFID) Crop Protection Programme (CPP) Research Outputs*.
- Henry, M.S.J., 1994. *J. Environ. Health* 12, 65–70.
- Hibbitt, C., 1990. Putting pesticides in perspective. *Agricultural Engineer. Summer 1990*, p. 61.
- Hoffman, I.F., Jere, C.S., Taylor, T.E., et al., 1999. The effect of *Plasmodium falciparum* malaria on HIV-1 RNA blood plasma concentration. *AIDS* 13, 487–494.
- IPPC, 1997. International Plant Protection Convention—New Revised Text Approved by the FAO Conference at its 29th Session—November 1997.
- Jha, D., Chand, R., 1999. National Centre for Agricultural Economics and Policy Research (ICAR), New Delhi, India from Agro-Chemicals News in Brief Special Issue, November.
- Joshi, M., 2001. The Future Role of Pesticides in US Agriculture. Committee on the Future Role of Pesticides in US Agriculture, Board of Agriculture and Natural Resources and Board on Environmental Studies and Toxicology, Commission on Life Sciences. National Academy Press, p. 31.
- Kamuanga, M., 2001. Farmers' perceptions of the impacts of tsetse and trypanosomiasis control on livestock production: evidence from southern Burkina Faso. *Trop. Anim. Health Prod.* 33 (2), 141.
- Keiserukhsky, M.G., Kashirsky, O.P., 1975. Economics of plant protection in the USSR. In: VIII International Congress of Plant Protection, Papers at Sessions, Moscow, USSR, vol. 2, p. 12.
- Kolbe, W., 1982. Effect of different crop protection programmes on yield and quality of apples II (1967–1981). *Pflanzenschutz-Nachrichten Bayer* 35 (2), 189.
- Kucharik, C.J., Ramankutty, N., 2005. Trends and variability in US corn yields over the 20th century. *Earth Interactions* 9, 1–29.
- Lewis, N., Ruud, J., 2004. Apples in the American diet. *Nutr. Clin. Care* 7 (2), 82.
- Lewis, N., Ruud, J., 2005. Blueberries Am. Diet, *Nutr. Today* 40 (2), 92 March–April.
- Likainen, E., 2001. The Challenge of Ensuring Safer Cars. European Commission Responsible for Enterprise and the Information Society SPEECH/01/56.
- Lindblade, K.A., Eisele, T.P., Gimnig, J.E., Alaii, J.A., Odhiambo, F., ter Kuile, F.O., Hawley, W.A., Wannemuehler, K.A., Phillips-Howard, P.A., Rosen, D.H., Nahlen, B.L., Terlouw, D.J., Adazu, K., Vulule, J.M., Slutsker, L., 2004. Sustainability of reductions in malaria transmission and infant mortality in western Kenya with use of insecticide-treated bednets: 4 to 6 years of follow-up. *JAMA* 291 (21), 2571–2580.
- Lomborg, B., 2001. *The Skeptical Environmentalist*. Cambridge University Press, reprint ed. (August 28, 2001). ISBN: 0521010683.
- McNeely Jeffrey, A., Scherr Sara, J., 2003. *Ecoagriculture: Strategies to Feed the World and Save Wild Biodiversity*. Island Press. 279pp.
- Miller Stanley, F., 1982. The effects of weed control technology change on rural communities. *Outlook Agric.* 11 (4), 172.
- Neuenschwander, P., 2001. Biological control of the Cassava Mealybug in Africa: a review. *Biol. Control* 21, 214–229.
- Petrusheva, N.I., 1975. Protection of horticultural crops in the USSR and future perspectives. In: Papers at Sessions, VIII International Congress of Plant Protection, Moscow, USSR, vol. 2, p. 124.
- Pimentel, D., 1997. *Techniques for Reducing Pesticide Use. Economic and Environmental Benefits*. Wiley, USA.
- Pimentel, D., Acquy, H., Biltonen, M., Ric, P., Silva, M., Nelson, J., Lipner, V., Giordano, S., Horowitz, A., D'Amore, M., 1992. Environmental and economic costs of pesticide use. *Bioscience* 42, 750–760.
- Product Safety Commission, 2006. At: <<http://www.cpsc.gov/LIBRARY/FOIA/FOIA05/os/Electrocutions2001.pdf>>.
- Ravlin, F.W., Robinson, W.H., 1985. *Bull. Entomol. Soc. Am.* 31, 45–50.
- Ridsill-Smith, J., Pavri, C., 2000. Single spring spray protects pastures. *Farming Ahead* No. 103, July 2000, p. 60.
- Ross, G., 2005. Risks and benefits of DDT. *Lancet* 366 (November (9499)), 1771.
- Templeton, S.R., Zilberman, D., Jick Too, S., 1998. An economic perspective on outdoor residential pesticide use. *Policy Anal.* 32 (17), 416 A–423 A.
- Townson, H., Nathan, M.B., Zaim, M., et al., 2005. Exploiting the potential of vector control for disease prevention. *Bull. World Health Organ.* 83 (12), 942–947.
- Upton, A.C., 1982. The biological effects of low level ionising radiation. *Sci. Am.* 246, 41–49.
- US Dietary Guidelines, 2005. U.S. Department of Health and Human Services, U.S. Department of Agriculture, www.healthier.us.gov/dietaryguidelines.
- Warren, G.F., 1998. Spectacular increases in crop yields in the United States in the twentieth century. *Weed Technol.* 12, 752.
- Webster, J.P.G., Bowles, R.G., 1996. Estimating the economic costs and benefits of pesticide use in apples. In: *Proceedings of BCPC Conference*, Brighton. pp. 325–330.
- Webster, J.P.G., Bowles, R.G., Williams, N.T., 1999. Estimating the economic benefits of alternative pesticide usage scenarios: wheat production in the United Kingdom. *Crop Prot.* 18, 83.
- Yadav, R.S., Sampath, R.R., 2001. Deltamethrin treated bednets for control of malaria transmitted by *Anopheles culicifacies* (Diptera: Culicidae) in India. *J. Med. Entomol.* 38 (5), 613.
- Yancy, J., Cecil, H., 1998. *Study Touts Herbicide Benefits*, Vol. 32 (no. 11). Southeast Farm Press, p. 16.
- Zakharenko, V.A., 1975. Economics and prospects of pesticide application as related to the intensification of farming. In: Papers at Sessions, VIII International Congress of Plant Protection, Moscow, USSR, vol. 2, p. 6.
- Zettler, L.J., Arthur, H., 2000. Chemical control of stored product insects with fumigants and residual treatments. *Crop Prot.* 19, 577–582.

ARTICLE

Decline in pesticide poisonings in the United States from 1995 to 2004

JEROME M. BLONDELL, PH.D., M.P.H.

United States Environmental Protection Agency, Springfield, Virginia, USA

Background. Trends in rates of unintentional pesticide illnesses and injuries by type were estimated for the United States from 1995 to 2004. **Methods.** Poison Control Center data were examined for the years 1995 through 2004. Rates were calculated for pesticide type and selected pesticide classes based on estimated total United States population and proportion of population served. Pesticides as a proportion of poisonings to all substances over the years and vital statistics on deaths were examined to validate trends. **Results.** Incidence rates of serious pesticide poisonings and injuries have declined 42% from 1995 to 2004 and death rates declined 62% over the same period. Selected, more toxic pesticides such as organophosphate and carbamate insecticides, strychnine rodenticides, and paraquat herbicides have shown greater declines, ranging 63% to 79%. **Conclusions.** Pesticide poisonings and injuries appear to have declined in the past decade.

Keywords Pesticide; Insecticide; Poisoning; Trends

Introduction

The United States Environmental Protection Agency's (EPA) Office of Pesticide Programs is responsible for the licensing of pesticides and for safety assurance regarding pesticide use. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA shall establish procedures for monitoring people for incidental pesticide exposure, "including, but not limited to, the quantification of incidental human and environmental pesticide pollution and the secular trends thereof" (1). The EPA has elected to use poison control center (PCC) data as a source of information on pesticide exposure because it is nationwide in scope with a standardized format and definitions that permits comparisons over a period of years. The American Association of Poison Control Centers (AAPCC) has provided computerized data sets to the EPA with observations of reported acute adverse health effects from pesticide exposure. This is the single largest source of information in the United States on the acute health effects of pesticides. The purpose of this study was to examine trends in reports of pesticide exposure to PCC.

Methods

The AAPCC uses the Toxic Exposure Surveillance System (TESS) to collect information from PCC on reported poison exposures. Computer files of data on illnesses and injuries by pesticides were purchased from the AAPCC for the years 1995 through 2003; the basic methodology has been described elsewhere (2–4). An unpublished summary of data for 2004 was also provided to the author's specifications, courtesy of the AAPCC (Litovitz, personal communication). During these years, at least 83% of the U. S. population was included in PCC catchment areas reporting to the national database. The data excluded exposures to mixtures of products (about 8% of reports) where the primary cause of poisoning (between two pesticides or a pesticide and another product) could not be determined and intentional exposures (suicide attempts, abuse, malicious use, and unknown intention) that account for less than 3% of reports.

For this analysis, only the more serious symptomatic exposures, defined as moderate, major, or fatal medical outcomes, are included because the intent was to capture trends in cases that usually would require medical treatment. These typically account for about 15% of reported cases with known outcome; the other 85% having minor outcome that usually can be treated on site (e.g., at home with dilution and observation) and are more likely self-reported without confirmation by a health care provider. Known outcome means the poison specialist followed-up until an exposure could be classified as none (no symptoms reported), minor, moderate, major, or fatal. Minor effects are defined as symptoms which are "minimally bothersome . . . usually resolve rapidly, and usually

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The views expressed and the results/conclusions reached within this article do not necessarily reflect the opinions of the U.S. Environmental Protection Agency.

Address correspondence to Jerome M. Blondell, 8556 Tyrolean Way, Springfield, VA 22153-2240, USA. E-mail: jblondell@cox.net

involve skin or mucous membrane manifestations" (3). Moderate and above have "more pronounced, prolonged or more of a systemic nature than minor symptoms" and "usually some form of treatment is or would have been indicated." Note that this definition includes many cases of eye and skin injuries. However, not all skin and eye effects can be classified as injuries; some may be due to systemic effects. So the term "poisonings" or "symptomatic cases" used in this article is intended to include injuries without reference to whether the effects were due to systemic or topical effects (e.g., hives and lacrimation due to systemic immunological or neurological effects versus skin rash or corneal abrasion due to irritant properties).

Denominators for population at risk were based on estimates of total population served by Poison Control Centers based on U. S. census data for the catchment area served (2). Earlier studies have shown that 85% of households use pesticides (5).

Two methods were used to examine the potential for reporting bias and to validate observed trends. First, a proportionate hazard analysis was performed to see if the reported declines in pesticide poisonings were simply a reflection of reduced reporting for exposures and poisonings due to all substances. Greater declines in pesticide exposures would suggest a real decrease rather than a reduced use of PCC. Second, the trend in pesticide-related deaths reported by States to the National Center for Health Statistics (Compressed Mortality File Underlying Cause-of-Death, available at <http://wonder.cdc.gov/mortSQL.html>) were compared with the TESS trends to address overall reporting bias of pesticides versus other products, but does not address possible reporting bias among different types of pesticides (6).

pesticide reported to PCC participating in TESS. Just three types of pesticides account for 88% of the cases. Insecticides accounted for 61.2%, disinfectants 18.0%, and herbicides 8.4% of all reported moderate, major, or fatal outcomes.

Overall, unintentional moderate/major/fatal outcome poisonings declined 42% from 1995 to 2004. However, these declines are not uniform across all categories of pesticide types. For example, poisonings due to disinfectants declined 57%, more than for any other type of pesticide. Repellents, on the other hand, showed the least decrease in rates of 9%. Repellents consist of both insect repellents applied to the human body and moth repellents placed near vulnerable clothing and food stores. A separate analysis for these two categories revealed no change in the rate of poisoning due to insect repellents. Moth repellents, on the other hand, showed a decrease of 35% in poisonings.

A more detailed analysis found poisonings to organophosphate (OP) and carbamate insecticides (including mixtures with other types of insecticides) have declined the most. OP poisonings are down 72% and carbamate poisonings are down 67%. Pyrethrins and pyrethroids, on the other hand, show a decrease of only 3%. The decline for strychnine based on three cases in 2004 is 63% from 1995 to 2004. Paraquat poisonings have declined 79% from 1995 to 2004. The only remaining non-restricted use of strychnine and, therefore, for use by the general public, is for applications below ground to control pocket gophers. Sale of above ground uses was prohibited in 1988 and the public's use markedly declined in subsequent years as remaining stocks in the marketplace were exhausted. Paraquat reductions may be partly due to reformulation by the manufacturer who added an emetic and stenching agent to make ingestion less likely starting in 1988.

Results

Table 1 reports the annual incidence rate of moderate/major/fatal cases per million population in the U. S. for each type of

Validation

During the time period under study, the rate of serious unintentional poisonings from all substances declined 17% (based

Table 1. Average annual rate of unintentional poisonings (moderate, major, or fatal outcome) per million U.S. population for pesticides by type reported to the TESS, 1995 to 2004

Year	Insecticides	Disinfectants	Herbicides	Rodenticides	Fungicides	Repellents	Other*	Total
1995	8.89	2.95	1.355	0.325	0.206	0.920	0.324	14.97
1996	7.00	2.54	0.977	0.211	0.164	0.865	0.253	12.01
1997	6.28	2.20	0.892	0.216	0.160	0.552	0.230	10.53
1998	7.25	2.27	0.940	0.268	0.163	0.773	0.266	11.93
1999	7.34	2.01	0.885	0.238	0.123	0.602	0.332	11.53
2000	6.27	1.44	0.754	0.255	0.107	0.436	0.288	9.55
2001	5.27	1.33	0.736	0.192	0.107	0.590	0.265	8.49
2002	5.42	1.60	0.792	0.226	0.110	0.637	0.195	8.98
2003	5.21	1.35	0.767	0.238	0.088	0.682	0.155	8.49
2004	5.43	1.28	0.701	0.174	0.133	0.838	0.194	8.75
% decline 1995 to 2004	39%	57%	48%	46%	35%	9%	40%	42%

*Includes insect growth regulators, fumigants, wood preservatives, algicides, and molluscicides.

on Table 12 from the annual reports for the years 1995 through 2004, published each year in the *American Journal of Emergency Medicine*, suggesting a possible reporting bias. Perhaps there was less use of Poison Control Centers or perhaps the decline is real. However, pesticides showed a greater decline (42%) in rates, suggesting that at least 60% of the decline is not attributable to reporting bias. From 1995 to 2004, the decline in the rate of pesticide poisonings as a proportion of the rate for all substances went from 5.68% (14.97/263.3) to 4.02% (8.75/217.9), a decline of 29.2%. This decline suggests that much of the 42% decline reported in Table 1 is not due to overall reporting bias.

The National Center for Health Statistics (NCHS) publishes mortality data, available at <http://wonder.cdc.gov/mortSQL.html> (6). Disinfectants that are regulated as pesticides by EPA are not included in the mortality data discussed below. NCHS cautions that "death rates based on counts of twenty or less . . . are flagged as unreliable" (6). To avoid this problem, a comparison was made between the average rate for 1994 through 1996 based on 36 unintentional deaths with the rate for 2001–4, which is based on 20 unintentional deaths. The rate per million population declined 62%, from 0.045 during 1994–6 to 0.017 during 2001–4. This decline in deaths from 1994–6 to 2001–4 is greater than the decline in the number of serious poisonings reported from 1995 to 2004 suggesting that, perhaps, the decline in pesticide poisoning is not due to incomplete reporting.

Discussion

Starting in 2000, after human health risk assessments showed potential risks, negotiated agreements between the EPA and manufacturers eliminated nearly all residential uses of the two leading organophosphates, chlorpyrifos and diazinon, which accounted for 62% of TESS exposures to OPs from 1993 through 1996. There was concern that replacement with non-organophosphate insecticides would result in no net reduction in insecticide poisonings. TESS data indicate that poisonings due to non-OP insecticides was reduced from 1995 to 2004 by 19%.

Neither personal-use insect repellents nor pyrethrins/pyrethroids showed declines commensurate with other pesticides. This is consistent with the increased use of insect repellents in recent years to avoid West Nile Virus and Lyme disease, and increased use of pyrethrins and pyrethroids that have largely replaced the OPs and carbamate insecticides among residential pesticide users. Residential exposures account for about 93% of the pesticide reports to PCC. The small decrease in poisonings (3%) for pyrethrins and pyrethroids occurred despite increased residential use. Pyrethrins and pyrethroids are noted for their low toxicity; therefore, further investigation was undertaken to discover why they were responsible for any moderate or major medical outcomes according to PCC reports (7). An examination of symptoms among reports categorized as moderate

or major medical outcome due to pyrethrins/pyrethroids (1993–2003) revealed that the most common symptom was dyspnea, present in 45% of 7,096 reports. Also reported in 15% or more of the 7,096 reports was bronchospasm (18%), cough/choke (35%), eye irritation (36%), corneal abrasion (15%), nausea (18%), and vomiting (18%). The prevalence of the respiratory symptoms, dyspnea, bronchospasm, and cough/choke, suggest that pyrethrins and pyrethroids may be irritants and/or sensitizers that pose risks for persons with a history of respiratory illness, allergy, or asthma.

The trend in reduction of unintentional pesticide poisoning deaths has continued over many years (8). Data for 1980–1981 found 0.123 unintentional deaths per million U. S. population compared to 0.017 in 2001–2004, a 86% decline. For the years 1980 through 1998, when specific pesticide classes could be identified, there was a 59% decline in deaths due to organophosphate insecticides. Some of the earlier decline in deaths is likely due to the negotiated cancellations of most uses ethyl parathion in 1991 and all uses of mevinphos in 1995, two of the top ten causes of occupational hospitalized poisonings from 1977 through 1982 (8). In 2000 and 2001, EPA announced the phase out of all residential uses of chlorpyrifos and diazinon, the two leading causes of serious organophosphate insecticide poisoning. This latter action appears to be largely responsible for the 72% decline in OP insecticide poisoning reported above. In addition to these actions, other preventive measures have been introduced over the years to reduce OP insecticide poisoning in both the agricultural and residential sectors including: restriction of use to trained applicators, requirements for closed mixing-loading, enclosed cabs, and other engineering controls, changes in concentration and packaging design, changes in application rates and size of containers, and requirements for training of applicators and field workers.

Unintentional mortality from drugs, unlike pesticides, have shown a marked increase in death rates, increasing by 218% from 1990 to 2002, mostly due to narcotics and most notably the opioid analgesics (9). In 1980, 58% of unintentional poisoning deaths were reported due to drugs, but by 2004 the percent rose to 95% and the death rate was six times higher (6). Even for non-narcotic drugs the death rate increased over three-fold, although a small portion of this increase may be due to changes in coding of poisoning deaths that started in 1999 with the introduction of the Tenth Revision of International Classification of Diseases (8). Researchers at the Centers for Disease Control and Prevention concluded that the Food and Drug Administration (FDA) needed to do more "to identify ways to reduce deaths from opioid analgesics without diminishing the quality of care for patients" (9). The current author would suggest that FDA needs a more comprehensive approach to preventing drug-related poisonings and deaths making full use of other available sources of data besides their own Adverse Event Reporting System.

Limitations

Misclassification may occur when symptoms are reported over the telephone and are not confirmed by a physician or laboratory tests. In this study 63% of symptomatic cases were seen in a health care facility. Although some misclassification can be expected to occur, it is assumed that any differential between types of pesticides would not change significantly over the time studied, in a manner that would artificially affect trends. As noted by Calvert et al., "pesticide-related illness is not routinely encountered by the majority of primary-care providers in the United States and most receive minimal training on recognition of environmental and occupational illness" (4). "In addition, the ability to make the diagnosis is complicated by the fact that symptoms are often nonspecific and by the lack of readily available specific laboratory tests to measure the pesticide, its metabolites, and the effect of the pesticide. Even when tests are available, they are frequently not performed sufficiently promptly to detect an abnormality" (4). It is possible that physicians might variably report pesticide exposures to PCC according to their knowledge of the pesticide category, their assessment of the severity of the patient's symptoms and course, or their access to sources of medical information on pesticides other than PCC. Under reporting of poisonings by doctors and hospitals to PCC is a serious shortcoming. The range of referrals of poisonings from all substances from inpatient and outpatient cases to PCC is estimated at about 25% (10,11). This suggests that the rates of poisonings account for only about a quarter of the total cases that occur, especially those requiring treatment.

Surrogates for the population at risk can be considered such as sales data or pounds of active ingredients, especially for the home and garden market that account for 93% of all cases reported to PCC. Estimates of pounds of active ingredient in use by the home and garden market showed a 27% increase from 1995 to 2001, the last year for which data is available (12). Figures are not available for each pesticide type but for insecticides and herbicides, the estimated increase in use was 42% and 51%, respectively. This suggests that the decreases seen in rates of pesticide poisonings were not due to any marked reduction in residential pesticide use.

Conclusion

From 1995 to 2004 there has been an overall 42% decline in estimated serious symptomatic exposures to pesticides reported to PCC in the United States. At least 60% of this decline appears to be unrelated to any overall reporting bias.

Organophosphate insecticides declined 72% and carbamates 67%, the largest for any particular group of pesticides. Other toxic pesticides, such as paraquat and strychnine exhibited declines of about 79% and 63%, respectively. Declines in PCC-reported pesticide exposures are not fully understood because of the absence of denominator data on use and historical data on use patterns.

References

1. Code of Federal Regulations (2004). The Federal Insecticide, Fungicide, and Rodenticide Act. Section 20(c). Washington, D. C.: U. S. Government Printing Office. (Accessed July 21, 2006, at: <http://www.epa.gov/opp00001/regulating/fifra.pdf>).
2. Watson WA, Litovitz TL, Rodgers GC, Klein-Schwartz W, Reid N, Youniss J, Flanagan A, Wruk KM. 2004 Annual Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System. *American Journal of Emergency Medicine* 2005; 23:589-666.
3. AAPCC (American Association of Poison Control Centers). Toxic Exposure Surveillance System (TESS): Instructions for the Required Definitions and Fields for TESS 2002. Washington, D.C.: American Association of Poison Control Centers, 2001:1-125.
4. Calvert GM, Sanderson WT, Barnett M, Blondell JM, Mehler LN. Surveillance of pesticide-related illness and injury in humans. In: Krieger RI, ed. *Handbook of pesticide toxicology*. 2nd ed. San Diego, CA: Academic Press, 2001:603-641.
5. Whitmore RW, Kelly JE, Reading PL. National Home and Garden pesticide use survey: Final report. RTI/5100/17-01F, Research Triangle Park, North Carolina: Research Triangle Institute, 1992.
6. National Center for Health Statistics. Compressed mortality file underlying cause-of-death. Available at <http://wonder.cdc.gov/mortSQL.html>. Accessibility verified July 21, 2006.
7. Reigart JR, Roberts JR, eds. *Recognition and Management of Pesticide Poisonings*. 5th ed. Washington, D. C.: U. S. Environmental Protection Agency, 1999. Available at <http://www.epa.gov/pesticides/safety/healthcare/handbook/handbook.htm>. Accessibility verified July 21, 2006.
8. Blondell JM. Epidemiology of pesticide poisonings in the United States, with special reference to occupational cases. In: *Human Health Effects of Pesticides*. *Occupational Medicine: State of the Art Reviews* 12:209-220; Philadelphia: Hanley & Belfus, Inc., 1997.
9. Paulozzi LJ, Budnitz DS, Yongli X. Increasing deaths from opioid analgesics in the United States. *Pharmacoepidemiology and Drug Safety* 2006; 15:618-627.
10. Chafee-Bahamon C, Caplan DL, Lovejoy FH. Patterns in hospital's use of a regional Poison Information Center. *American Journal of Public Health* 1983; 73:396-400.
11. Harchelroad F, Clark RF, Dean B, Krenzelok EP. Treated vs. Reported toxic exposures: discrepancies between a Poison Control Center and a member hospital. *Veterinary and Human Toxicology* 1990; 32:156-159.
12. Kiely T, Donaldson D, Grube A. *Pesticide Industry Sales and Usage: 2000 and 2001 Market Estimates*. Washington, D. C.: U. S. Environmental Protection Agency, 2004. (Accessed July 21, 2006, at http://www.epa.gov/oppbead1/pestsales/01pestsales/market_estimates2001.pdf).

washingtonpost.com

Toddler Dies From Pesticide in Home

The Associated Press
Wednesday, July 18, 2007; 11:07 PM

LUBBOCK, Texas -- A family apparently trying to rid their home of roaches used an industrial-strength pesticide that released toxic fumes, killing a toddler and sickening four adults, authorities said.

The 2-year-old girl died Wednesday at a hospital a short time after she was taken there along with four adults. Two of the adults were treated and released and two women, 56 and 58, were in satisfactory condition, a University Medical Center spokeswoman said.

The pellets, which are typically for large-scale industrial use, such as a grain warehouse, were placed Tuesday in four locations in the house, fire officials said. The chemical, Phostoxin, releases a toxic gas when it comes into contact with moisture, Lubbock fire spokesman Chris Angerer said.

The commercial pesticide is not available over the counter, and it was not clear Wednesday where and how the family obtained the pellets.

Police have identified a person who may have given the commercial pesticide to the family and criminal charges could be pursued, Lubbock television station KCBD reported.

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News



Fire ants showing up in Phippsburg

Seth_Koenig@TimesRecord.Com

07/31/2007

PHIPPSBURG — A colony of what might be the first case of European fire ants in Sagadahoc County turned up recently at Phippsburg's EdgeWater Farm Bed and Breakfast — and it's not exactly welcome news.

Farm co-owner Carol Emerson said she discovered the invasive species approximately a week and a half ago while weeding near one of her many organic flower beds.

Since that day — when she disturbed a local population of the "ferocious" red ants and was stung near the inside of her knee — nests have been discovered in several other places among her network of gardens.

At Emerson's 71 Small Point Road property, the insects have come out in force whenever a garden worker jostles the wrong rock.

"When I saw them swarm, there was something crazed about them," she said Monday, pointing out a select few locations where the ants have emerged.

Dr. Eleanor Groden is leading a summerlong University of Maine study of European fire ants. Her team is documenting where in the state the species is found and the effects the ants have on the local environment.

Groden said if Emerson's ants are confirmed to be the fire ants, it would be the first case of them in the county.

"We haven't had a report of them yet in Sagadahoc County, but we were surprised that we hadn't," said Groden on Monday. "We just thought it was a matter of time before someone brought an infestation to our attention."



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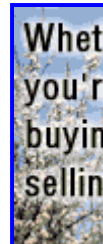
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The European fire ants have been confirmed in Cumberland, Hancock, Kennebec, Knox, Waldo, Washington and York counties, and Groden said this particular species is not one gardeners want to see.

A University of Maine guide explains that Maine populations of European fire ants, which were first documented in Eastport in the 1950s, "have increased considerably over the past decade."

Groden said that the fire ant species eliminates native ants and further draws aphids, which can decimate garden plants.

In addition, the creatures can drive their human neighbors away as well.

"Usually, a sting results in an inflamed red area from one to four inches in diameter, sometimes with a raised white area in the center," reads the university guide. "Where this insect has established nests, homeowners have reported that they are unable to use their yards and gardens because of repeated stings by the ants."

The ants are also sometimes difficult to spot until they've been disturbed, because they don't build a mound like fire ants found in the southern United States. The fire ants found in Maine, said Groden, are of European descent, whereas the southern fire ants originate in South America.

"It's important to note that these are not the same fire ants that appear down south," said Groden in a phone interview from Orono.

"Sting-for-sting, I've heard these fire ants are worse," she continued — although she admitted the southern fire ants will coordinate their attacks so that as many as several hundred sting simultaneously, a tactic not employed by their northern counterparts.

Despite their names, the red insects crawling around Emerson's gardens aren't bothered by the cold and have been found as far north as the Arctic Circle.

Monday afternoon, Emerson received a tip that ants don't like mint, so she said that would be among the next things she tries in an effort to get rid of the insects.

Part of Groden's research this summer, she said, is to test out ways to eliminate the infestations — a process that is easier said than done.

"A number of commercial products just don't work for these ants," said Groden, who added that by fall her team should have a better grasp on what pesticides are effective on the European fire ants.

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As bees go missing, a \$9.3B crisis lurks

The mysterious disappearance of millions of bees is fueling fears of an agricultural disaster, writes Fortune's David Stipp.

By **David Stipp**, Fortune

August 28 2007: 2:55 PM EDT

(Fortune Magazine) -- It's a sweet time for honeybees in the rolling hills of eastern Pennsylvania, and the ones humming around Dennis vanEngelsdorp seem too preoccupied by the blooming knapweed nearby to sting him as he carefully lifts the top off their hive. VanEngelsdorp, Pennsylvania's state apiarist, spots signs of plenty within: honeycomb stocked with yellow pollen, neat rows of wax hexagons housing larval bees, and a fertile queen churning out eggs.

But something has gone terribly wrong in this little utopia in a box. "There should be a lot more workers than there are," he says. "This colony is in trouble."

That pattern -- worker bees playing Amelia Earhart -- has become dismayingly familiar to the nation's beekeepers over the past year, as well as to growers whose crops are pollinated by honeybees. A third of our food, from apples to zucchinis, begins with floral sex acts abetted by honeybees trucked around the country on 18-wheelers.

[The mysterious deaths of the honeybees](#)

We wouldn't starve if the mysterious disappearance of bees, dubbed colony collapse disorder, or CCD, decimated hives worldwide. For one thing, wheat, corn, and other grains don't depend on insect pollination.

But in a honeybee-less world, almonds, blueberries, melons, cranberries, peaches, pumpkins, onions, squash, cucumbers, and scores of other fruits and vegetables would become as pricey as sumptuous old wine. Honeybees also pollinate alfalfa used to feed livestock, so meat and milk would get dearer as well. Ditto for farmed catfish, which are fed alfalfa too.

And jars of honey, of course, would become golden heirlooms to pass along to the grandkids. (Used for millennia as a wound dressing, honey contains potent antimicrobial compounds that enable it to last for decades in sealed containers.)

In late June, U.S. Agriculture Secretary Mike Johanns starkly warned that "if left unchecked, CCD has the potential to cause a \$15 billion direct loss of crop production and \$75 billion in indirect losses."

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SPECIAL C



PHOTO: DAVID YELLEN

Pennsylvania apiarist Dennis vanEngelsdorp helped form a group trying to crack the case of the vanishing insects.

[\\$9.3 billion worth of endangered crops](#)

Late last year vanEngelsdorp, a strapping, 37-year-old Netherlands native with a thatch of blond hair and a close-cropped goatee, helped organize a group of bee experts to identify the killer. In recent months he's acted as the team's gumshoe, driving thousands of miles to collect bees and honeycomb samples from CCD-afflicted hives to analyze for clues.

Meanwhile, Pennsylvania State University entomologist Diana Cox-Foster has scoured bees from collapsed colonies for signs of disease-causing microbes. She's shown that the insects are chock-full of them, as if their immune systems are suppressed.

Now the entomologists, aided by Ian Lipkin, a Columbia University scientist known for cracking the case of the West Nile virus (he identified the mosquito-transmitted killer of birds and sometimes people), are closing in on possible culprits and reportedly have submitted a study identifying a virus associated with CCD to a scientific journal. The bug may have been introduced into the U.S. via imported bees or bee-related products, say researchers familiar with the study.

"If I were a betting man," says Dewey Caron, a University of Delaware entomologist who co-authored a recent report on CCD's toll, "I'd bet it's a virus that's fairly new or one that's mutated to become more virulent." Other pathogens, such as fungi, may have combined forces with the virus, he adds.

But merely showing that germs selectively turn up in cases of CCD, he cautions, won't necessarily nail the culprit, for it will leave a key question unanswered: Are such microbes the main killers, or has something else stomped bees' immune systems, making them vulnerable to the infections?

After all, the first report on AIDS focused on a strange outbreak of rare fungal pneumonia, "opportunistic" infections whose root cause was later identified as HIV, the human immunodeficiency virus.

[A fight about fish farms](#)

Fortunately, a bee apocalypse seems unlikely at this point. Beekeepers have recovered from CCD-like hits in the past -- major bee die-offs seem to occur about once a decade. Most beekeepers recently contacted by *Fortune* say hives generally appear normal of late.

Still, ominous reports of worker-scarce hives like the one vanEngelsdorp recently examined suggest that whatever causes CCD is still in circulation and may well decimate hives again when bees' floral support system drops away this fall.

If that happens, "it will be a lot worse than the first time, because [commercial beekeepers] have already spent a lot of their money" replacing lost bees, says Richard Adee, head of the country's largest beekeeping operation, Adee Honey Farms of Bruce, S.D., which, despite its name, is largely a pollination business.

The losses weren't insured, he adds: Because of all the unpredictable things that can kill bees, from mites to droughts, insurers have long refused to cover them. "We'll see a lot of guys just



PHOTO: DAVID YELLEN

A frame removed from a hive afflicted by colony collapse disorder (CCD). The 'smoker' on top is used to sedate the bees.



PHOTO: DAVID YELLEN

David Hackenberg sounded the alarm about collapsing colonies.

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hang it up."

So that's the thing to worry about: While CCD isn't likely to obliterate honeybees, it may wipe out enough migratory beekeepers to precipitate a pollination crisis.

They're already thin on the ground -- a rare breed of truck drivers who also happen to be applied entomologists, amateur botanists, skilled nursemaids of cussed old machines, traveling salesmen, and Job-like nurturers of finicky, stinging insects that, when they're not mysteriously dying off, can suddenly swarm on you like something out of Hitchcock.

Commercial beekeepers make up only about 1% of the 135,000 owners of hives in the U.S., but they manage over 80% of the nation's 2.4 million honeybee colonies. If the waning number of hives in the U.S. is any indication, commercial beekeeping was already in a long-term decline before CCD struck -- in 1960 there were about five million hives, more than twice as many as there are today.

Meanwhile, demand for pollination services is growing, largely because of our love affair with the almond -- it's increasingly seen as a health food, and the FDA acknowledged in 2004 that there are data "suggesting" a daily dose of 1.5 ounces of almonds or other nuts, along with a low-fat diet, may lower the risk of heart disease. By 2012 nearly 90% of the hives now estimated to exist in the U.S. will be needed to pollinate California's almond groves each spring, according to the Almond Board of California.



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The health of honeybees are a key indicator of the health of our earth. Beekeeper Chris Harp talks about the possible consequences of losing the honeybee population.

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Commercial beekeeping has a lot in common with the disappearing family farm. The typical bee rancher is a salt-of-the-earth, 50-something, strong-armed guy who often sweats through the night forklifting hives filled with seriously annoyed bees onto a flatbed semi in order to rush them to his next customer's field 500 miles away, which just may be near a crop sprayed with insecticides that will kill 15% of his livestock as they wing around the area.

Cheap honey imported from China and Argentina has clobbered his profits, forcing him to work his bees ever harder as migratory pollinators. He loses lots of bees to "vampire" mites, hive-busting bears, human vandals, and sometimes to beekeepers gone bad, who steal hives by night and pollinate by day. His kids can see that there are much easier ways to make a living.

But for all that, he's never lost the sense of wonder that came over him the first time he heard the piping of a queen -- a kind of battle cry that newly emerged honeybee queens make before fighting to the death for hive supremacy. From outside a hive, it sounds like a child wistfully tooting a toy trumpet in a distant room.

If CCD flares up again, one of the casualties may be the Paul Revere of colony collapse, a lanky, 58-year-old beekeeper named David Hackenberg. The story of the disappearing bees began one afternoon last October when he and his son Davey pulled into one of their "bee yards" near Tampa to check on 400 hives they had placed there three weeks earlier.

The Hackenbergs' main center of operations is a farm near Lewisburg, Pa., but like most migratory beekeepers, they move their bees south each winter for a few months of R&R (rest and reproduction) before the rigors of spring pollination.

Hackenberg, a gregarious raconteur with a Walter Brennan voice, says the first sign of trouble was that "there were hardly any bees flying around the hives. It was kind of a weird sensation, no bees in the air. We got out our smokers" -- bellows grafted to tin cans that beekeepers use to waft bee-sedating smoke into hives before opening them - "and smoked a few hives, and suddenly I thought, 'Wait a minute, what are we smoking?'"

"Next thing, I started jerking covers off hives ... It was like somebody took a sweeper and swept the bees right

out of the boxes. I set there a minute scratching my head, then I literally got down on my hands and knees and started looking for dead bees. But there weren't any."

Attack of the mutant rice

Hackenberg spread the word about his vanished bees. Within days other beekeepers began reporting similar cases. Penn State's Cox-Foster, vanEngelsdorp, and other bee experts launched an investigation. After turning up more than a dozen cases of collapsing colonies across the country, the team issued a report in mid-December telling of beekeepers who'd lost up to 90% of their bees.

The "unprecedented losses," according to the report, had many keepers "openly wondering if the industry can survive."

By late spring CCD had made headlines around the world. Assorted phobia purveyors vied to adopt the die-off as a poster child for everything from cellphone emanations to God's Just Wrath. Internet bloggers thrilled themselves silly bandying about a sentence from Albert Einstein, which the great physicist apparently tossed off about 40 years after his death to the public-relations department of a French beekeeping group: "If the bee disappears from the surface of the earth, man will have no more than four years to live."

A survey sponsored by Bee Alert Technology, a Missoula, Mont., firm that sells hive-tracking devices and other bee wares, turned up reports of CCD in 35 states and Puerto Rico by early June.

Despite the widespread impression that CCD started with Hackenberg's losses last October in Florida, says Bee Alert CEO Jerry Bromenshenk, "our survey shows that it probably first began to show up the previous spring in Michigan, Wisconsin, and Iowa. By midsummer [last year] it was moving through the heartland," hitting hives in the Dakotas, then appearing widely a few months later in the South and on both coasts.

A survey led by vanEngelsdorp and Florida apiary inspector Jerry Hayes suggests that a quarter of U.S. beekeepers were struck by CCD between September 2006 and March 2007. Those hit by mysterious die-offs lost, on average, 45% of their hives.

The surveys failed to show patterns suggesting CCD's cause. But they provided alibis for some prime suspects, such as beekeeper enemy No. 1: blood-sucking Varroa destructor mites. (Picture a tick as big as a Frisbee glommed onto your back -- that's what Varroa is like for a bee.) Varroa both transmits harmful viruses to bees and suppresses their immune systems.

But CCD has been reported in many hives without significant mite problems, says Jeff Pettis, an entomologist at the U.S. Department of Agriculture's Bee Research Laboratory in Beltsville, Md.

Sugar cane ethanol's not-so-sweet future

Another leading suspect -- stress on bees due to migratory pollination -- hasn't gotten off the hook so easily. Low honey prices coupled with rising pollination fees for certain crops have prompted migratory beekeepers to put their bees on the road more than ever during the past few years.

Some now truck hives coast to coast, beginning in February with California almonds, then moving on to crops in the East, such as Maine blueberries. That potentially exposes bees to ever more diseases and insecticides. And many of the crops, such as cranberries, don't provide adequate bee nutrition.

The insects aren't very good travelers either. When a truck carrying bees gets caught in a summer traffic jam, for instance, hives quickly overheat, despite the fact that the millions of workers inside them furiously fan their wings in an attempt to prevent it, says Wes Card, a beekeeper whose Merrimack Valley Apiaries in Billerica, Mass., pollinates crops from California to Maine.

"Then every minute counts," he adds, for unless the driver can quickly find a way to pull off the road and hose down the hives with cooling water, desperately hot queens emerge from their inner sanctums and typically wind up venturing into nearby colonies on the truck, where they are perceived as alien invaders and promptly killed. (Ironically, worker bees typically execute a condemned monarch by clustering around her and vibrating their wing muscles to generate heat, fatally raising her temperature -- beekeepers call it "balling the queen" because the executioners form a ball of bees.) A hot day can turn a load of hives into a costly mess within

minutes.

Stress probably isn't the main culprit, though. In fact, the biggest commercial beekeepers -- those with over 500 hives, most of whom are migratory pollinators -- lost a smaller percentage of their hives when hit by CCD last winter than did hobbyist beekeepers, according to the survey co-authored by vanEngelsdorp.

Further, there's some evidence that CCD may antedate the modern stresses put on bees. Large numbers of honeybees have mysteriously vanished a number of times since the mid-19th century, suggesting that CCD may be just the latest episode in a "cycle of disappearance" caused by a mystery disease that periodically flares up like a deadly worldwide flu epidemic.

Still, entomologists who have personally observed the effects of CCD insist that it is unlike any bee die-off they've seen. The University of Delaware's Caron, one of the bee world's biggest names, says he was stunned when 11 of 12 hives in the school's apiary collapsed last winter, apparently because of CCD.

"Never in 40 years had I witnessed the symptoms I was seeing," he says.

[Winning in the wine biz](#)

One of CCD's strangest symptoms, say bee experts, is a phenomenon that might be called the madness of the nurses. Nurse bees are workers that nurture a hive's preadult bees, called brood. Workers begin their adult lives as nurses, and only during the final third or so of their six-week lives do they become foragers, venturing outside the hive to collect nectar and pollen.

Researchers have discovered that the young nurses are maintained in a kind of immature, thickheaded state by chemical signals emanating from the queen. Nurses aren't supposed to leave the hive. They're not ready to cope with the big outside world, which requires a mature bee's smarts. Besides, with nurses on leave, the all-important brood would wither.

Yet empty hives struck by CCD are often found with intact brood, which means nurses were on the job shortly before all the bees flew off forever. Beekeepers find this gross dereliction of duty much weirder than the disappearance of foragers, which essentially work themselves to death and often die outside the hive.

Says Hackenberg: "Basically, I've never seen bees go off and leave brood. That's the real kicker."

To explain the psychotic behavior, some beekeepers, including Hackenberg, point the finger at an increasingly popular class of insecticides called neonicotinoids. The chemicals are widely used by farmers on fruits and vegetables that bees pollinate, as well as on corn and other crops often grown nearby.

Soon after [Bayer \(Charts\)](#), the German drug and chemicals concern, first put the products on the market in the early 1990s, they were implicated in a bee die-off in France, where their use was then sharply restricted. Since 2000, studies by French and Italian researchers have suggested that low, "sublethal" doses of the chemicals -- which bees might get from lingering traces of the insecticides in fields -- can mess up the insects' memories and navigational abilities, potentially making them get lost. Bayer has countered with its own studies, which it asserts demonstrate that the products, when properly used, don't pose significant risks.

Honeybees' exposure to trace amounts of neonicotinoids can't be ruled out, says Chris Mullin, a Penn State University entomologist investigating whether pesticides are involved in CCD.

But he and other CCD investigators doubt that neonicotinoids will turn out to be the primary culprits. For one thing, many other chemicals to which bees are exposed are nerve toxins that can make them act strange at low doses. And it's hard to reconcile the rapid, widespread appearance of CCD last year with the fact that numerous such chemicals have long been widely used.

Could infectious microbes induce the nurses' insanity?

[The great corn gold rush](#)

Maybe. Young workers with a disease caused by "sacbrood" virus tend to start foraging abnormally early in life, when their healthy peers are still nursing. And as if discombobulated in their new roles, they fail to collect

pollen.

Although sacbrood virus has been detected in bees from some hives with CCD symptoms, as have a number of other viruses, it doesn't appear to be closely associated with the disorder. But its ability to warp young bees' behavior suggests that viruses may well induce nurses to do the unthinkable.

Another explanation may make more sense, though: Perhaps the nurses aren't really acting crazy when they fly away. Instead, their strange behavior may represent a perfectly natural attempt by doomed workers to protect their sisters from killer microbes.

After all, a hive's workers represent a famously close-knit sorority, geared by evolution to act strictly in the best interests of their colonies. (Male "drones" don't work, by the way. They loaf about the hive most of their lives, zip out about noon every day in hopes of mating on the wing with young queens, then immediately die after copulating, presumably happy.) Beekeepers have long known that sick bees generally leave the hive to die, minimizing the risk that they will infect others.

In his seminal 1879 tome *The A B C of Bee Culture*, Amos Ives Root, an early giant of U.S. beekeeping, marveled that "when a bee is crippled or diseased from any cause, he [sic] crawls away ... out of the hive, and rids the community of his presence as speedily as possible. If bees could reason, we would call this a lesson of heroic self-sacrifice for the good of the community."

Might a fast-spreading, immune-suppressing disease be making nurses so sick that their urge to stay put is overruled by the altruistic impetus to depart?

[The organic milk price war](#)

The effort to answer such questions has entered a new phase with the recent linking of specific infectious agents to CCD (the ones whose identities are expected to be disclosed soon in a scientific journal). Now Cox-Foster says she and colleagues are trying to reproduce CCD's effects on bee colonies by seeding healthy hives with the agents -- the biomedical equivalent of getting a killer to confess.

Meanwhile, scattered reports over the summer of hives with abnormally few workers and little stored honey have many bee people worried. A few beekeepers, frazzled by earlier heavy losses and worried that truly ruinous ones are on the way, have already bailed out.

CCD 2 would probably be a lot uglier for growers -- and for us fruit and veggie eaters -- than version one was. In fact, we got lucky the first time it hit: "A lot of the bees brought to California this year were total junk," their hives sparsely populated because of CCD and other problems, says Lyle Johnston, a Rocky Ford, Colo., beekeeper who arranges the placement of 50,000 hives owned by other keepers in almond groves each spring. "But we had the most perfect weather during the almond bloom that I can recall. It saved our butts," by enabling bees to take to the air more often than they usually do.

"We dodged the bullet with fruit, too, this year," says the University of Delaware's Caron. "We had weak bees, but the weather was exceptional during the apple, blueberry, and cranberry blooms."

Unfortunately, Caron and others note, by keeping crop prices low, the good weather may have actually discouraged legislators from funding studies on CCD. To beekeepers' dismay, the farm bill recently passed by the U.S. House of Representatives, which calls for \$286 billion to be spent over the next five years on everything from school snacks to biofuels, earmarked no funds specifically for CCD research.

And the lucky run of weather probably won't last much longer. Extraordinarily dry weather through spring and early summer in California and the Southeast has stressed bees in those regions, potentially setting up many hives for collapse later in the year.

Despite making some progress, cash-strapped scientists looking into CCD aren't likely to identify what causes it -- and ways to fend it off -- before the high-risk season for bee die-offs arrives with the onset of cold weather.

So what to do in light of this new, unsolved, and probably ongoing threat to our food supply? Don't panic. But do take time to slowly savor your next sweet, spicy slice of cantaloupe, watermelon, apple, peach, or pear.

The pure pleasure of it may get a lot rarer. ■

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Money & Business

Monsanto's Biotech Makeover Takes Root

It scores with corn and soybeans. Next up: battling drought

By David LaGesse

Posted 8/19/07

Rows of crops at a Monsanto test farm near Jerseyville, Ill., can read like passages from the Old Testament. These sick-looking plots of corn are beset by a plague of beetles, those by a plague of moths. And back in the corner of one field, deprived of moisture amid a midwestern heat wave, stands corn with stalks that are browning and leaves curling. The plants are suffering from the first signs of drought, the indiscriminate killer that has most vexed agriculture since its beginning.



Testing. Researcher Heidi Windler with drought-tolerant cotton plants in a greenhouse at Monsanto's Chesterfield, Mo., research campus. (Jon Lowenstein—Aurora for USN&WR)

Growing next to the wilting corn is Monsanto's future: rows of corn that are equally parched but that stand taller and greener. They carry a gene, developed by Monsanto scientists, to help the corn weather a dry spell. It's a trait that Monsanto executives are betting will drive the company forward another decade, if not longer.

Drought tolerance is a potential blockbuster, bringing benefit to farmers worldwide and riches to the company that successfully gets it to market. "It has immense, global appeal," Monsanto Chairman and CEO Hugh Grant says at the company's St. Louis headquarters. "It has the potential to reshape this company one more time."

That's saying a lot for Monsanto, which entirely remade itself during the past two decades. It has shifted from an industrial chemical company to one focused almost entirely on plant breeding, most notably in the science of transplanting genes from one species to another. When he joined the company in the early 1980s, says Chief Technology Officer Robert Fraley, "we owned oil fields, turning the oil into plastics. Now we're entirely about seeds and biotech."

"Frankenfoods." The company weathered tough years in the transition. Monsanto had spun off its chemical business in the 1990s and was briefly owned by Pharmacia, a pharmaceutical company that wanted Monsanto's drug-related lines. Pharmacia spun off Monsanto's ag-related

business in 2000. The new Monsanto struggled at first, losing two chief executives in three years and about \$1.7 billion in 2002. Its stock tumbled more than 50 percent that year to about \$7 a share. Having placed all its bets on biotech, Monsanto was stalled amid widespread controversy over its genetically altered soybeans and corn, derisively called "Frankenfoods" by critics abroad and at home. The company was also seen as a corporate bully, trying to ram the new technology down the throats of farmers, a conservative lot who were hesitant to adopt radically new approaches. Suspicion of the company's motives was fueled by its first successful genetically modified crop, a soybean that encouraged the use of a key chemical that Monsanto had maintained in its portfolio—the already hugely successful Roundup herbicide.

Then, in 2003, things began to turn around. The third CEO in three years was Grant, a longtime company man who brought a lilting Scottish accent to the corner office and a gentler approach to working with regulators and farmers. And farmers began to see significant benefits from planting Monsanto's Roundup-ready soybeans. "There was an inflection point five years ago," Grant says.

Sales had already been rising for the soybeans, which made it easier for farmers to protect their crops from choking weeds, and the company eked out a small profit in 2003. This year, an astounding 91 percent of the 64 million acres planted with soybeans nationwide will carry that Roundup-ready gene. But what has sent Monsanto's stock soaring, today at about 10 times its 2002 low, were gene-altered hybrids in the larger, faster-growing, ethanol-fueled corn market. Monsanto succeeded there with genes that also make corn tolerant of Roundup, as well as others that kill pests that feed on the plant's roots and leaves. Some of the company's best profits come from "stacking" all three traits into one seed. In 2006, Monsanto's profits reached nearly \$700 million, and they're on track to hit \$1 billion this year.

Head start. Now Monsanto is promising the ultimate goal in corn management: drought tolerance. Success isn't guaranteed, despite the promising trials at Monsanto's test fields near Jerseyville and elsewhere. Battling drought is more complex than the other traits introduced so far through genetics, such as pest and herbicide resistance. "But either Monsanto is able to make it work, or nobody can make it work," says Vincent Andrews, a stock analyst with Morgan Stanley. "And barring Monsanto making mistakes, we just don't see anyone catching up."

Its perceived lead is partly a reflection of Monsanto's early investment in biotech. The company poured billions during the 1980s and 1990s into research and buying seed companies. It also reflects the methodical nature of the science of crossing plant genes, which despite its reams of data and years of trials, starts with high imprecision.

Early on, in fact, it was a "gene gun"—literally, a 22-caliber slug—blasting genes from one plant into the tissue of another. "It's the brute-force method," says William Kosinski, a Monsanto scientist, while giving a tour of the company's labs. More often now, it is a quieter injection involving bacteria that are expert at carrying genes into foreign tissues, but no more exact as to where and how the target DNA attaches to the host plant. The only way to know how the gene

expresses itself in the new plant is to grow it (and scores of variations) to see which might take on the characteristic, such as Roundup tolerance.

"It's a long winnowing process," says Thomas Peters, Monsanto's chief scientist for new corn traits. "There are no skipping steps." Each gene project eventually leads to hundreds of plants being cultivated in growth chambers, which are rooms filled with bright lights and sealed behind stainless steel doors that give them the look of walk-in refrigerators. There are 122 of the growth chambers at a Monsanto lab building in a St. Louis suburb alone—the most at any one location. The plants that graduate move to greenhouses that sit atop the six-story lab building. Steadily winnowed down over several years, as many as 70 in a promising project make it to the first year in a Monsanto test field, where the selection process continues for three to six more years. His corn teams may have 10 or 12 projects underway in any one year, Peters says, and maybe only one every three years leads to a "Eureka moment" of a commercialized plant. Along the way, crops get analyzed, including at a lab with machines that can each process 5,000 ears of corn a day, kernel by kernel. "You never know when you might find the one you're looking for," says Monsanto scientist Steven Modiano.

It's that randomness of the initial process that fuels some criticism. "We don't know enough about plant genomes to know what all the effects will be," says Bill Freese of the Center for Food Safety, an environmental group. He and other critics say the new genes can generate new or raised levels of toxins in a plant or introduce proteins that cause allergies—and argue that testing is inadequate. Biotech proponents say governmental regulation is stringent and that people have lived with those genetically altered soybeans for a decade with no food or feed safety issues. "The thing I'm most proud of is the industry's impeccable environmental and safety record," says Fraley, Monsanto's technology chief.

While best known as a research powerhouse, Monsanto has also led the industry in marketing and distribution. Growing seed and getting it to the right markets, on time, is a huge logistical challenge, says Ben Johnson, an equity analyst at Morningstar. "Every production run for seed is an entire growing season," he says.

Less weeding. There have been commercial flops. Genetically altered wheat appeared close to market when, under CEO Grant, Monsanto killed the venture after farmers voiced concerns that foreign markets would close to all U.S. wheat. But the move also helped assure producers that Monsanto was becoming less arrogant and more willing to work with exporters and regulators. "It's been a learning experience for everyone involved," says Martin Barbre, who farms 4,300 acres of corn and soybeans with his son and son-in-law in southeastern Illinois and considers himself a fan of biotech. But even Barbre is given pause by Monsanto's success. "As a producer, it bothers me a bit that there isn't more competition in the traits in beans," he says.

Still, the Roundup-ready beans have meant fewer of the more toxic herbicides that he used before, and he plants the beans more closely together—he doesn't have to till later for weeds. Farming's more productive, and more fun, he says. "Otherwise, I'd probably be out on a tractor

right now in this heat."

Like a lot of producers, Barbre has his eye on planting more corn. Demand for ethanol has as much as doubled prices in recent years. Where the nation once consistently planted 80 million acres in corn, it has planted 93 million acres this year, with more expected next. It's an extraordinary shift in a business, says Grant, that since the 1940s has been extraordinarily predictable. For Monsanto, corn has already displaced soybeans as the company's biggest profit maker. And crops have eclipsed the plummeting income from Roundup, which is no longer protected by Monsanto's patent. But in corn, the St. Louis company has competition in Roundup-ready and pest-protected strains from other seed companies, including the Pioneer subsidiary of DuPont and Syngenta, two that are also racing to produce drought-tolerant strains.

Monsanto execs have said they're confident they'll be first with water-efficient corn, somewhere around 2010. Monsanto hopes other new products will keep its momentum going until then, including seed that yields more soybeans and beans with more healthful oils. But drought tolerance is a trait that can be applied across the company's seeds, including cotton and fruits and vegetables. It's what he focuses on now more than anything, Grant says: "We have to get it right."

At a Glance

Name: Monsanto Co.

Headquarters: St. Louis

Chairman and CEO: Hugh Grant

Employees: 17,000

2006 profit: \$689 million

2007 profit: \$1 billion (estimate)

Major products: Genetically modified corn and soybeans, herbicides

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