household insecticides. Resin strips impregnated with DDVP were placed in homes, public buildings, buses, aircraft, and ships to control pests such as cockroaches.

By the late 1970s many companies manufactured it, including Amvac. Total annual output in the United States rose as high as 4.2 million pounds.[19] Then, scientific studies raised doubts about its safety and by the early 1980s annual use fell below 1 million pounds.

Like all organophosphate pesticides, dichlorvos poisons the nervous system. Acute exposure causes perspiration, nausea, vomiting, diarrhea, headache, and fatigue. Long-term, low exposures can also bring on these symptoms. Very high exposures cause convulsions and loss of consciousness. However, compared with similar pesticides, dichlorvos does not pose exceptional risks from contact during application. The main concern has been that it may cause cancer in humans.

Studies show it is an animal carcinogen. Rats and mice that inhale or ingest high doses of dichlorvos produce thyroid, adrenal, pituitary, and stomach tumors. Epidemiological studies suggest that dichlorvos can also cause cancer in humans. One showed a significantly elevated risk of leukemia among farmers in Iowa and Minnesota who used dichlorvos, even when they had used it as long as 20 years in the past. Another showed an elevated rate of non-Hodgkin lymphoma among Nebraska women who had used dichlorvos. Still a third found a "significantly increased risk" for brain cancer among children in homes using Amvac's No-Pest Strips.[20] The statistical power of these and similar studies is weak because they are based on small numbers of people with likely exposures to multiple pesticides. Nevertheless, they have ominous implications.

In 1980 the EPA initiated the first in a series of dichlorvos reviews. By law, the agency must regularly reassess whether a pesticide poses "unreasonable risk to man or the environment taking into account the economic, social, and environmental costs and benefits of [its] use."[21] With this criteria, even very dangerous pesticides can stay on the market if their risks are controlled and outweighed by their utility.

After the first review in 1980, the EPA classified dichlorvos as a "suspected" human carcinogen that acted by mutating genetic material in cells. A second review seven years later led to its classification as a "probable" human carcinogen. This bad news caused the market for it to shrink even more. One by one, agrichemical firms stopped selling it until only Amvac was left. The company was determined to keep it on the market.

Amvac has a large budget for supporting the registration of its older pesticides in the face of doubts by increasingly skeptical regulators. In 1995 the EPA sought to cancel most uses of dichlorvos. Amvac responded by submitting supportive data, but the agency found it unpersuasive. So Amvac agreed to cancel almost two dozen applications, including aerial spraying and all uses in restaurants and food processing plants.[22]

Meanwhile, Congress in 1996 required the EPA to review pesticides under a new, tougher standard that required a "reasonable certainty of no harm."[23] The agency finally finished its dichlorvos review in 2006. It allowed continued marketing, but further restricted its uses. Amvac agreed to cancel registration for more applications, including all home uses except impregnated resin strips. In 2010 it agreed to cancel five additional fogging and spray applications.[24]

Dichlorvos can no longer be applied on lawns and turf, in cracks and crevices, and with handheld foggers. In addition, dichlorvos-impregnated pest strips in homes are limited in size. Larger strips containing more than 16 grams can be used only in garages, sheds, and crawl spaces occupied less than four hours a day. They can be used in vacation homes and cabins only if the dwellings are vacated for four months after use. Smaller strips and flea and tick collars for cats and dogs that contain less than 16 grams of dichlorvos are still in use. According to the EPA, the air concentration of dichlorvos in a room where a

[19] Renu Gandhi and Suzanne M. Snedeker, "Critical Evaluation of Dichlorvos' Breast Cancer Risk," *Program on Breast Cancer and Environmental Risk Factors in New York State,* Critical Evaluation #7, March 1999, p. 1.

[20] Ibid., p. 3.

[21] Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (as amended), 7 U.S.C §136(bb)(1).

[22] Environmental Protection Agency, "Dichlorvos (DDV); Deletion of Certain Uses and Directions," 60 FR 19480-19581, April 19, 1995.

[23] This was the Food Quality Protection Act of 1996.

[24] Environmental Protection Agency, "Product Cancellation Order for Certain Pesticide Registrations," 75 FR 26227, May 11, 2010.

dog or cat is wearing one of these collars averages less than one-fortieth of the exposure level at which poisoning symptoms are detectable.[25] Recently, Amvac has targeted customers trying to control bedbugs with ads for hanging dichlorvos-impregnated strips that release vapors into a room.

Exposure of the U.S. population to dichlorvos is estimated as infinitesimal, 0.000007 milligrams per kilogram of body weight each day.[26] Even so, regulators believed that dichlorvos residues in food posed a cancer risk to the general population and that there were unacceptable risks to the nervous systems of those who mixed, handled, and applied it. The greatest danger is from skin contact. Based on animal studies, estimates are that short-term absorption of as little as 0.25 ounce of dichlorvos through the skin would cause death in 50 percent of applicators weighing 150 pounds.[27] This makes dichlorvos one of the most toxic pesticides in use.

Inhalation toxicity is lower, but still greater than most other pesticides. Current EPA estimates are that inhaling 198 parts per million over an eight-hour period would be fatal to 50 percent of exposed adults. Overall, the EPA believed that these risks outweighed the benefits for all but a few remaining applications.

Meanwhile, other countries have banned dichlorvos. In 2002, the United Kingdom rejected evidence submitted by Amvac and suspended all uses. Angola, Fiji, Denmark, and Sweden have also banned it. Amvac continued exporting dichlorvos to Australia, Canada, and Mexico.

COSTS AND BENEFITS OF PESTICIDES

Poisonous agrichemicals have high social and environmental costs. Their use on crops and in homes causes tens of thousands of acute exposure injuries each year. Long-term exposure from residues in foods, drinking water, and soil causes an unknown number of chronic illnesses including cancer, birth defects, liver poisoning, and neurological deficits. Many pesticides, especially the older organochlorines and organophosphates, do not discriminate between pests and other forms of life. They kill wildlife and pets along with target insects. An accurate calculation of monetary losses from such problems is infeasible.

Accidents increase the cost burden. Years ago a Southern Pacific freight train derailed on a steep curve above the Sacramento River north of Mt. Shasta in California. One tank car carried 13,000 gallons of metam sodium, a herbicide manufactured by Amvac. The resulting spill virtually sterilized a long stretch of the river, annihilating life right down to the moss on the rocks. It killed 200,000 fish and wiped out a celebrated trout-fishing area.[28] Lawsuits claimed that Amvac failed to identify properly and label its shipment, and it agreed to pay $2 million, although it bore no responsibility for the train's derailment.

A later mishap with metam sodium is more typical of accidental exposures. In Arvin, California, 72 workers processing carrots and 178 town residents were sickened when metam sodium manufactured by Amvac drifted from fields where it was being sprayed.[29] The applicator paid a $60,000 fine.

If the costs of pesticide use are great, so are the benefits. The major benefit is availability of a bountiful, affordable food supply. Pesticides control fungal infections, insects, and weeds that would otherwise decimate U.S. crop yields. Without control measures, 50 to 90 percent of fruit and vegetable crops would rot from fungal infections before harvest. To protect them, growers use about 100 million pounds of fungicides annually. Doing so saves an estimated $13 billion in crop value.[30]

[25] Ibid., p. 165. This figure is based on a margin of exposure of 39 for infants, who are presumed more sensitive to dichlorvos vapor than adults. Margin of exposure is the ratio of the dose at a "no observable adverse exposure level" to an observed or estimated dose.

[26] Environmental Protection Agency, *Interim Reregistration Eligibility Decision for Dichlorvos (DDVP)*, EPA 738-R-06-013, June 2006, app. J, p. 151. There are 31,000 milligrams in one ounce.

[27] Ibid., table 4.1a, Guideline No. 870.1200, p. 123.

[28] Scott Thurm, "Record Damages for 1991 Rail Spill Settlement," *San Jose Mercury News*, March 15, 1994, p. A1.

[29] Robert Rodriguez, "California Investigates Rise in Pesticide-Caused Illnesses in 2002," *Fresno Bee*, February 27, 2004, p.1; and Miller, "Pesticide Maker Sees Profit When Others See Risk," p. A25.

[30] Statement of Jay Vroom, in *Review of the EPA Pesticide Program*, Hearings before the Subcommittee on Conservation, Credit, Rural Development, and Research of the Committee on Agriculture, U.S. House of Representatives, 109th Congress, 2nd Session, September 28, 2006, p. 50.

Pesticides kill mosquitoes, ticks, rats, and other vectors that carry illnesses such as the plague, Lyme disease, and encephalitis. They make human habitations more comfortable by controlling cockroaches, mold, mildew, termites, ants, and spiders.

Herbicides reduce soil erosion, save water, and reduce fuel and labor costs for growers. Their use facilitates increasingly popular no-till agriculture in which farmers poison weeds rather than plowing them under. With less plowing there is less erosion, which means lower water treatment costs, less flood damage, and larger reservoir capacity.

Herbicides also kill unwanted growth that competes with crops for water. Without them, crop protection would require as many as 1.1 million hours of hand weeding in peak growing season. The labor force to employ at this job does not exist. Organic farmers, who cannot use herbicides, spend $1,000 per acre weeding their crops compared with only $50 for growers using chemical weed controls. One study estimated the overall benefits of herbicides at $26 billion in 2005.[31]

Finally, pesticides preserve wildlife habitats and protect endangered species. Without their use vastly expanded acreage would be required to grow necessary food crops. More land would be converted from its native state to farms, ranches, plantations, and orchards.

So pesticides clearly have both great costs and great benefits. There are other methods for controlling agricultural pests, but they complement pesticides rather than replace them. Cultivation techniques such as tilling and crop rotation make environmental conditions less favorable for destructive organisms. Biological control methods include release of insect predators such as wasps, lacewings, or lady bugs and the spread of friendly bacteria that compete with damaging strains. In the 1990s, big companies launched bioengineered seeds and their use has soared. Some crops are bred to have insect-resistant traits. Others are genetically manipulated to survive specific herbicides, giving farmers more alternatives for fighting weeds that over time become resistant to popular chemicals.

The rise of biological alternatives has not ended long-term growth in pesticide sales, which have risen an average of 11 percent a year since 1995 and reached a high of $10 billion in 2007.[32] For the time being, pesticides are still needed to protect the food supply and quality of life to which Americans are accustomed. In the words of an agricultural researcher:

> [S]ome people want a total ban on pesticides, but they must be ready to accept termites in their houses, fleas in their carpets, moldy vegetables, food-borne toxins, food shortages with soaring prices, and outbreaks of long-forgotten diseases.[33]

AMVAC MOVES AHEAD

Amvac now has more than 40 pesticide brands. It manufactures them at four plants in California, Idaho, Missouri, and Alabama and sells them in the United States and through foreign sales offices in Costa Rica, Mexico, Brazil, Switzerland, and the United Kingdom.

Amvac emphasizes profitability. Three directors—its two founding entrepreneurs and the son of one founder, now president and CEO—own 22 percent of its stock. Compensation of its president and CEO, which was $806,303 in 2009, is based on four factors: "achieving financial results that equal or exceed" targets, introducing new compounds, controlling manufacturing costs, and defining "a clear vision and strategy."[34] The ongoing shift to biological pest controls sustains its strategy. As industry giants continue to discard older pesticides, they create opportunities for Amvac.

Amvac adopted a seven-page Code of Conduct and Ethics in 2006. It states: "[O]ur efforts are focused on achieving the business and personal ethical standards as well as compliance with the laws and regulations that are applicable to our business." It intends its code to "ensure decisions that reflect care for all of

[31] Ibid., p. 50.

[32] Bureau of the Census, *Statistical Abstract of the United States: 2010,* 129th ed., table 813.

[33] Keith S. Delaplane, "Pesticide Usage in the United States: History, Benefits, Risks, and Trends," Cooperative Extension Service, University of Georgia College of Agricultural and Environmental Sciences, *Bulletin 1121,* November 2000, p. 1.

[34] American Vanguard Corporation, *Notice of Annual Meeting and Proxy Statement,* April 27, 2010, pp. 18 and 21.

our stakeholders."[35] The only mention of the environment is this brief section.

> The Company is committed to doing all that it can to assist in minimizing the degradation of our natural environment. Accordingly, employees should always take care in disposing of any waste materials or releasing any discharges into the air or water and comply with all applicable regulations and procedures required by law and by Company Code. If an employee is unclear about what is required, he/she must not dispose of any material or release any discharges until he/she has determined what procedures apply.[36]

A recessionary climate beginning in 2008 weakened Amvac. Sales dropped as farmers had difficulty getting credit and distributors cut their inventories. But by cutting costs, reducing long-term debt, and cutting its dividend, the company maintained a strong balance sheet, positioning itself for renewed growth and predicting rising pesticide demand when prosperity returned.

Amvac's presence is a lesson in capitalism. Legal opportunities for profit elicit the requisite effort. Actions are justified by their overall utility. Doubtless Amvac's strategic thinkers would be inspired by the words of a Robert Frost poem.

> But a crop is a crop,
> And who's to say where
> The harvest shall stop?[37]

Questions

1. Does Amvac have an ethical strategy? Does it pursue its strategy in an ethical manner?
2. Do you believe that Amvac is faithful to its ethics code? Does the code adequately address the consequences of its operations? What might be added or changed to improve it?
3. Should the law prohibit Amvac and others from exporting pesticides barred from use in the United States?
4. Is the value to society of pesticides such as dibromochloropropane, mevinphos, and dichlorvos great enough to warrant the risks they pose?
5. If economic and market conditions remain favorable for Amvac's strategy, would you buy its stock?

[35] American Vanguard Corporation, *Code of Conduct and Ethics,* adopted March 8, 2006, at www.amvac-chemical.com., p. i.

[36] Ibid., p. i.

[37] "Gathering Leaves," in Edward Connery Lathem, ed., *The Poetry of Robert Frost* (New York: Holt, Rinehart and Winston, 1969), p. 235.