Drugs, PESTICIDES, *and* Politics— *A* Potent Mix *in* Colombia

HARLAN BATES, NAS

Planes spraying coca plants fly high over Colombian fields to avoid being attacked from below. Observers say the pilots use a sophisticated system to track their spray applications.

As the controversy over glyphosate applications in Colombia's coca fields continues, politics and passion may overtake the science.

NAOMI LUBICK

On a regular basis, planes fly over the forests and farms of Colombia, dropping their payloads of herbicides to get rid of a dangerous crop: coca. Middlemen and drug dealers make billions of dollars on the final product—bricks of cocaine for sale in the U.S. and around the world—from coca grown primarily by poor farmers.

The U.S. considers those plane flights to be necessary in its "war against drugs" and the glyphosate mixture used for the eradication of coca bushes to be a lesser evil. But concerns over the environmental and human-health impacts of the pesticide have reopened a debate on the toxicity of glyphosate, tying scientific uncertainties to political disputes over

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how best to proceed in getting rid of coca. In a recent attempt to reach consensus on the issue, a group of researchers who are outsiders to the eradication program reviewed the application of glyphosate in Colombia. Initiated in 1999, this U.S.-supported program, called Plan Colombia, funds "drug war" activities at hundreds of millions of dollars a year, including coca- and poppy-spraying flights over an area twice the size of Texas.

Glyphosate itself has long been deemed by the U.S. EPA and nongovernmental researchers to be relatively innocuous to ecosystems. The forestry industry in North America uses it, in addition to various other herbicides, to kill competing plants. Different glyphosate mixtures have made it one of the most widely used agricultural herbicides in the world. Human-health problems associated with its application usually come from mishaps with the mixture, such as its being splashed into the eyes, or from skin exposure when inappropriate clothing is worn.

JON MARSHALL

Keith Solomon, holding a branch of a coca plant, led studies to determine the ecotoxicity of glyphosate mixtures as applied in the coca eradication campaign in Colombia.

As the key component of Monsanto's main product line Roundup, glyphosate kills plants by blocking the shikimic acid pathway that produces enzymes necessary for biosynthesis of aromatic amino acids. The chemical homes in wherever growth occurs, generally in leaves and root tips. That focused biochemical activity makes it harmless to mammals, says Charles Helling, a retired U.S. Department of Agriculture (USDA) researcher who has spent two decades studying glyphosate and other herbicides and has been a U.S. observer of the Plan Colombia program.

But for glyphosate to do its work on the hardy coca plant, the herbicide has to be mixed with more toxic chemical surfactants. These added components break through the waxy, oily barrier on coca leaves, allowing the glyphosate to enter the plants' cells. Those surfactants could also increase toxicity to other organisms, including frogs—a theory that researchers are examining. This possibility raises concerns that the U.S. "war on drugs" may be waged at the expense of Colombia's environment.

Reviewing the science

In 2004, the Organization of American States (OAS), a UN-like body with ambassadors from every state in the Americas, and its internal agency, the Inter-American Drug Abuse Control Commission (CICAD), hired a panel to take a closer look at the environmental impacts of Plan Colombia. The team is led by Keith Solomon of Guelph University (Canada), who has received some funding from a pesticide consortium that includes glyphosate-maker Monsanto, and the panel's researchers hail from England, Italy, and elsewhere outside the U.S. and Colombia. That outsider status, the sponsors hope, will provide objectivity to assessments.

The evaluation team's latest report, published in February in *Reviews of Environmental Contamination and Toxicology* (**2007**, *190*, 43–125), followed on the heels of its report to OAS, which was presented to the U.S. Congress in January. The team concludes that the glyphosate mixtures used in the program are potentially harmful to tadpoles, particularly those living in shallow pools at depths of about 10 centimeters. Lead author Solomon and his colleagues accompanied spraying missions, during which the pilots track the applications by global positioning satellites and geographic information system analyses. "It's very sophisticated stuff," Solomon says of the procedures the pilots follow. The team also tested five stream sites downstream from coca and other fields several times in a 24-week period after spraying, and they found only very small amounts of glyphosate from areas where no aerial spraying occurred.

R. A. Lautenschlager, a forestry ecologist and the executive director of the Atlantic Canada Conservation Data Centre, says that the evaluation panel relied on previous work in North American forests to show that glyphosate (plus surfactants) is not directly toxic to an ecosystem. But it has side effects by reducing plant biomass, which indirectly affects animals and other plants, Lautenschlager adds. "These things lead to changes in the kind of animals and population sizes out there, because they change habitat, not because they have toxic effects," he points out. The spraying gets rid of certain plants but allows others to take over. Lautenschlager underscores that his experience is limited to North American forests with different water regimes and spraying schedules than those in Colombia, but he agrees with the evaluation team that the harm is most likely small.

Others argue that harmful ecosystem effects are a problem and that toxicity to frog species should be of more concern. Rick Relyea of the University of Pittsburgh recently published a controversial suite of studies reporting very high toxicity for several different mixtures of glyphosate and surfactants. He reported lethal dose rates of Roundup preparations containing polyoxyethyleneamine (POEA), a surfactant known to make the herbicide more toxic to frogs. However, Relyea's experiments were conducted at concentrations that critics of the work, including the review panel, argue are much higher than those actually used in agricultural settings.

Relyea says that "much lower than worst-case-scenario [concentrations] resulted in 70% death of North American toads" in work that Solomon and colleagues do not cite in their review. Relyea also emphasizes that native Colombian frogs have yet to be studied. Other scientists point out that aside from the new review, data on the actual mixtures used in Colombia—a Roundup mixture combined with the Colombian-made product Cosmo-Flux—do not exist in the literature.

Solomon and his colleagues, however, predict moderate toxicity of glyphosate mixtures at levels of exposure similar to some of Relyea's lowest concentrations, according to results published by other researchers. Solomon notes that his team is now running tests of glyphosate mixtures at a controlled site in Colombia that is owned by the Colombian government. In those field trials, researchers will be able to address typical North American concoctions of glyphosate and surfactants, as well as Roundup mixed with Cosmo-Flux, says Solomon. Their goal is to look for safer mixtures and any impacts on frogs.

Former USDA researcher Helling says that because of the conditions where farmers grow coca, he would be surprised if many frogs can be found near the fields. "I've never seen any evidence of frogs," he says, "and I don't think that's anything to do with areas of spraying. Coca is not grown in areas that are wet," where fields have standing water. However, he acknowledges that tree frogs may live deeper inside untouched forests near fields.

In March and April 2006, during U.S./Colombian flyovers to rate the program, Helling and other observers methodologically documented the presence of water near or in more than 160 coca fields that had been sprayed. "What we found was, roughly speaking, just under 20% of the fields had some incidence of water less than 200 meters away," Helling says. Those cases mostly had small streams, but also "occurred in some very selective places," where irrigation ditches are necessary for drainage or where coca farmers had built ponds for water supplies to use with their own pesticide applications. Where running water occurs, it tends to be shielded by forest foliage, he says.

Scientists may fail to spot any evidence of exposure because of the timing of the field checks. Solomon points out that ephemeral ponds from rain could be missed when the spraying program's efficacy is checked, particularly depending on how soon the field checks follow rain and whether people can get on the ground. Those ponds could serve as frog nurseries and expose tadpoles in the fields at a particularly sensitive developmental stage. Solomon's team will perform toxicity tests on eight species of frogs endemic to Colombia, a country with the most indigenous amphibian species in the world.

Politics of spraying

While the scientific debate rages, politicians and activists have voiced concerns about the downstream effects of the spraying on humans. Ever since Plan Colombia started, activists, scientists, and politicians have been watching it carefully, and their conclusions rarely mesh. Part of the problem is a lack of data on the ground, plus a potent mix of anecdotal health data and political sovereignty issues.

Several years ago, Ecuador asked Colombia to suspend its spraying program near its borders because of concerns over drift. Colombia complied, leaving a 10-kilometer zone at its border with Ecuador until last December, when encroaching coca fields in that buffer led Colombian president Alvaro Uribe to approve the resumption of spraying. In response, the Ecuadorian government reintroduced its political and scientific objections to the spraying at an OAS hearing in January. Francisco Carrión, Ecuador's minister of foreign affairs, directly responded to the OAS team's assessment of glyphosate, presenting evidence of cross-border drift.

KEITH SOLOMON

Coca growers themselves mix pesticides, including glyphosate, in labs and in the field.

Although tens of meters of drift may be possible, "we would be extremely surprised to find [droplet] movement from the area [of] more than 100 meters," says Jon Marshall, editor of *Weed Research* and one of the coauthors, with Solomon, of the recent reviews for OAS. Aerial spraying can be extremely accurate, and because it is used extensively in the U.S., drift has been well studied. However, Colombian pilots must fly "faster than [in] conventional spraying for crops and forests elsewhere, for the pilots' safety," to avoid being shot from below by people protecting the coca crops, Marshall notes. The faster speed could change the physics of the falling droplets.

Experiments in an Australian wind tunnel are looking more closely at that issue and have produced preliminary reports, says Marshall, who consults on agricultural spraying programs in the U.K. as head of Marshall Agroecology, Ltd. He says the Australian trials tested conventional aerial sprayer nozzles like those used in Colombia. The research will allow the team to “get an idea of what the spread of the droplet size is [and] take that information and put it into [drift] models.”

From frogs to humans

Issues of drift have added to concerns over human health. Ecuador’s Carrión cited an unpublished 23-person study that found human-health biomarkers, such as DNA damage, characteristic of pesticide exposure in people living across the border. Colombia has ignored those findings, he says. In response, the Colombian government points to upcoming research from Solomon and his team that will carefully examine a statistically significant group of people who may have been exposed to spraying. (Ecuador has asked for further studies in which they or the UN might participate or oversee.)

KEITH SOLOMON

A creek near a coca field in the Cucuta region of Colombia provided surface-water samples.

To address human-health effects farther afield, the panel engaged other researchers (from Italy and Colombia) to start local human toxicity studies. So far, Solomon says, they have taken blood serum samples from people living in regions where spraying occurs to get exposure information immediately before the pesticide applications and then a week and several weeks later. “It’s not easy,” he explains. The team recruited local people who work with the health-care system, and “even they are meeting with significant resistance” when they try to take samples from people, because of lack of trust of any association with the spraying program.

The team will face scientific trouble too, notes Lautenschlager. Correlating health effects with actual spraying is incredibly difficult. Doubt can be bolstered by anecdotal accounts, he and other researchers say. “When it comes to pesticides anywhere in the world, people are highly skeptical,” he says. Surveys taken around the world underscore that point.

Anecdotal reports of human exposure have been collected by activist organizations working in Colombia, such as the Interamerican Association for Environmental Defense (AIDA), Earthjustice, and Witnesses for Peace. Observers have documented cases of pilots “overspraying”, such as overshooting the end of a field and failing to close the plane’s spray nozzles in time, or even directly spraying water bodies, such as ponds that may serve as drinking-water sources.

The U.S. State Department tracks complaints about crops that have been mistakenly sprayed and has found that of 6500 complaints compiled from the beginning of the program, only 36 have merited compensation, at $200,000 apiece. But Anna Cederstav, an organic chemist working with Earthjustice and AIDA, points out that complaints are typically made by an uneducated populace that lacks resources. She says that many mistakes may go unreported, or claimants simply may not be able to provide adequate proof of land ownership or fulfill other stringent requirements. People who don’t even have calendars in their homes, she says, probably cannot pinpoint the exact date of a flyover.

Glyphosate on the ground

Activist groups emphasize that coca spraying leads to a ripple effect on local communities from the movement of coca growers throughout the country as they look for new places to grow when spraying pushes them out. Growers recently moved into protected national forests where the government pledged not to spray. Last year, the Colombian government had to fund an expensive manual eradication program in these protected forests, which led to the deaths of 40 eradicators and government law enforcement officers, killed by people protecting the coca plots, Helling says. Emphasizing the dangers on the ground (and in the air) for those participating, he thinks that aerial spraying remains the best option for eradicating coca in the region.

Yet the air campaign is not achieving its goals, critics say, pointing out that field acreage has remained steady. “It seems the U.S. strategy is to chase coca crops around the Andean region indefinitely,” Cederstav comments, “even if that means causing deforestation and eventually needing to spray every acre with high-concentration glyphosate solutions . . . without generating any substantial impact on crop production.”

In the end, some researchers and foresters who use glyphosate in the field argue that the spraying is the lesser of two evils. Some pesticides and other products used by coca growers are more harmful than the government spraying efforts, Solomon says. Even more ecologically damaging is the indiscriminate destruction of rainforest to grow the illegal crop. These impacts may be exacerbated by the fact that legal agriculture in Colombia uses a larger mix of pesticides, the hazards of which dwarf the menace of the focused spraying campaign. Until researchers untangle the health and environmental impacts of the program, this volatile mix of science and policy will continue as long as the spraying takes place.

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