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## **Coping with environmental and health Impacts in a floricultural region of Ecuador**

**Jaime Breilh**

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*Editor*

# Ecohealth Research in Practice

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*Editor*

Dominique F. Charron  
International Development Research Centre  
PO Box 8500  
Ottawa, ON, Canada K1G 3H9  
dcharron@idrc.ca; ecohealth@idrc.ca

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Farmers in Ecuador discuss potato production methods that use less pesticide.  
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## Chapter 5

# Coping with Environmental and Health Impacts in a Floricultural Region of Ecuador

Jaime Breilh

In the early 1990s, like many other countries, Ecuador experienced fast economic growth that resulted in both rapid concentration of wealth and social exclusion that marginalized the poor. Rapid economic development during this time resulted in environmental degradation, which in turn affected human health and amplified poverty (Breilh and Tillería 2009).

Today in rural areas of Ecuador, the expansion of the agro-industry is evident, mainly in enclaves of high technology floriculture and horticulture enterprises. In many cases, these agri-businesses occupy ancestral agricultural lands where indigenous and *mestizo* communities, along with traditional *haciendas* and other, middle-sized farms, have operated for centuries. As these new, high technology farms continue to sprout up, there are fewer opportunities for traditional communities in these regions to produce food for local and national consumption, or to sustain their livelihoods (SIPAE 2004).

New economic, social, and cultural relationships brought about by industrialized agriculture for export markets have created a “new rurality” – an increased number of large agro-industrial units at the expense of smallholder agriculture. Although agro-industry provides employment opportunities and regional economic development, it also poses social, health and ecological challenges to communities, scientists and policymakers. The case of floriculture farms in Ecuador is a good example of this challenge (CEAS 2005; Breilh and Tillería 2009).

Modern floriculture brings with it technologically intensive activity that is imposed on the low-technology context of traditional agriculture in Ecuador. The contrast is not only technological. This agricultural transformation exacerbates unequal access to both land and water resources. Floriculture farms abundantly use pesticides and water, and have little incentive to apply alternative pest management

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J. Breilh (✉)  
Universidad Andina Simón Bolívar, Quito, Ecuador  
e-mail: jbreilh@uasb.edu.ec

and water treatment or conservation methods. An overly permissive pesticide policy environment allows excessive and uncontrolled use of pesticides. Smallholder farmers in the highlands also overuse pesticides, particularly on potato crops. Medium- to high-toxicity pesticides are widely available and inexpensive (Breilh et al. 2005). Pesticide use is also detrimental to soils. The accumulation and persistence of pesticide residuals in soils increases as more pesticides are applied, which reduces soil microbial mass and diversity (Aguirre 2004).

The city of Cayambe is located in the Granobles watershed in the Andes region in northern Ecuador. There are 147 floriculture farms in this watershed, or about 38% of all such farms in the country. In 2001, the Health Research and Advisory Center (CEAS) was invited by different community organizations and community leaders based in the Cayambe region to discuss the emerging issue of industrialized floriculture. A multistakeholder workshop took place in May 2001 in Quito to discuss the different views, needs, and knowledge gaps around this issue. Stakeholder representatives from the CAMAREN consortium (<http://www.cap-net.org/>) for natural resources management, the technical school in Cayambe, the indigenous community of Cangahua, the ECUANARI<sup>1</sup> indigenous organization, the UNOPAC (<http://unopac.org/>) peasant organization of Cayambe, the President of the Environment Committee of the Municipality of Cayambe and other municipal authorities, the local health services, the workers' floriculture union, the School of Chemistry, and CEAS met over 3 days to discuss the main goals for a participatory research project that would assess the social, cultural, environmental, and health impacts of floriculture in the region.

Communities and their representatives had already been discussing the pros and cons of floriculture, and they shared their views during the initial workshop. Floriculture was seen to provide employment opportunities with salaries slightly higher than average, but was suspected of causing pesticide contamination that affected both humans and ecosystems. Some community elders also claimed that community bonds were being affected, and that negative "western" patterns of consumerism were resulting from these changes. A collaborative project was developed to assist the community in building the knowledge and evidence needed to guide and promote community-based awareness and action, and to strive for policy change.

## Getting Started

At the outset, the community suspected that chemical contamination was widespread. There was anecdotal evidence of environmental changes such as strong smell of sulfurous vapours near greenhouses, and changes in the colour of surface waters. Some people described how local animal species and endemic insects were

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<sup>1</sup>Confederación de Pueblos de la Nación Kichwa de Ecuador.

beginning to dwindle in number. Rising social unrest and negative behaviour patterns, such as increased drug use, were also causing alarm among some community members. Finally, health complaints included headaches and lack of concentration in school-children neighbouring the floriculture farms, and self-reported symptoms such as recurring headaches, stomach cramps, and drowsiness among workers in the flower industry.

Pesticide-intensive agriculture like floriculture and other activities in Ecuador relies on easily accessible, inexpensive, and poorly regulated chemicals, especially organophosphate and carbamate products, which are designated as classes I (extremely or highly hazardous) and II (moderately hazardous) by the World Health Organization (2005). Floriculture workers are exposed to pesticides by contact, inhalation, or ingestion while they work in the fields, greenhouses, or refrigerated rooms where the flowers are processed. The complex exposure patterns in Cayambe can be characterized as chronic low-dose exposure to multiple products from many sources (Breilh et al. 2009). Reports of acute pesticide toxicity are rare. This chronic pattern of exposure produces diverse physiological and clinical impacts in workers (Alavanja et al. 2004, 2999; Wesseling et al. 1997): reduced neurotransmitter enzymes (erythrocyte acetylcholinesterase (AChE) and plasma AChE (buChE)); elevated levels of liver enzymes (including alanine aminotransferase (ALT) and aspartate aminotransferase (AST)); bone-marrow suppression with decreased levels of hemoglobin and reduced white blood cell (WBC) counts; neurobehavioral deficits; and self-reported symptoms like ear, nose, and throat irritation, irritable character, headaches, dizziness, unexplained sweating, and weakness.

Potentially widespread pesticide contamination in Ecuadorian floricultural areas is suspected to arise from: wind-borne drift of chemicals from cut-flower plantations; careless disposal of used pesticide containers in the environment; household pesticide use; and reuse of the pesticide-laden plastic sheeting salvaged from cut-flower greenhouses. Contamination was confirmed in samples of irrigation water running off from flower farms. Analyses demonstrated the presence of many toxic chemical residuals, including organophosphates (malathion, diazinon, and cadusafos); carbamates (carbofuran, methomyl, and oxamyl); and chlorinates (chlorothalonil and endosulfan) (Breilh 2007).

## **Project Methodology and Results**

The project goal was to study the relationship between floriculture and the health of floriculture workers, their communities, and the surrounding ecosystem. As a first step, key stakeholders were identified. Community organizations were vital to providing support for project activities, and the platform needed for stakeholders to debate conflicting views around floriculture. Stakeholders included local leaders, representatives of municipal government, experts from the Ecuadorian ministries of health and environment, peasant women's organizations, employees in the regional health system, entrepreneurs from the flower industry, and flower workers. As the

project progressed, others became involved. These included local water network leaders, Ecuadorian universities under the leadership of Universidad Andina Simón Bolívar, the Flower Label Program (FLP)<sup>2</sup>, and faculty from the University of British Columbia, Canada.

The principles of ecohealth – multidisciplinary, stakeholder participation, and gender and social equity (Lebel 2003) – provided the approach needed to tackle the complex problems related to expanded floriculture production and human and ecosystem health. The team complemented this approach with a political-economy perspective, which included the analysis of inequitable power relations defined by class, ethnicity, and gender (Breilh 2004).

### *Pesticide Dynamics in the Watershed*

The Granobles watershed was the focus for assessing pesticide dynamics in the ecosystem. The watershed was subdivided according to the agricultural water system used, and sampling sites were systematically identified to detect chemical residuals in the water and sediments. Sites were selected upstream and downstream from traditional agricultural areas and flower farms. Four different sampling series (2004–2007) were taken at 28 irrigation-water sites through different seasonal stages (related to climate and agricultural variations). Geographical identifiers were recorded using hand-held GPS. Sample collection underwent standardized quality assurance procedures to avoid external contamination and chemical degradation and to assure cold-chain conservation before chromatography and mass spectroscopy were used to identify nearly 20 of the most frequent agricultural contaminants.

### *Health Exposure and Impacts*

In 2008, pesticide exposure in the worker population was assessed using a cluster sample of working-age adults in each of two communities of the Granobles River basin. After various discussion sessions with the leaders and community groups, the project obtained the participation of 69 families in Cananvalle and 35 families in San Isidro. The study collected clinical and socio-economic data. One economically active member from each family was recruited to participate in the survey of social and cultural practices related to life style and pesticide-exposure patterns. This was supplemented with information gathered during focus groups. San Isidro represented a low-pesticide exposure area, located upstream from the floriculture area,

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<sup>2</sup>For more information on the Flower Label Program see: <http://www.fairflowers.de> whose certification adheres to the International Code of Conduct for the Production of Cut-Flowers.



above 3,000 m in the highlands. This area is characterized by agriculture crops (particularly potatoes), which can represent a different source of pesticide exposure. The community of Cananvalle (at 2,200–2,500 m) is in the valley, and was presumed to be more exposed to pesticides because it was closer to the floriculture growing areas.

Data were obtained from physical examination and clinical tests performed by medical personnel (CEAS 2005) with informed consent of the patients. Urine samples were collected and tested for pesticide residuals and residuals from phthalate components of plastics. Analysis was conducted using a gas chromatographer coupled to a mass spectrometer. Solid-phase extraction (SPE) was based on EPA 8270 and employed National Institute of Standards and Technology (NIST), Wiley, and National Bureau of Standards (NBS) libraries. Throughout project planning and fieldwork, community members participated actively in validating the representativeness of samples, and in organizing and conducting surveys.

The 2008 field work built on two earlier investigations of pesticide exposure. In 2003, floriculture workers in two farms were studied: those in a more modern, higher technology production system ( $n=51$ ) and those who were part of an older less-developed system ( $n=110$ ). Occupational pesticide exposure was assessed in these groups of floriculture workers. Their health records were obtained, and additional data were gathered using questionnaires that addressed social and occupational information, exposure patterns, use of protective gear, and vulnerability. In 2005, an international collaborative study of the neurobehavioural impact of pesticide exposure among children 3–61 months old was undertaken. Survey data were collected from mothers of children in this age range who had lived for at least 1 year in the study area. Three communities were included in the study based on a range of likely pesticide contamination levels and, because they were known to the researchers, the likelihood that the communities would participate and collaborate in the research. An adapted version of the Ages and Stages Questionnaire (ASQ) – a neurobehavioural screening instrument – was applied to assess communication, fine motor, gross motor, problem solving, and personal social-traits in the children (Handal et al. 2007).

Children 3–23 months old who resided in high-exposure communities scored lower in gross motor, fine motor, and social skills. Children 24–61 months old from these same communities scored lower in gross motor skills. The relation between high exposure to organophosphates and carbamates and poorer neurobehavioral development was robust, after controlling for other variables linked to social determinants of delayed development (Handal et al. 2007). This study showed that children are one of the most vulnerable populations, especially those who had higher levels of exposure and were living in the low valley. The project also responded to the need expressed by the Technical College of Cayambe, which was one of the first community organizations to request a scientific study to assess children's exposure to pesticides and the corresponding health impacts.

The project explored the sensitivity of a wide range of monitoring tests, and recorded clinical signs and symptoms to assess exposure to pesticides. To diagnose the impacts of chronic exposure to pesticides, the project developed a Basic Battery

of tests, which combined neurobehavioural assessment with blood and urines tests. The Basic Battery test was combined with an acetylcholinesterase (AChE) test in adults to assess flower workers (2003) and the two community groups (2008). Flower workers were also assessed using computer-assisted neurobehavioural evaluation tests such as the Neurobehavioral Evaluation System (NES2) for reaction time, fine coordination and finger tapping, hand eye coordination, and symbol digit operations.

## *Environmental Results*

Pesticide residuals were found in 67.9% of the 28 water and soil sampling sites in the Granobles River basin. The organophosphate malathion was the most common, and tended to accumulate in river sediments; but other organophosphates (diazinon and cadusafos); carbamates (carbofuran, methomyl, and oxamyl); and chlorinates (chlorothalonil and endosulphan) were also detected. High levels of organophosphates were found in most samples (in highland and valley sites), which shows the mixed pattern of pollution caused by agriculture crops (mainly caused by potatoes in the high valley) and floriculture production (in the low valley).

Project results also showed that tonnes of discarded greenhouse debris, including greenhouse plastic sheets and containers contaminated with pesticides, were being dumped in creeks or sold to poorer members of the community for reuse at home, in animal sheds, or for agricultural purposes. In fact, more than half of the families in Cananville used contaminated greenhouse plastic sheets and wooden splints in their houses and animal sheds.

## *Health Results*

Overall results showed that flower farms workers and both highland and low basin communities were highly exposed to pesticides. Different health impact indicators yielded exposure gradients among the three populations. AChE suppression tended to be more pronounced in workers, followed by the low basin community and finally in the highland area (ANOVA,  $p=0.000$ ). Other tests did not follow the expected gradient but evidence extended exposure throughout the region. As expected, the AChE test showed low levels of toxic exposure in comparison with other tests and compound indicators, due to its lack of sensitivity for assessing chronic exposure. A clear majority of flower workers presented symptoms related to chemical exposure (69.1% accumulated at least four of them); showing a consistent significant difference between high and low risk sections of the farm. Other chemical exposure screening tests showed considerably high positivity and also significant differences between high and low exposure sections. On average, a considerable number of the workers (58.5%) suffered AChE suppression, or had at least one positive blood test

and at least seven symptoms associated with pesticides exposure. The impact rose to 82.6% in those who worked in the high exposure sections of the farm. The neurobehavioral assessment of flower workers (measured by NES2) also showed high impact levels and significant differences between farm sections (Breilh et al. 2009; Breilh et al. submitted).

Ten percent ( $n=69$ ) of urine samples from Cananvalle indicated pesticide residuals: diazinon (banned in USA for being an endocrine disruptor and causing bone-marrow toxicity); carbofuran (one of the most dangerous restricted-use carbamates); and malathion (relative low human toxicity but readily converts to malaaxon, a substantially more toxic metabolite). In all cases with pesticide-residual positive urine samples, blood AChE tests did not indicate any impairment confirming the poor sensitivity of this test for low-dose or chronic exposure to pesticides. Of the urine samples from San Isidro, 8.6% ( $n=35$ ) were positive for pesticide residuals (Breilh et al. 2009).

Plastics residuals (from greenhouses and chemical containers) were found in urine samples from people in Cananvalle, near the floriculture areas. The levels recorded were above those allowed by the Environmental Protection Agency (US-EPA). Of the 60 urine samples collected in Cananvalle, 51 (85%) showed evidence of exposure to phthalate components, such as Di-2-ethylhexyl phthalate (DEHP) and methyl glycol phthalate, from plastics. These are carcinogenic compounds that are also known to cause hormone disruption (US-EPA 2010). DEHP toxicity has been reported and its public-health significance needs to be studied further (Schulz 1989).

## ***Social and Economic Results***

Salaries slightly above the average rural wages attract indigenous and *mestizo* community members to jobs in floriculture. However, this comes at a cost. The research showed that floriculture workers are exposed to highly demanding, repetitive, routine, and stressful work. Workers are given insufficient breaks (especially during cycles of high-flower demand such as Valentine's Day and throughout the months of November to January), and suffer from chronic exposure to chemical, physical, and ergonomic hazards (Breilh et al. 2005).

Floriculture workers are predominantly young (18–30 years old), have partial high school education, and have little involvement with the indigenous community organizations (if indigenous) or unions. Gender roles and responsibilities, as can be expected, differ according to tasks. For example, women are preferentially hired for postharvest activities because they are assumed to have finer manual dexterity than men. Although the involvement of young women in floriculture eases the negative aspects of their former lives in traditional patriarchal communities, it also exposes them to new challenges from industrial power relations, particularly in their interactions with mainly male supervisors. Many female workers reported having been harassed and criticized for leaving their traditional roles.

Communities neighbouring floriculture farms are affected by the industry. Many young adults seek employment on flower farms. Consequently, pesticide residues reach their households by way of contaminated clothes, plastics, wood, and other material. Therefore, the unsafe and unhealthy use of pesticides has affected not only those who deal with these chemicals directly, but even those on the periphery of the industry. As noted above, children also demonstrate early symptoms of chronic low-dose exposure to pesticides.

The project helped identify a new economic incentive for floriculture farms to cut down on harmful pesticide use. The International Code of Conduct for Cut Flower Production requires farms to comply with a set of standards for: social protection; environmental, occupational, and health protection, including rigorous control of pesticide application, exposure, and worker protection; and gender and organizational rights. Flowers certified under this Code of Conduct command higher prices in export markets. Therefore, the project developed and implemented a farm-certification program for the floriculture industry in Ecuador. Part of this work involved developing a rigorous checklist for assessing on-farm compliance with the International Code of Conduct for Cut Flower Production, and a compliance monitoring system. As a result of this project, about 18% of floriculture farms in Ecuador now comply with the International Code of Conduct.

## Conclusion

By leveraging knowledge, social networks, platforms for innovative research, and postgraduate training, the project opened policy space for better governance. For example, the project helped set up a Health Rights Network, which is coordinated by the Health Department at Universidad Andina Simón Bolívar of Ecuador. This network hosted a series of workshops and focus group discussions on sustainable rural development. It advocated for health and environmental rights, and was successful in having these principles incorporated into the new constitution of Ecuador (Republic of Ecuador 2008). The project was also pivotal in introducing ecohealth to academic programs at the universities of Cuenca (master's course on health with an ecosystem perspective) and at Universidad Andina Simón Bolívar of Ecuador (PhD program on health, environment, and society).

The project generated evidence of neurobehavioural impacts of pesticide exposure among community children and floriculture workers. It also led to the first certification program in Ecuador for the health of workers and the environment for agro-industrial floriculture farms. Several alternative clinical instruments for measuring pesticide exposure were also explored (Breilh et al. submitted). The project developed *Healthy Flowers*, a health care management software, that is now being tested in a small number of farms as a tool for epidemiological assessment of toxicity.

The project translated research into action that improved occupational and household health conditions for floriculture workers and their families and neighbours. As well, in the form of an international certification program, the project identified and institutionalized an economic incentive for the industry that may allow such changes to persist.

In the course of this work, the team has come to understand environmental sustainability as not only the capacity of society to satisfy its current and future basic needs. Sustainability is now seen to also include multidimensional links between health, society, and the environment (Breilh 2004). From this standpoint, there is a need to develop *sustainable capacity*, defined as society's capacity and aptitude to produce equitable, healthy, and dignified working and living conditions for all people. This is what the indigenous people of Ecuador call *sumac kawsay* or good living.

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