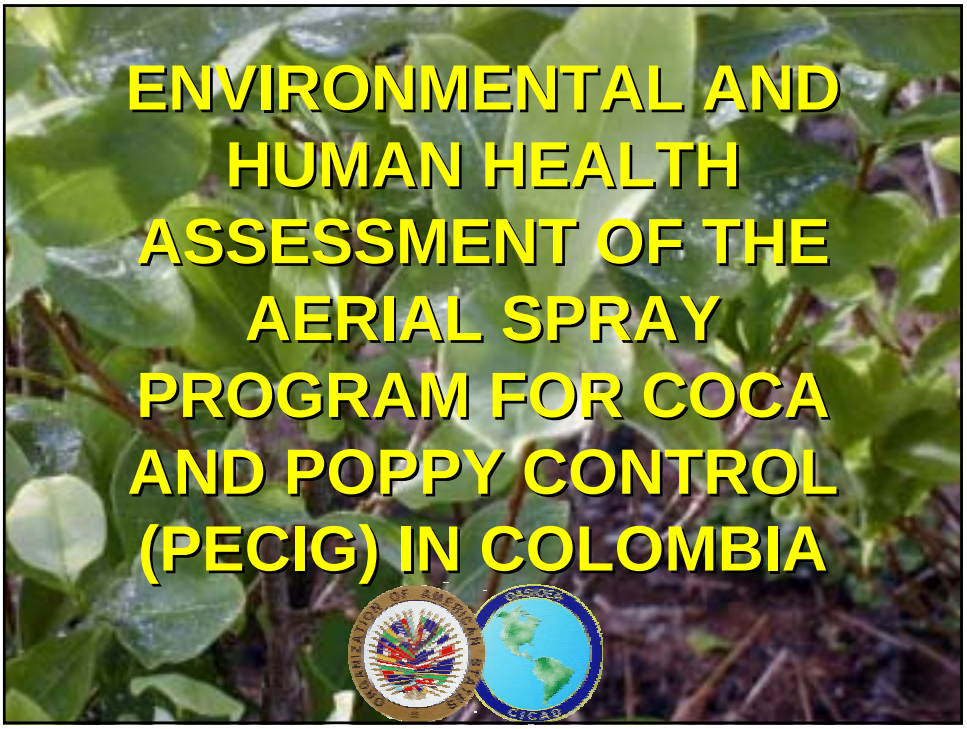


ENVIRONMENTAL AND HUMAN HEALTH ASSESSMENT OF THE AERIAL SPRAY PROGRAM FOR COCA AND POPPY CONTROL (PECIG) IN COLOMBIA

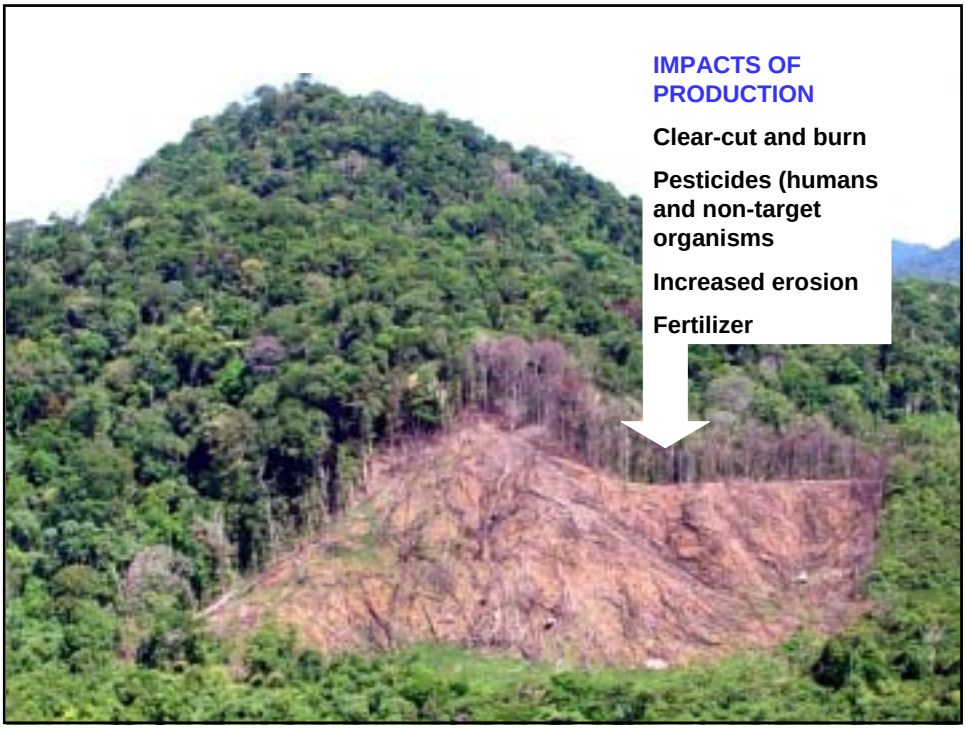
Report prepared for the Comisión Interamericana para el Control del Abuso de Drogas (CICAD)
Organization of American States (OAS)
37th session

Santo Domingo, April 26, 2005

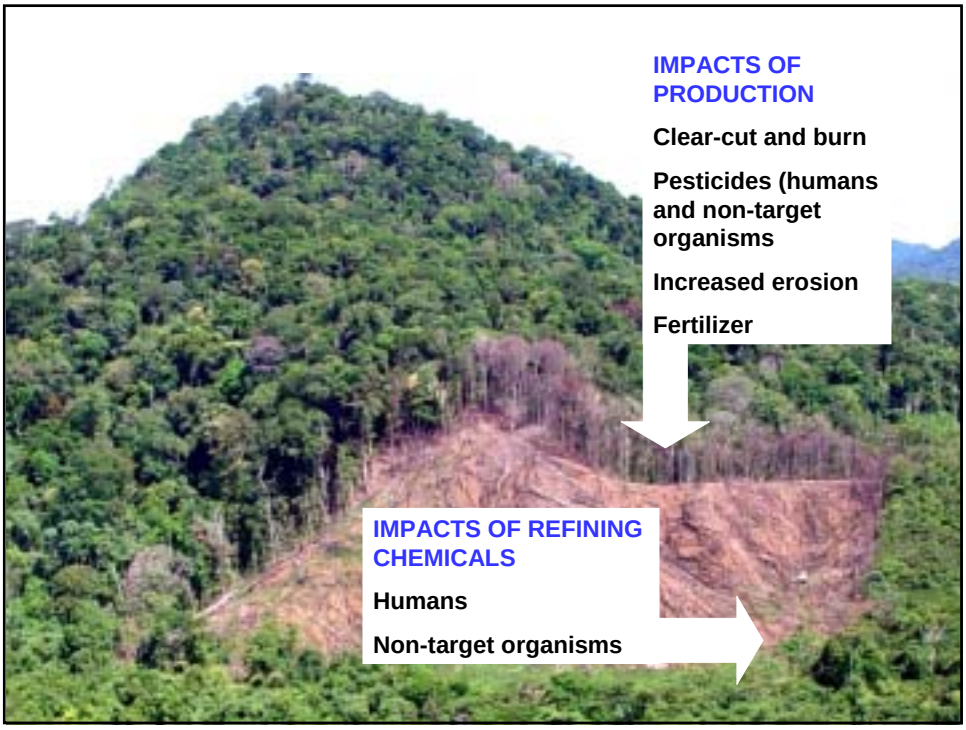
- Dr. Keith R Solomon
  - University of Guelph, Canada
- Dr. Arturo Anadón
  - Universidad Complutense de Madrid, Spain
- Dr. Antonio Luiz Cerdeira
  - EMBRAPA, Brazil
- Dr. Jon Marshall
  - Marshall Agroecology, Somerset, UK
- Dr. Luz-Helena Sanin
  - University of Toronto, Canada and Autonomous University of Chihuahua, Mexico

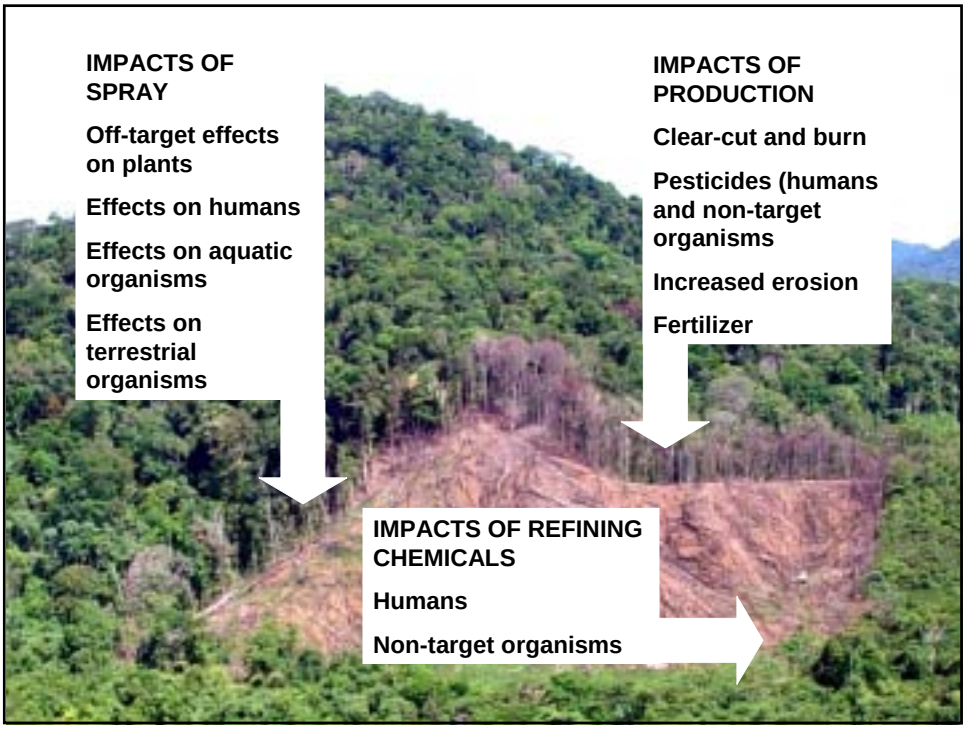
APPROACH

- **Scientific team with expertise in several areas**
- **Followed the standard approach to risk assessment**
  - **Problem formulation and stressor characteristics**
  - **Exposure characterization**
  - **Effects characterization**
  - **Risk assessment**
- **Reviewed the open scientific literature and government reports**
- **Conducted special studies in Colombia and elsewhere to characterize effects and exposures**
- **Science-based assessment for publication in the scientific literature**

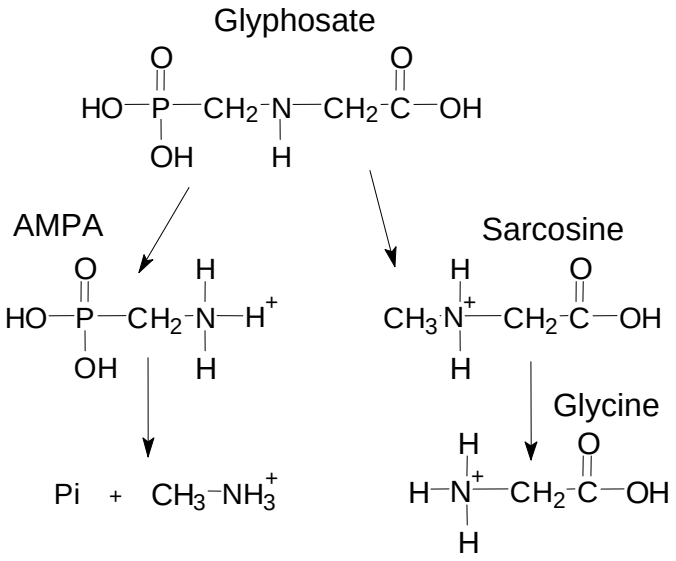

IMPACTS OF PRODUCTION
Clear-cut and burn
Pesticides (humans and non-target organisms
Increased erosion
Fertilizer


humitron


IMPACTS OF PRODUCTION
Clear-cut and burn
Pesticides (humans and non-target organisms
Increased erosion
Fertilizer
IMPACTS OF REFINING CHEMICALS
Humans
Non-target organisms

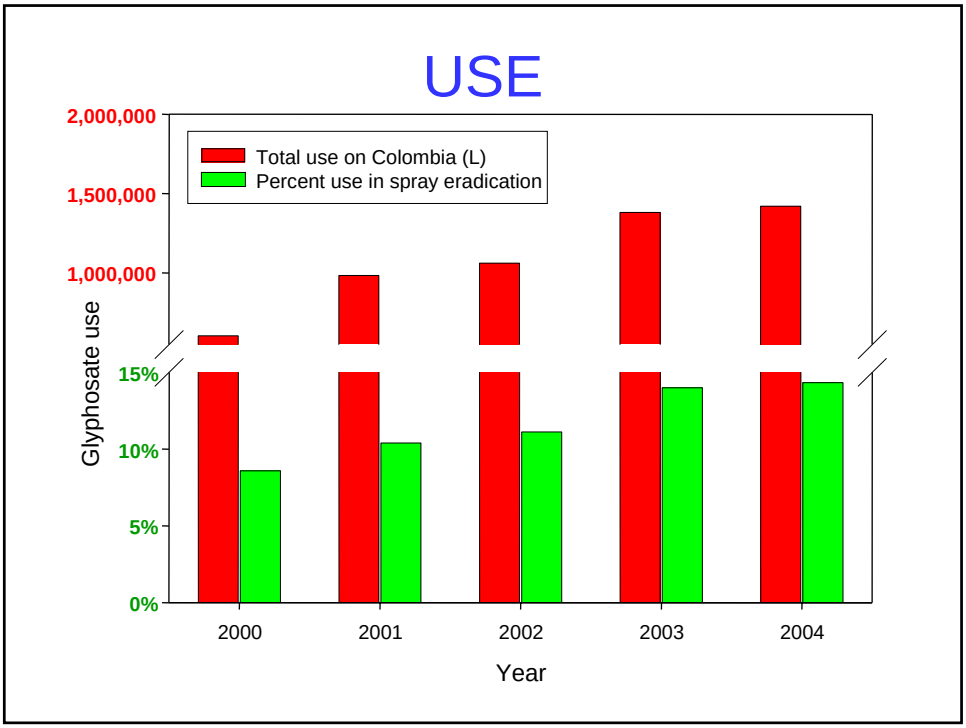

IMPACTS OF SPRAY
Off-target effects on plants
Effects on humans
Effects on aquatic organisms
Effects on terrestrial organisms
IMPACTS OF PRODUCTION
Clear-cut and burn
Pesticides (humans and non-target organisms
Increased erosion
Fertilizer
IMPACTS OF REFINING CHEMICALS
Humans
Non-target organisms

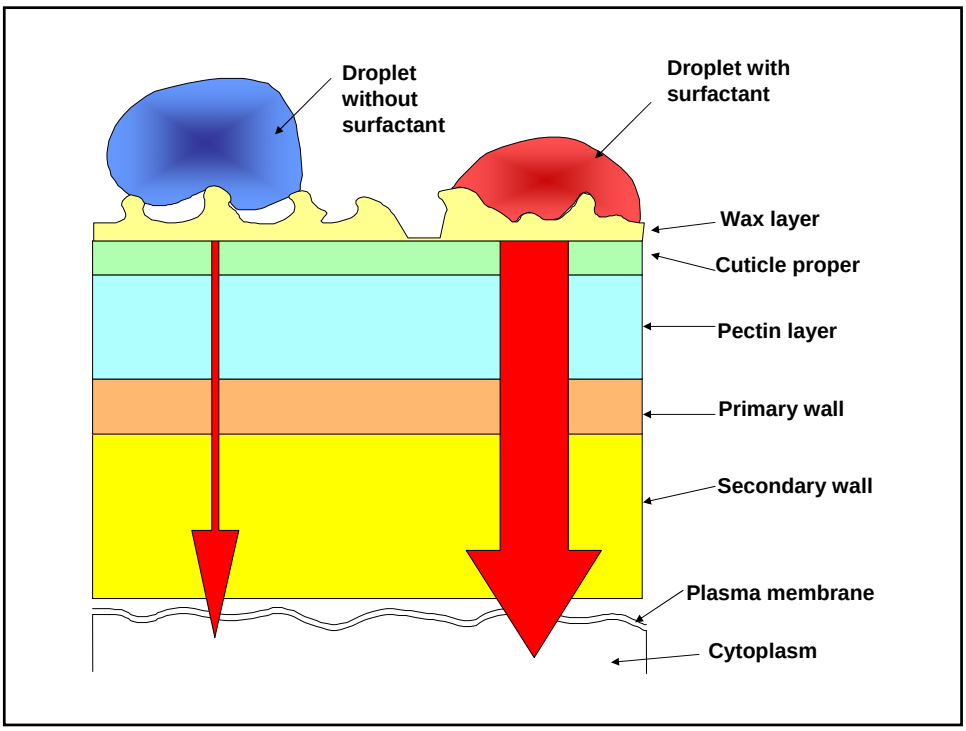
CHARACTERISTICS

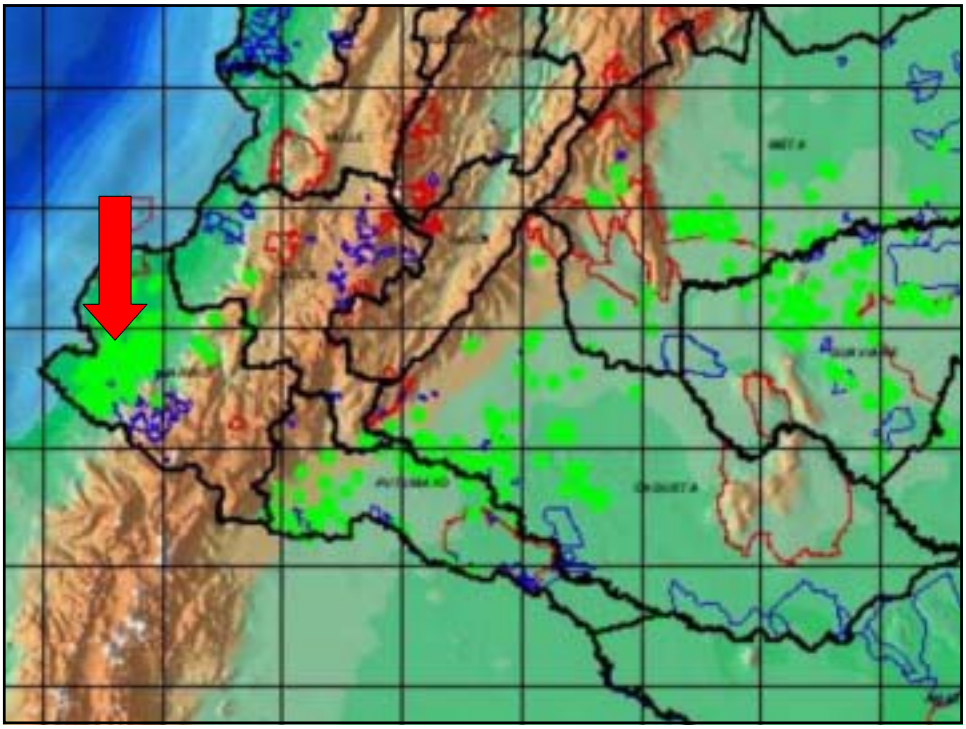


GLYPHOSATE

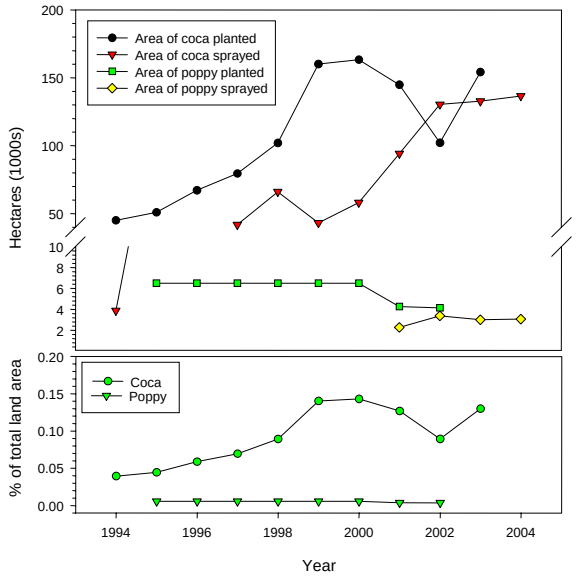
- Glyphosate is not highly mobile in the environment
- Rapidly and tightly bound on contact with soil and aquatic sediments
- Very short biological activity in soils and water
- Does not biomagnify or move through the food chain
- Does not leach into groundwater from soil.


USE
2,000,000
1,500,000
1,000,000
15%
10%
5%
0%
Glyphosate use
Total use on Colombia (L)
Percent use in spray eradication
2000
2001
2002
2003
2004
Year


Droplet without surfactant
Droplet with surfactant
Wax layer
Cuticle proper
Pectin layer
Primary wall
Secondary wall
Plasma membrane
Cytoplasm

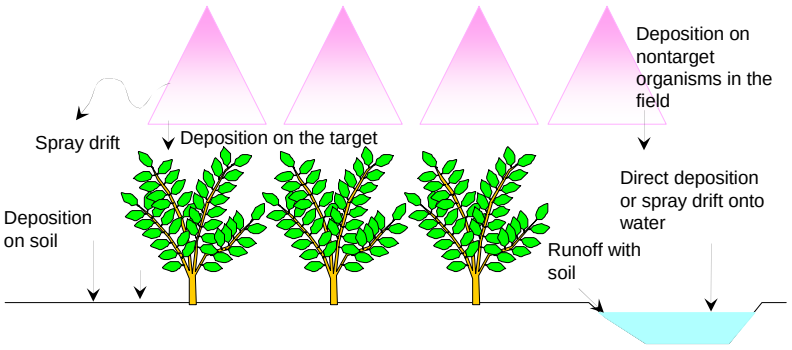


AREAS SPRAYED



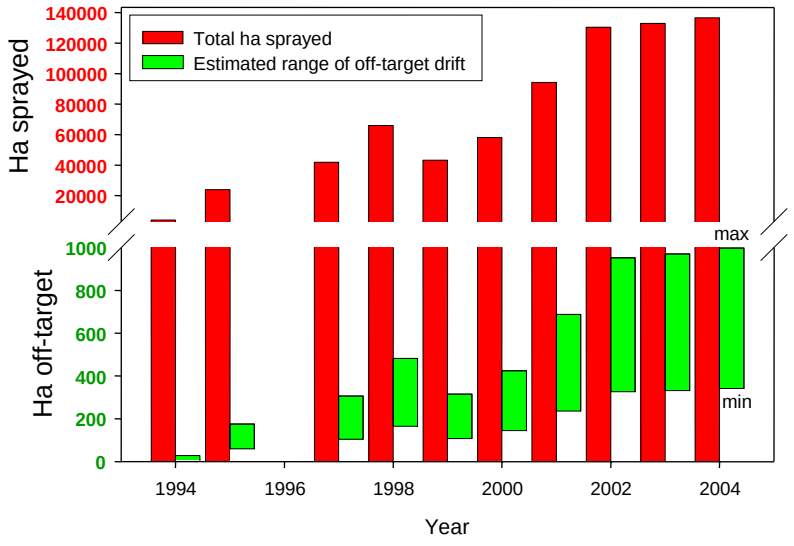
BIODIVERSTY HOTSPOT

PATHWAYS OF EXPOSURE



OFF-TARGET DEPOSITION

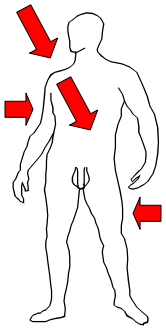
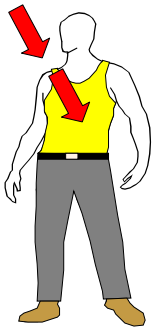
OFF-TARGET DEPOSITION



EXPOSURES

- Applicators
  - Mixer-loader
  - Pilots
  - Technicians
- Bystanders

DIRECT OVERSPRAY

Extreme worst case	Worst case	Most likely case
		
Whole body (2 m^2)	0.25 m^2	**0.25 m^2**
100% absorption	100% absorption	**2% absorption**
14.2 mg/kg bw	1.8 mg/kg bw	**0.04 mg/kg bw**

TOTAL ESTIMATED EXPOSURES

Source of exposure	**Exposure value in mg/kg bw**	
	Coca	Poppy
Direct overspray	0.04	0.01
Reentry	0.26	0.06
Inhalation	0.01	0.01
Diet and water	0.75	0.18
Worst case total exposure from all sources	1.05	0.26

ENVIRONMENTAL EXPOSURES

Surface water scenario	Exposure in µg/L	
	Coca sprayed at 4.982 kg/ha (3.69 kg AE/ha)	Poppy sprayed at 1.2 kg/ha (0.89 kg AE/ha)
2 m deep, rapid mixing and no absorption to sediments, no flow.	185	44
0.3 m deep, rapid mixing and no absorption to sediments, no flow.	1,229	296
0.15 m deep, rapid mixing and no absorption to sediments, no flow.	2,473	595
0.15 m deep, rapid mixing and 50% absorption to sediments, no flow.	1,237	297

SAMPLING IN COLOMBIA

Site name	Location	Altitude (m)	Major crop types	Known pesticide use
Valle del Cauca, Río Bolo	N 03º27.642' W 076º19.860'	1002	Sugar cane	Glyphosate and other pesticides
Boyacá, Quebrada Paunera	N 05º40.369' W 074º00.986'	557	Coca	Manual eradication, no aerial spraying of glyphosate
Sierra Nevada, Quebrada La Otra	N 11º13.991' W 074º01.588'	407	Organic coffee	None
Putumayo, Río Mansoya	N 00º43.259' W 076º05.634	329	Coca	Aerial eradication spraying
Nariño, Rio Sabaletas	N 01º27.915' W 078º38.975'	15	Coca	Aerial eradication spraying

DETECTION OF GLYPHOSATE

Surface water collection site	Total number of samples	Frequency of detection (n and %) for site	
		Glyphosate	AMPA
Valle del Cauca, Río Bolo	17	1 (5.9%)	0 (0%)
Boyacá, Quebrada Paunera	18	1 (5.5%)	0 (0%)
Sierra Nevada, Quebrada la Otra	18	0 (0%)	0 (0%)
Putumayo, Río Mansoya	16	0 (0%)	0 (0%)
Nariño, Rio Sabaletas	17	0 (0%)	0 (0%)

MDL = 25 µg/L

Other pesticides detected at Nariño - 2,4-D, endosulfan I, endosulfan II, endosulfan sulfate

EFFECTS IN MAMMALS

- **Glyphosate**
  - Very low acute and chronic toxicity
  - Not teratogenic
  - Not mutagenic
  - Not carcinogenic
  - Not immunotoxic in mammals
  - **Cancer epidemiology**
    - No strong association with cancer
  - **Neurological epidemiology**
    - No strong association
  - **Reproductive epidemiology**
    - Association with reproductive responses – Time to Pregnancy

GLYPHOSATE AND COSMOFLUX®

- **ACUTE STUDIES (GLP guideline studies)**
  - Very low acute oral toxicity
  - Very low acute dermal toxicity
  - Low to moderate inhalation toxicity
  - Low to moderate skin irritant
  - Moderate eye irritant (recovery)
  - Not a skin sensitizer
- Addition of the adjuvant Cosmo-Flux® to the glyphosate did not change its toxicological properties to mammals

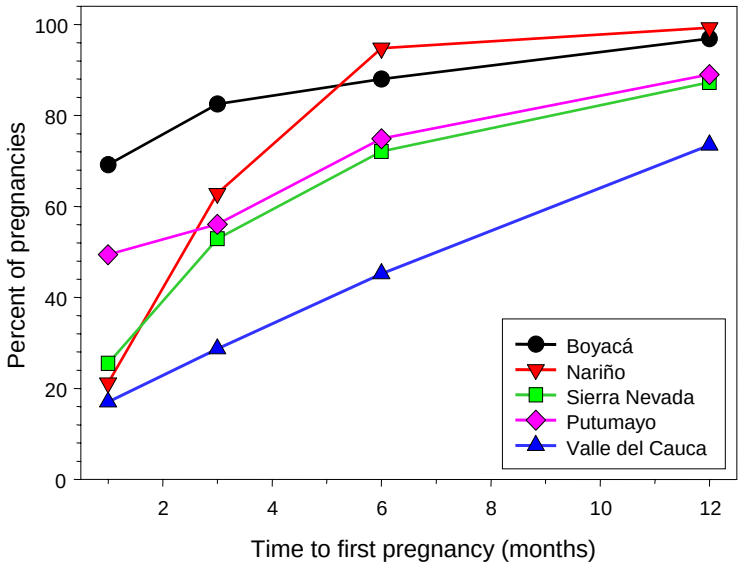
EPIDEMIOLOGY STUDY IN COLOMBIA

- Questionnaire study in 5 regions in Colombia
- Time to (1st) Pregnancy (TTP)
- 600 women in each location (3000 total)
- Ecologic study based on region – use of glyphosate for eradication
- Other factors were also assessed

EPIDEMIOLOGY REGIONS

Site name	Focal crop	Known pesticide use
Valle del Cauca	Sugar cane	Glyphosate and other pesticides. Glyphosate applied by air.
Boyacá	Coca	Manual eradication, no aerial spraying of glyphosate. Use of other pesticides unknown.
Sierra Nevada	Organic coffee	No pesticide use and no coca known to be grown. Use of other pesticides unknown.
Putumayo	Coca	Aerial eradication spraying with lower intensity. Use of other pesticides unknown.
Nariño	Coca	Aerial eradication spraying with higher intensity. Use of other pesticides unknown.

TIME TO PREGNANCY



ALTERNATIVE MODEL

Variable	OR	95% CI
Region		
Boyacá	1.00	--
Nariño	0.56	0,47; 0,66
Sierra Nevada	0.36	0,31; 0,43
Putumayo	0.35	0,29; 0,41
Valle del Cauca	0.15	0,13; 0,18
Age at first pregnancy > 20 years	0.81	0,73; 0,91
Irregular relationship	0.76	0,68; 0,84
Consumption of coffee		
Medium (1-3 cups per day)	0.91	0,81; 1,04
High (4 and more cups per day)	0.84	0,69; 1,02
Perception of contamination of water	0.91	0,81; 1,01

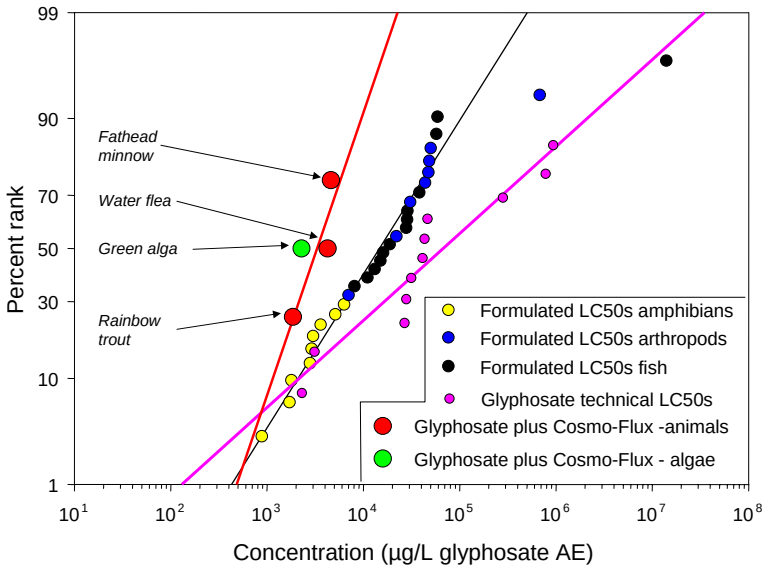
RESULTS OF EPIDEMIOLOGY

- The greatest risk (TTP) was in the Valle del Cauca region
- No association between TTP and eradication of illicit crops
- Reason(s) for the increased risk for longer TTP in the Valle del Cauca region not known
  - Not due to exposure to pesticides alone - Sierra Nevada (organic crops) also showed a significant difference from reference (Boyacá)
- Study designed to test hypotheses related to the use of glyphosate in eradication spraying - data cannot be used to identify causality associated with other risk factors
- To test this question in Valle del Cauca or any other region, a new study would have to be designed and conducted

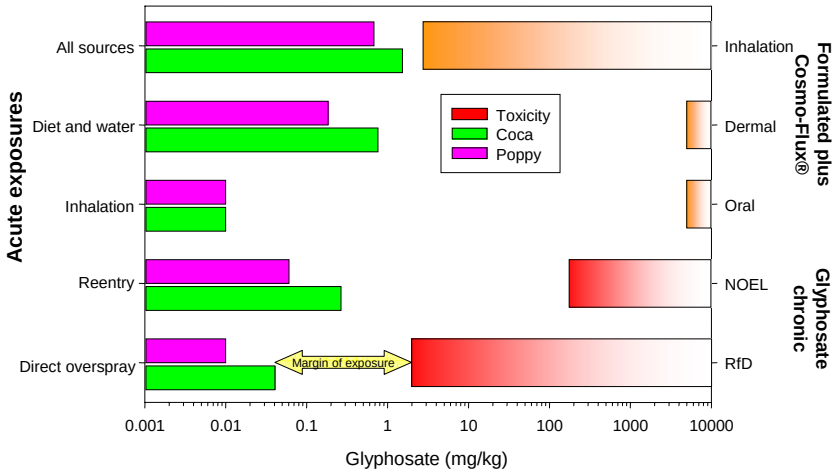
EFFECTS IN THE ENVIRONMENT

- **GLYPHOSATE AND ROUNDUP®**
  - Published papers
  - Government documents (U.S.EPA, EU, etc)
- **GLYPHOSATE AND COSMOFLUX®**
  - Special studies on the mixture
  - Honey bee
  - *Daphnia magna* (aquatic invertebrate)
  - Aquatic alga
  - Two fish (fathead minnow, rainbow trout)

ECOTOXICOLOGY DATA

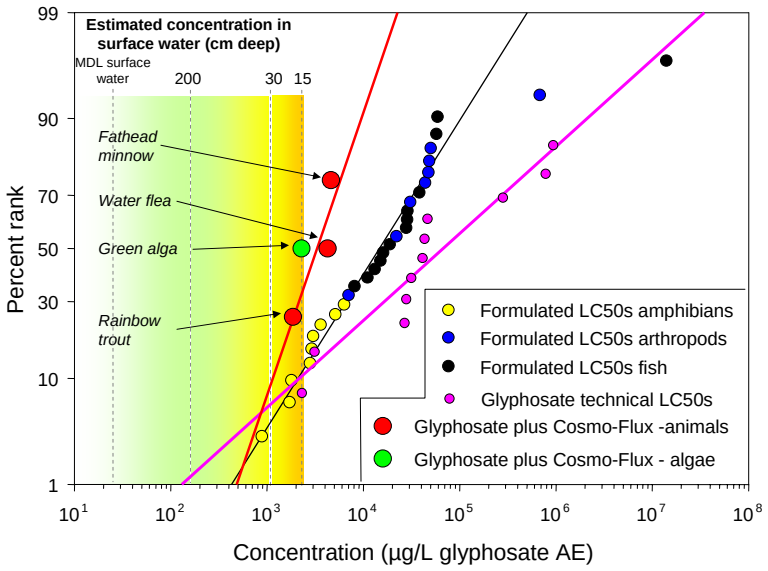


HUMAN RISK ASSESSMENT



Margin of exposure is protective for all sources of contamination and is even lower because acute exposures are compared to chronic effect doses

ENVIRONMENTAL RISK



HUMAN HEALTH CONCLUSIONS

IMPACTS	INTENSITY SCORE	RECOVERY SCORE	FREQUENCY %	IMPACT SCORE	% IMPACT
Clear cutting and burning	5	3	3	45	**16.7**
Planting the coca or poppy	0	1	100	0	**0.0**
Fertilizer inputs	0	0.5	10	0	**0.0**
Pesticide inputs	5	3	10	150	**55.5**
Eradication spray	**<0.1**	**0**	**1**	**<0.1**	**<0.1**
Processing and refining	5	3	5	75	**27.8**

ENVIRONMENTAL CONCLUSIONS

IMPACTS	INTENSITY SCORE	RECOVERY TIME (Y)	IMPACT SCORE	% IMPACT
Clear cutting and burning	5	60	300	**97.6**
Planting the coca or poppy	1	4	4	**1.3**
Fertilizer inputs	1	0.5	0.5	**0.2**
Pesticide inputs	2	0.5	1	**0.3**
Eradication spray	**1**	**0.5**	**0.5**	**0.2**
Processing and refining	2	1	2	**0.7**

RECOMMENDATIONS FOR CURRENT PRACTICES

Practice	Benefit of continuance	Rank
Mixer-loader, worker, and environmental protection in storage, mixing, and loading operations.	Protection of the humans and the environment from excessive exposures.	5
Use of state of art application technology.	Accurate records of location and areas sprayed	5
Replace the respirator worn by the mixer-loader with a full face shield to reduce the potential exposure of the eyes.	Reduce the risk of splashes of concentrated formulation into the eyes.	5
Use of glyphosate in the eradication program.	Risk to humans and the environment is judged to be lower than any currently-available alternatives. New candidate products should only be considered after an appropriate risk assessment has been conducted.	4

NEW RECOMMENDATIONS (1)

Recommendation	Benefit of new data	Rank
Conduct a study to identify other factors associated with time to pregnancy (TTP).	Better understand and manage human health risks.	3
Including proximity to surface waters in Geographic Information System (GIS) analysis of locations and areas of coca and poppy fields.	Better indication of likely frequency of contamination of these habitats.	2
Identify mixtures of glyphosate and adjuvants that are less toxic to aquatic organisms than the currently used mixture. The priority of this recommendation would depend on the results of the GIS analysis.	Reduction in possible environmental impacts to non-target organisms in shallow surface water environments.	2
Testing of the glyphosate-Cosmo-Flux® formulation for toxicity to amphibians.	Decrease in uncertainty regarding the toxicity to amphibians.	2

PROXIMITY TO WATER

NEW RECOMMENDATIONS (1)

Recommendation	Benefit of new data	Rank
Conduct a study to identify risk factors associated with time to pregnancy (TTP).	Better understand and manage human health risks	3
Including proximity to surface waters in Geographic Information System (GIS) analysis of locations and areas of coca and poppy fields.	Better indication of likely frequency of contamination of these habitats.	2
Identify mixtures of glyphosate and adjuvants that are less toxic to aquatic organisms than the currently used mixture. The priority of this recommendation would depend on the results of the GIS analysis.	Reduction in possible environmental impacts to non-target organisms in shallow surface water environments.	2
Testing of the glyphosate-Cosmo-Flux® formulation for toxicity to amphibians.	Decrease in uncertainty regarding the toxicity to amphibians.	2

NEW RECOMMENDATIONS (2)

Recommendation	Benefit of new data	Rank
Use of GIS to quantify areas of coca and poppy production in biodiversity hotspots.	Better understand potential effects on important sources of biodiversity from clear-cutting and planting of coca and poppy.	2
Use of GIS to quantify size of fields planted to coca and poppy and track these over time.	Allow more accurate quantification of potentially impacted areas as well as recovery.	2
Review the regulatory status of glyphosate on a regular basis.	Ensure that new testing and toxicity data on glyphosate are included in the risk assessment of its use in eradication spraying in Colombia.	2
If new mixtures are used, measurement of exposures to glyphosate in bystanders to sprays and reentry into sprayed fields.	Better characterization of human exposures under conditions of use in Colombia.	1

ACKNOWLEDGEMENTS

SAT members

Jorge Rios and Adriana Henao of the CICAD office and the Executive Secretariat of CICAD

PTG Team members

Staff of the Ministry of Foreign Affairs and Ministry of Justice of Colombia

Staff of the National Police (Antinarcoticos)

Captain James Rae