French Republic

PARLIAMENTARY OFFICE FOR SCIENTIFIC AND TECHNOLOGICAL ASSESSMENT

Pesticide use in the Antilles: current situation and perspectives for change

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Between 1972 and 1993, the use of a persistent organic pollutant in banana plantations in the Antilles, chlordecone, has had effects on the health protection of consumers, on plant growth and the natural environment of Guadeloupe and Martinique.

Public authorities have been aware of the problem since 1999, have passed a number of health protection measures and have initiated epidemiological studies on the potential effects of this situation.

It was only in 2008, however, that a consistent plan, "the chlordecone plan" comprising 40 actions to undertake, was implemented in order to coordinate the action of 7 Ministries and 15 research organisations.

I. THE FACTS

1. Production of the molecule

The first use of chlordecone

Chlordecone was first synthesised in 1951, patented in 1952 and starting in 1958 was produced in three factories in the United States, one of them in Hopewell, Virginia.

The molecule was used primarily as an agricultural pesticide.

b) *The Hopewell incident*

In July 1975, manufacturing operations at Hopewell were suspended because serious hygiene and safety failures were found in the production process.

These failures resulted in considerable pollution of the immediate surroundings of the plant and acute toxic effects were discovered among plant workers and residents in proximity.

Following this incident, the production and distribution of chlordecone were prohibited in the United States in 1976.

c) *Production resumed to meet the needs of the Antilles*

Use of the molecule was explicitly authorised in France in 1981.

It was manufactured in Brazil and formulated at 5% as Curlone by the company Calliope in the Aude Department. It was marketed in the Antilles by the company Vincent de Lagarrigue.

Production of the molecule was prohibited in France in 1991, but remaining stocks were used in the Antilles until September 1993.

2. Chlordecone: a "chemical alien"

Chlordecone is a resistant molecule, composed of carbon atoms "caged" inside chlorine atoms.

This molecular configuration gives the molecule elevated physical and chemical stability that reduces its degradation:

- the product is also **very slightly volatile** and is **heat stable**,
- **the product has a high affinity for organic matter in soil and sediments. This is why sediments are contamination vectors of fresh water and receiving sea water**.

Finally, chlordecone **accumulates in fat** and can thus concentrate in the food chain, in particular in aquatic environments.

3. Presence of the molecule in the Antilles

a) *Assessment of the extent of pollution*

Chlordecone was used in banana plantations on the two largest islands of the French Antilles (French West Indies).

The total extent of highly polluted areas accounts for only a modest part of arable land (8 and 9% on the two islands) but if we add moderately contaminated areas, this figure jumps to one quarter of arable surfaces:

CONTAMINATION DES SOLS

	Surface agricole utile (ha)	Surfaces en bananeraies pendant les années 1970 à 1993 (ha)	Surface moyennement à fortement contaminée* (ha) % SAU	Surface fortement contaminée (ha) ** % SAU
GUADELOUPE	34500	6570	5200 (15 %)	3100 (9%)
MARTINIQUE	32000	12400	6200 (19 %)	2510 (8%)

*Sols présentant des concentrations > 0.25 mg CLD/kg, seuil garantissant une teneur dans les végétaux < 0.05 mg/kg
**Sols présentant des concentrations > 1 mg CLD/kg, seuil garantissant une teneur dans les végétaux < 0.20 mg/kg

b) *Behaviour of the molecule in the environment*

The behaviour of the molecule in the environment results from its properties:

- it has a high propensity for retention in soil,
- if it subjected to only slight runoff in theory, but intense tropical rains can carry away large quantities of organic matter,
- and its principal theoretical paths of evacuation are extraction by plants and transfer by leaching soils toward the water table and watercourses.

This widespread distribution may vary depending on soil type. Some clays, called andosols, have a highly pronounced fracture structure (surface of 100 to 600 m² for 1 g of material) that traps the molecule.

These soils consequently release the molecule into the environment much more slowly.

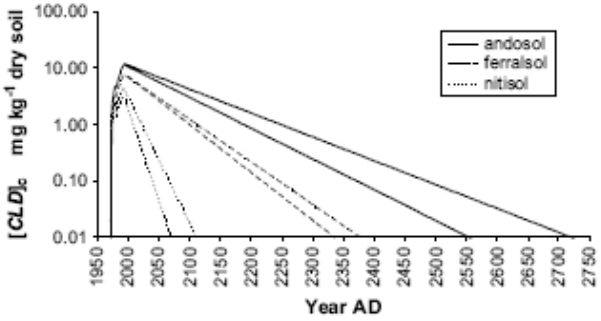
c) *Retention in soil lasting centuries*

A model recently refined by researchers at the INRA (National Agricultural Research Institute) and the CIRAD (Centre for International Cooperation in Agriculture Research for Development) has shown that in plantations with continuous use of chlordecone from 1972 to 1993, the molecule will remain in the soil for:

→ 60 to 100 years in nitisols;

→ 3 to 4 centuries in ferralsols;

→ and 5 to 7 centuries in andosols.



II. A TROUBLING FINDING: CHLORDECONE HAS DISAPPEARED FROM GLOBAL CONTROL PLANS AND SURVEILLANCE

Attention to the presence of chlordecone in the Antilles has masked an important fact: the molecule has also been widely used worldwide.

1. Assessment attempt: the search for lost chlordecone

a) *The quantity of chlordecone produced from 1958 to 1991*

According to the report of the persistent organic pollutants commission of the United Nations Environment Programme (UNEP), **1600 tonnes of chlordecone** were produced in the United States from 1958 to 1976.

Information gathered indicate that **200 tonnes** of active substance were produced in Brazil from 1981 to 1991.

Total of 1800 tonnes

It is known that about 300 tonnes (120 tonnes from 1972 to 1976 imported from the United States and 180 tonnes manufactured in Brazil from 1981 to 1991) were used in the Antilles.

Where are the remaining 1500 tonnes?

b) *Geographic areas of chlordecone use*

Use in North America was very low.

Information gathered showed that more than 90% of the chlordecone produced in the United States (1600 tonnes) were exported.

In particular:

- to Latin America where it was used to combat banana weevils, but to a lesser extent than in the Antilles since climatic conditions did not make this pest a priority;
- in Africa: Cameroon and Ivory Coast;

- and more massively in Germany and Eastern Europe.

Before 1976, the German company **Spieβ und Sohn** imported large quantities of a preparation called Kelevane containing 80% chlordecone, to combat potato pests. A part of this was re-exported to Eastern Europe (former East Germany, Poland and the USSR including Ukraine).

Kelevane degrades to chlordecone in soil.

It was prohibited in West Germany in 1980 and in East Germany in 1983.

The management of the company that succeeded Spieβ und Sohn (Spieβ Urania) refused to meet investigators and so no further information is available.

They nevertheless alerted German federal and parliamentary authorities on this question.

2. An environmental issue at the global scale?

Chlordecone diffuses slowly into soil towards watercourses and groundwater and eventually into sea water.

It is taken up by crops to varying extents.

The molecule, has recently been included on the list of persistent organic pollutants by the Stockholm Convention, has not been produced since 1991.

Since it is no longer produced (as attested by declarations of about 40 countries to the FAO), it is not monitored.

We are thus potentially in the presence of a harmful active substance that will continue to spread for another century and whose potential harmful effects have not been studied (except in the Antilles).

We could thus one day be faced with a global environment problem requiring international cooperation.

III. EVALUATION OF THE SCIENTIFIC ASPECT OF THE "CHLORDECONE PLAN"

The "Chlordecone Plan" comprises 40 actions revolving around four major topics:

- increase understanding of the environment,

- reduce exposure of populations,

- provide healthful food and manage contamin-ated environments,

- and ensure communication of implementation of the plan by encouraging international cooperation.

There are a number of research programmes co-ordinated with this plan, whose evaluations are briefly describe below.

1. Detailed mapping of pollution must be resumed

a) *The soil pollution map*

Soil pollution status was assessed by modelling conducted in 2004.

This mapping is 97% effective for the most highly polluted soils, but:

- in Martinique where pollution is more diffuse, samples taken by the Chamber of Agriculture found 23% of plots polluted to varying degrees and that were located outside traditional banana growing areas,
- available data (5000 in Martinique, 3500 in Guadeloupe) are not digitised and are depicted with various geo-reference systems,
- by 2013, about 4000 analyses are planned for each island to extend the body of data.

The preparation of formal conditions to consolidate, reference and digitise these data must be accelerated.

b) *Pollution of continental waters and marine environments*

The determination of pollution of river water, underground water and marine environments is relatively incomplete. In addition, there are very few data on river sediments and alluvial fans, while sediments are the principal vectors of contamination.

2. The system of analyses must be improved

It is essential for the analysis system to be reliable, for both research purposes and health protection.

a) *The search for greater reliability*

The detection and quantification of chlordecone in various solid matrices (soil, plants, animals) is a difficult process.

It creates divergent interpretations and is characterised by high margins of uncertainty (20 to 35% depending on the matrix and the quantity of pollutant in samples).

Efforts have been made to increase reliability and this work must be continued.

b) *Development of more rapid and less costly analysis systems*

SPME (Solid Phase Macro Extraction) provides rapid results with solid matrices and also avoids extraction phase costs.

This method is useful, however, only for very small samples (< 100 µg).

It would be desirable for researchers involved to respond to the ANR (National Research Agency) project calls on the metrology of pollutants.

3. Research on the behaviour of the molecule in the environment must be continued and extended

a) *Research on the transfer of chlordecone from the soil to other environment sectors*

Considerable research has been and is being conducted in this area:

- the study of the University of the Antilles and Guyana have shown undeniable contamination of the fauna inhabiting continental waters,
- the current study of the CEMAGREF (Centres for the Study of Agricultural Automation and Rural Engineering of Waters) on transfers from catchment basins to the sea,
- ongoing "Chlordexpo" studies conducted in particular by the INRA-CIRAD on behaviour of the molecule in soil and its transfer to aquatic environments.

b) *Defining the universal presence of the molecule in other environments*

There are three priority environment sectors concerned:

. Water tables

They are under-used, especially in Martinique, although considerable increases in daily drinking water consumption are predicted between now and 2015 (70,000 m^3/day more compared to current consumption of about 120,000 m^3/day).

It would thus seem necessary to encourage the BRGM (Geological and Mining Research Agency) project to obtain a precise determination of the pollution of this "heritage" water.

. Marine environments

The IFREMER (Institute for the Exploration and Use of the Sea) study on pollution of marine fauna has shown:

- high chlordecone concentrations in alluvial fans in the most highly affected areas,
- a close correlation between pollution and the biology of species and thus extensive contamination of saprophages (scavengers) and higher sedentary predators,
- a variable contamination of intermediate carnivores depending on the habitat zone,
- slight contamination of grinder herbivores (coral environments).

Since the sea furnishes a large part of domestic food sources in the Antilles (60% in Guadeloupe), it is urgent to develop and implement actions in this field:

- by increasing the number of analyses to render consumption safe,
- by analysing pollution dynamics and localisation in marine environments,
- by giving thought to the relevance of the maximal residue limit (20 µg/kg fresh product) that is consistent with European regulations but resulting from an independent decision by French authorities.

The health safety limit set by the AFSSA (Agency for the Health Safety of Foods) for fish is 200 µg/kg and that set by American authorities in 1976 is 300 µg/kg.

- and by transposing provisions for consumers of home-grown root vegetables in polluted zones (Family Gardens programme) to fish.

. Fish farms

Inland fish farming on the islands (in particular fresh water shrimp farms) is threatened.

It is thus desirable to determine the conditions required to ensure the longevity of these farms (fasting effect on decontamination, developing processes not in contact with the ground to prevent contamination by basin sediments).

4. Work on transfers to crops is about to enter the stage of formal standards that protect both farmers and consumers, provided the European Union "hygiene package" is applied.

Studies by the INRA and the CIRAD have led to a standard for safe cultures: for all soils containing less than 100 µg of chlordecone/kg, it is safe to grow even species that are the most sensitive to contamination (root vegetables).

This standard is based on a very safe transfer margin (5 to 1, while the average is 10 to 1), enabling the sale of products whose chlordecone content is lower than the very strict reference limits set by European regulations (20 µg/kg of fresh product).

For land with more than 100 µg/kg, a list of permissible crops - excluding root vegetables - is in the process of being proposed to farmers.

It will be necessary, however, to monitor the implementation of the European Union "hygiene package" that took effect in September 2008 that makes the farmer responsible for what he plants without requiring him to first conduct soil analyses as had been planned by Prefectoral decrees in 2003.

5. The current state of epidemiological studies and the prostate cancer polemic

a) *The TIMOUN study ("little kid" in Creole)*

The TIMOUN study analysed the neurological consequences of chlordecone impregnation of a cohort of pregnant women and newborns.

The results will be published as they are acquired (at the present time, the cohort of babies has been observed for 18 months and it is planned to continue the study until the age of 4-5 years).

b) *The **Karuprostate** study*

The occurrence of prostate cancer is highly ethnic-dependent. In 2002, its incidence standardised to the age of the world's population varied from 1.4 in China to 80 in continental France, 155 in Martinique, and between 170 (California) and 200 (Detroit) for African-Americans.

This prevalence of appearance of the pathology in certain populations does not exclude that exposure to pesticides could be an aggravating factor in general.

The Karuprostate study whose results will be published in July attempts to analyse the relationship between prostate cancer and chlordecone.

The value of this research on the comparison between a cohort of 690 men with prostate cancer and another of 710 case controls (randomly chosen) is to **be based on** – rare in environment exposure studies – **an objective factor: chlordecone contents of subjects' blood**.

c) *The polemic caused by the recent work of Prof. Belpomme*

In an article published recently in the "International Journal of Oncology", Prof. Belpomme affirmed that the rate of increase of prostate cancer is increasing more rapidly in Martinique than in continental France.

This conclusion was refuted by some scientists working on the problem. They pointed out that the calculation method used by Prof. Belpomme to establish this differential progression (regression line y = ax + b) is not recognised by the WHO International Caner Research Centre. When methods recognised by the scientific community are applied, the numbers obtained are relatively close:

- 5.33% for 1978-2000 in continental France
- and 5.65% for 1981-2000 in Martinique.

While awaiting the results of the Karuprostate study, it is surprising that weak scientific methods were used to deal with such an important question.

6. There must be more studies on remediation of the natural environment.

Chlordecone will remain present in the soils of the Antilles for **one to seven centuries**.

It diffuses slowly toward continental waters and marine environments.

It is thus necessary to rapidly consider devoting more research to methods of decontamination.

In summary, although we can estimate that the "chlordecone plan" will lead to health and food safety for Antilles populations (provided there are more surveillance and control plans for products from marine environments), it will have to be extended beyond its planned application horizon in 2010, accompanied by more studies and actions for preserving and rehabilitating the environment.

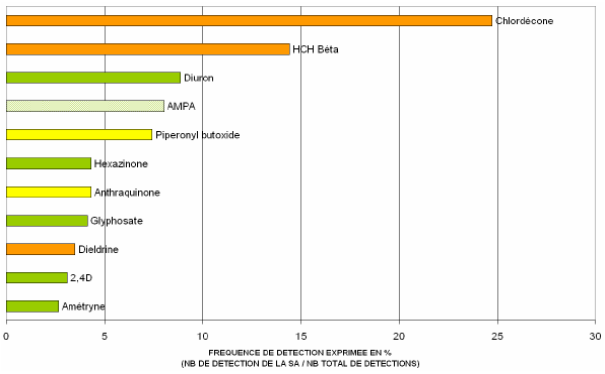
IV. EXPOSITION OF ANTILLES POPULATIONS TO OTHER PESTICIDES

The French West Indies are among the Departments where the use of pesticides has decreased the most (-60% in 10 years). This decrease is due partially to a genuine effort by the banana profession, the largest

consumer of pesticides. The statistical decrease, is, however, also due to the shrinkage of arable land (since 2000, -26% in Martinique and -37% in Guadeloupe), resulting from increased real estate construction.

What is the situation on exposure of local Antilles resident to other pesticides?

1. Confirmed environmental pollution



Surveillance conducted from 2003 to 2008 by the DIREN (Regional Environment Office) in Guadeloupe based on screening for the presence of a panel of 350 molecules, reveal the presence of 39 of these substances.

These 39 products are broken down into 49% herbicides and related metabolites, 13% organochlorine insecticides, 28% other insecticides and 10% fungicides.

Among the 17 substances present at concentrations higher than 0.1 µg/L, there are 11 herbicides or metabolites.

In particular, more than 90% of detections of glyphosate and its metabolite, AMPA, were higher than 0.1 µg/L (limit for drinking water).

Analyses campaigns in 2005-2006 in Martinique showed that pesticides are present in 80% of the water supply system (96% in continental France).

2. Exposure of foods to pesticides

This study is being conducted by the AFSSA and the results are expected not before 2010.

Before this, a first approximation of this food exposure can be made by comparing the results obtained by control and surveillance plans of Anti-Fraud Services.

At the national scale in 2007 and among 125 pesticide residues, anti-fraud investigators found that 44.5% of edible plant samples contained pesticides and residues and that 7.6% of samples were higher than authorised limits.

In Guadeloupe, the same multi-residue analyses found only one non-compliant control in 2007 (spring onions) and 2008 (green bananas).

In Martinique, only one control was positive in 2008 (parsley) and there was none in 2007.

This first approximation shows that food exposure to pesticides in the Antilles is lower than in continental France.

3. The case of paraquat

a) *Conclusions of the AFSSA*

The conclusions of the AFSSA (July 2008) were based on all studies conducted by the European Food Safety Agency that confirmed the authorisation of paraquat in 2003 and by the surveillance committee set up at this occasion.

The AFSSA concluded (July 2008):

- that the very low migration of paraquat to crops did not reveal unacceptable risks for consumers,

- and that because of its interdiction, it is not justified to determine its possible accumulation potential in soils.

b) *The glyphosate risk: a deleterious effect of interdicting paraquat and of limiting the panoply of pesticides*

The 1991 European Union Directive aimed at reducing the number of authorised molecules from about 1000 to around 300.

As desirable as this could seem at first glance, it resulted in the increased use of systemic herbicides such as glyphosate, whose spectrum of action is less precise and whose over-use creates bioresistance.

It would be a good idea to start a study on the presence of this pesticide in Antilles water supplies and its public health consequences.

V. ADAPTATION OF TROPICAL ANTILLES AGRICULTURE TO THE PLAN FOR REDUCING THE USE OF PESTICIDES

The "Eco-Phyto 2018" plan aims to reduce the use of pesticides by 50% in ten years.

French overseas Departments are within the scope of this plan.

When considering this challenge, it is to be remembered that agricultural practices in the Antilles **are very different from those of continental France:**

- **its climatic conditions** involve high temperatures and high annual precipitation (more than 4 m/years in certain zones) that are not without consequences for pesticide use,

- **a lack of alternating seasons** limits the beneficial effects of freezing temperatures on plant pests,
- **the absence of a vegetative period** (resulting in better mobilisation of fertilisers) results in a frequency of herbicide treatments that is not the same as that of temperate climates,
- **the tropical nature** of some species grown, heat and high seasonal rainfall subject crops to a much more diversified range of plant aggressions.

Taken together, these particularities are such that the use of pesticides in the Antilles cannot strictly comply with the same stipulations as those applied in Europe. Nevertheless, the French Antilles are subjected to the same rules for pesticide use as continental France and European Union member states. **It would thus be desirable that public authorities pressure the EU to implement adaptation measures included in European regulations. A joint action could be conducted with Spain and Portugal, whose overseas territories have similar problems.**

1. The "Eco-Phyto DOM" plan

This plan is composed of several sections:

. establishing suitable indicators is a task confided to the AFSSET (Agency for the Health Protection of the Environment);

. rendering technical practices safe for consumers.

The main issue to address is the lack of usage standards.

In light of the small market size of French overseas Departments and Territories, the major plant treatment companies have not had their products certified for tropical cultures.

The result of this is that 85% of agricultural uses in the Antilles are orphans.

The plan aims to find substitution products and also to implement *in situ* certifications of pesticides for tropical cultures.

. Development of research to reduce pesticide use.

Aside from controlling weed invasion by using co-culture plants and reducing the use of production factors in market gardening, this action aims to generalise the use of *in vitro* seedlings. This is because many tropical cultures are based on seedlings obtained by vegetative means, that favours the durability of plant pests.

. The development of surveillance networks for plant aggressors.

2. The "sustainable banana" plan

Although globally marginal (2% of exports), the Antilles banana economy is very important for the islands, accounting for 15,000 jobs.

This sector is threatened:

- by the open market of the European Union,
- by the progressive limitation of authorised pesticides, whereas products freely imported in the European Union (banana dollar zone) originate in areas where this use is highly permissive.

The "sustainable banana" plan is thus a response to this dual challenge in order to create a niche market.

a) *Changes in agricultural practices*

The combat against a range of aggressors, in the past based on the use of pesticides, is now being addressed by different practices to reduce the quantities of applied treatments:

- weevils are now eliminated by trapping,
- the battle against nematodes (worms) is now based on fallowing and replanting with healthy *in vitro* seedlings,
- experimenting with co-culture grasses aims to reduce the use of herbicides,
- the fight against yellow cercosporiosis has been rendered more rational (surveillance of the appearance of mould, limited airborne treatments).**If these treatments are prohibited, there may be an unexpected result if the change occurs without a transition period: less precise water cannons will require the use of twice as much treatment product for the same surface.**

b) *The search for seedlings resistant to black cercosporiosis*

This mould is much more virulent than yellow cercosporiosis, requiring more than 50 airborne treatments a year.

Originating in Latin America (Honduras, 1972), it is progressing on both sides of the Antilles arc – Porto Rico to the north (2004) and Grenada to the south (2006).

The CIRAD uses classical biotechnology techniques to produce wild-type banana hybrids resistant to black cercosporiosis but compliant with agronomic requirements and those of the supply chain.

Although the CIRAD plans on producing up to 1500 different hybrids every year, there is currently insufficient funding to establish validation indicators.

If we want to save Antilles bananas, it is important to free up resources for this action with the participation of the profession (that receives € 130 million/year from the European Union).

It would also be desirable to create a **technical banana centre** in the Antilles, similar to that for sugar cane on Reunion Island.

PROPOSALS

1. FIND THE LOST CHLORDECONE, IN PARTICULAR IN EUROPE: CONTINUE DETERMINING AREAS OF USE OF CHLORDECONE IN THE WORLD
2. CONTINUE EFFORTS TO MAKE ANALYSES MORE RELIABLE AND PROMOTE RESEARCH FOR THE DEVELOPMENT OF MORE RAPID AND LESS COSTLY ANALYSIS METHODS
3. START DEVELOPING POLLUTION MAPPING AND EXTEND IT TO CONTINENTAL WATERS AND MARINE ENVIRONMENTS
4. PREPARE THE FUTURE BY SUPPORTING WORK ON THE REMEDIATION OF NATURAL ENVIRONMENTS AND ON THE ENVIRONMENTAL BEHAVIOUR OF CHLORDECONE
5. EXTEND THE "CHLORDECONE PLAN" BY ENFORCING THE PARTS DEVOTED TO MARINE ENVIRONMENTS AND FISH FARMING
6. ESTABLISH BLOOD IMPREGNATION STANDARDS FOR THE MOST HIGHLY EXPOSED POPULATIONS
7. FURTHER ENCOURAGE THE "SUSTAINABLE BANANA" PLAN AND SUPPORT BIOTECHNOLOGIES APPLIED TO BANANAS
8. ORGANISE ACTIONS OF PUBLIC AUTHORITIES FOR THE POST-2010 TIME FRAME
9. EUROPEAN AND GLOBAL COORDINATION OF THE IDENTIFICATION OF DANGERS AND ESTABLISH REFERENCE TOXICOLOGY VALUES
10. ADAPT PESTICIDE REGULATIONS TO ANTILLES GEOGRAPHY WITHOUT REDUCING HEALTH PROTECTION REQUIREMENTS

July 2009