ANALYSIS OF PARAMETERS TO BE CONSIDERED IN ESTABLISHING PESTICIDE MAXIMUM RESIDUE LIMITS IN COLOMBIA

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ABSTRACT

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An analysis of the parameters to be considered in establishing pesticide maximum residue limits in Colombia and the application of them to residue limits of aldrin and dimethoate in potatoes is made. This analysis includes the study of parameters of two different types. The first one is those parameters which, at a given moment, due to the nature of the research done internationally, could be accepted as valid for Colombia. The second one includes those variables which, due to the available infrastructure and their specific nature, must be studied under the conditions of the country.

The suggested parameters to be accepted from an international level are: the methodology used by the Environmental Protection Agency (EPA) and by FAO/WHO in establishment of maximum residue limits; the Acceptable Daily Intake (ADI's) proposed by the Joint Meeting of FAO/WHO (JMPR) and the careful study to accept or reject the International Codex Alimentarius maximum residue limit suggestions.

The parameters analyzed under the Colombian conditions are legal and administrative ground work for pesticides; a compendium of studies on pesticide residues and available resources for this kind of work; per capita/day consumption of food; average weight of the Colombian consumer; agricultural practices used in growing potatoes; field experiments and sampling that must be done; analytical techniques in residue analysis; suggestion of the maximum residue limits for aldrin and dimethoate in potatoes.

This work is presented as a basic document that makes it possible to formulate a policy on pesticide residues and tolerances for Colombia on the basis of international research and discussion of the every-day Colombian community questions.

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INTRODUCTION

The problem of contamination is as old as mankind. From the very beginning, man has had to confront the dangers of chemical and microbiological contamination. Initially, this was the result of uncontrollable circumstances independent of any activity of man, such as the presence of micotoxins, salmonella and other microorganisms in stored food, fluorine in water and mercury in fish; later, as civilization progressed, man became the most significant source of contamination in his own environment. The poor health in cities and countryside, water pollution, food contamination by insects and rodents (which are, in turn, vectors of disease), the use of lead containers--all of these are problems and dangers that have become greater with the "Industrial Revolution," which has increased the use of coal and several different metals and has initiated new industrial techniques that can result in contamination.

Over the centuries, man discovered several substances that can be directly applied to food or crops to protect them against insects and other destructive organisms. At the same time, this discovery was the beginning of deliberate contamination using substances that were potentially toxic for man himself. This activity has grown almost exponentially over the last 50 years to the point that special programs are needed to reduce it.

As a fundamentally agricultural country Colombia cannot stay out of the debate going on today about the use of crops pesticides. Two of the main points of controversy deal with the residues that pesticides can leave on crops and the pesticide maximum residue limits on crops that make them usable without causing toxic side effects for humans.

For this reason and the fact that a program dedicated to the study of pesticide residues did not exist in the country, the author decided to present to Colombian Institute of Agriculture (ICA), a project to create an entity in charge of the implementation of this kind of work. The answer to this project was the creation of the Section of Residues and Tolerances, which belongs to the Division of Control of Agricultural Supplies. This Office started its activities in February 1977.

The first step, as it is required for this type of project, was the establishing of a laboratory for residue analysis and the training of personnel in this kind of analysis. This goal was achieved in the first two years of activity. The next step was the standardization of the analytical techniques and to carry out the research with potatoes in order to establish the maximum residue limits of aldrin and dimethoate.

Simultaneously with the foregoing work, the elaboration of the present document was started. The basic reason was the necessity to put together in a publication the parameters needed to be studied in order to establish a maximum residue limit. A tolerance setting model was the principal aspect in stating this type of work in the country. The study was organized in two main parts: 1) the review of the international information and documents dealing with residues and maximum residue limits, and 2) to gather the Colombian information and surveys together in order to extract the variables needed in establishing maximum residue limits.

The international analysis is presented at the beginning and is the consequence of an extensive review and study of documents and publications from the Environmental Protection Agency (EPA), the Food and Agricultural Organization (FAO), the World Health Organization (WHO) and the Codex Alimentarius. Reference is made also to the legislation existing in other countries and to the level of development achieved for several Latin American countries in relation to residues and maximum residue limits of pesticides.

As a result of the foregoing review, two parameters were selected to be applied in the Colombian conditions. They were the Acceptable Daily Intake (ADI) given by the

Joint Meeting FAO/WHO and the recommendations for the aldrin and dimethoate tolerances in potatoes given by the Codex Alimentarius. Also the procedure followed by EPA and FAO/WHO in establishing tolerances was recommended for the country.

With regard to the Colombian conditions, the first objective was to analyze the feasibility to implement the program of residues and maximum residue limits at a national level. This goal was followed by other objectives which include the analysis of all parameters that must be taken into account in order to calculate the maximum residue limits for aldrin and dimethoate, in potatoes.

The analysis of each parameter involved an investigation to collate the useful information needed that had been done in the country, as well as to carry out the type of research and studies that had not been done. The manner of presentation follows for each variable analyzed: presentation of the basic aspects as a background, discussion of the pertinent information and conclusion about the data needed to calculate the maximum residue limit.

The real importance of the present work is the fact that it is the first study made in residues and maximum residue limits in Colombia. The work was designed in a manner that permits clarification of concepts, establishes a base for further studies with different crops and pesticides, and is presented as a basic document for the structure. It has a solid technical base for the formation of policy and establishing regulations in the field of residues and use of pesticides in crops.

OBJECTIVES

General Objective:

Evaluate the parameters for the establishment of maximum residue limits for pesticide on food crops using as an example the crop of major human consumption and the insecticides (an organochlorine and an organophosphate) of major use in that crop.

Specific Objectives:

Analyze the international information pertaining to residues and maximum residue limits to determine those parameters that had already been studied internationally and to become familiar with the kind of work carried out by other countries and international institutions such as the Codex Alimentarius, the Food and Agricultural Organization (FAO), the World Health Organization (WHO), and the Environmental Protection Agency (EPA).

Based on the foregoing analysis, to define those procedures and data that can be extrapolated directly into the Colombian conditions and consider those aspects that must be studied in a specifically Colombian context.

Analyze each of the parameters selected for Colombia based on information already existing in the country and on surveys and research that are needed to obtain the pertinent information. The order for the analysis of these parameters will be:

1. Feasibility for implementing a residue program for the country analyzing two principle aspects:
    1.1. the legal, technical and economic policy aspects of pesticides in Colombia, and
    1.2. the studies made in residues and the existing infrastructure in the country.
2. Analysis of percapita food consumption and to prioritize food items as a base for later studies.
3. Verify from information available in the country if the average body weight of consumers (60 kg) used as international standard in calculating maximum residue limits is applicable to Colombia.
4. Analyze the agricultural practices used in growing crops of major human consumption with special emphasis on the utilization of pesticides. Three

aspects will be considered for this analysis:

4.1. general information on the crop,

4.2. official agronomic practices recommended in Colombia in order to define "good agricultural practice" in the crop selected for the present study, and

4.3. analyze the agronomic practices actually used by growers for the crop under study in order to determine the major pesticides and their methods of application in commercial plantings.

5. Select an example for the application of the analyzed parameters for which the crop of major consumption and the insecticides (one organochlorine and one organophosphate) used in that crop will be selected. This example will consist of:

5.1. design and conduct an experiment at the "Tibaitata" Research Center of the Colombian Agricultural Institute (ICA), to determine the residues of the insecticides under experimental conditions, and

5.2. sample fields of the crop to determine the residues of the insecticides under study under the conditions used by the growers.

6. Discuss the analytical methods used in determining the residues of the insecticides under study and to comment on the results.

7. Propose maximum residue limits for the selected insecticides in the crop studied based on both sets of data as applied to Colombia.

PESTICIDES

There is no clear evidence of when the first pesticide appeared on the Earth. Plinio provides the first available information around 60 B.C. when he writes about the advisability of placing the wheat seed in an extract of cypress to reduce mildew. Marco Polo is attributed with having brought pyrethrum to Europe from the Far East, and the natives of South America have been given credit for using sabadilla to control lice before the arrival of Columbus.

In 1793 ground tobacco was already being used to control plant aphids. During this same century, oil, kerosene and creosote were used as pesticides. In 1865, Paris green made its appearance and was recommended for the control of the red potato beetle. In 1886, the use of sulphur and cyanide was introduced to control scales in California. At the same time, lead arsenate was used as an overall insecticide and as a herbicide. In time, substances like fluorine, mercury, zinc, thallium, chromium and others gradually made their appearance and were recommended for use as pesticides.

The use of organic synthetic pesticides began before World War II and included dinitrophenols, carbon disulfide, methyl bromide, naphthalene and p-chlorobenzene. DDT was known in laboratories for many years, but only in 1939 were its insecticidal properties recognized. Benzene hexachloride (BHC) was recognized as an insecticide in 1940 in France and England. These discoveries brought on a new era in the use of pesticides in food production, public health and agriculture in general. They also initiated a series of research projects aimed at developing new compounds including insecticides, acaricides, fungicides, herbicides, nematocides and other pesticides to replace, as HCN did in 1916, those less efficient compounds that insects had developed a physiological resistance to.

Tables 1 and 2 quantify the consumption of pesticides in agriculture. High yields are associated with the use of pesticides; this is not surprising if you keep in mind

TABLE 1. Areas and countries in order of Pesticide Use per Ha of major crop yields

Area or country	Pesticide (g/ha)	Yield (kg/ha
Japan	10,790	5,480
Europe	1,870	3,430
United States	1,490	2,600
Latin America	220	1,970
Oceania	198	1,570
India	149	820
Africa	127	1,210

Source: (Industrial production and formulation of pesticides in developing countries, Vol. I: General principles and formulations of pesticides, Kenneth C. Walker, "International Aspects of Pesticides," United Nations, New York, 1972, p. 15).

TABLE 2. Use of insecticides in developing countries expressed in thousands of tons.

Area or country	1971	1972	1973	1975	1976	1977
Mexico	11.5	14.8	15.7	16.3	16.8	20.4
Argentina	10.0	10.1	9.9	11.0	11.4	11.9
India	20.2	24.6	32.2	41.0	47.2	55.1
Philipines	0.3	0.6	1.9	2.0	2.4	2.9
Sudan	10.5	8.6	7.7	8.0	9.0	10.0
All countries	73.1	92.9	106.4	132.2	143.0	156.4
Asia, Oceania	28.7	42.4	53.2	53.4	61.3	66.5
South America	12.9	15.3	17.6	39.0	40.0	40.7
Africa	14.4	12.6	11.2	11.7	12.8	14.5

Source: (GTZ. Pesticide Residue Problems in the Third World. A Contribution of the GTZ Residue Laboratory in Dartmstadt and its foreign activities. 179, p.9) that FAO estimates show that one-third of the food produced in the world is destroyed by pests.

The contribution made by pesticides in increasing agricultural production in recent years has also given rise to a growing concern about adverse effects, especially as regards residues present in vegetable food products and the environment. Table 3 summarizes the most frequent damage done to the environment.

TOLERANCE OR MAXIMUM RESIDUE LIMIT

The following definitions establish the scope of the meaning of these terms.

Pesticide Residue

Under the Codex Alimentarius, the term "pesticide residue" refers to any substance or substances in food for man or animals resulting from the use of a pesticide. It also includes any specified derivatives, such as degradation and conversion product, metabolites and reaction products that are considered to be of toxicological significance.

Codex Tolerance/Codex Maximum Residue Limit

For the purposes of the Codex Alimentarius, these terms mean the maximum concentration of a pesticide

TABLE 3. Potentially adverse effects of pesticides on the environment

ENVIRONMENTAL ELEMENT	POTENTIALLY ADVERSE EFFECT
1. abiotic environment	Presence of residues in the air, water and soil.
2. Plants	Presence of residues; damage due to phytotoxicity; changes in the plant (misuse of pesticides).
3. Animals	Presence of residues in domestic and wild animals; physiological effects (non-viability); mortality in wild species, mortality of beneficial insects, predators and parasites; changes in insect populations.
4. Man	Presence of residues in tissues and organs; effects of occupational exposure.
5. Food	Presence of residues.
6. Target organisms	Development of resistance.

Source: N. Van Tiel. Pesticide in Environment and Food. Environmental Quality and Safety, Vol. I., 1972.

residue that is recommended by the Codex Alimentarius to be legally permitted in or on a food commodity. The concentration is expressed as parts by weight of pesticide residue per million parts by weight of the food commodity. In general, it refers to the residue resulting from the use of a pesticide under circumstances designed to protect the food or food commodity against pest attack, and applied according to good agricultural practice.

Bases for the Establishment of Maximum Residue Limits

The description of the fundamental bases for the establishment of maximum residue limits based on the document written for this purpose by the Environmental Protection Agency (EPA) and is very similar, generally speaking, to the criteria used by the FAO/WHO Joint Meeting.

1. Principles

1.1. Considerations: To determine the amount of residue permissible in food, efforts must be made to see to it that this amount does not exceed residue incurred under "correct agricultural practice" and that the final amount of residue in food consumed on a daily basis does not go beyond the accepted amount that is safe for prolonged consumption.

The FAO/WHO Joint Meeting and the Codex Committee on Pesticide Residues define "good agricultural practices" with regard to the use of pesticides as "the officially recommended or authorized usage of pesticides under practical conditions at any stage of production, storage, transport, distribution and processing of food and other agricultural commodities, bearing in mind the variation in requirements within and between regions, and which takes into account the minimum quantities necessary to achieve adequate control, applied in a manner so as to leave a residue which is the smallest amount practicable and which is toxicologically acceptable."

1.2. Identity of Agents: Maximum residue limit is expressed, as regards the identification of chemical agents, in terms of chemical and toxicological considerations and interactions. The problem of identification is not as complex when the final residue is the parent product or when it is converted into another simple product and not, as in other cases, into a complex made up of the parent product and several metabolites. The chemical agent that must be borne in mind when regulating maximum residue limits will depend on its toxicological significance, the relative proportion in the total residue and the confidence limits of the analytical methods employed. When the components have a constant relation, it is possible to establish maximum residue limit on the basis of one simple component but all metabolites of pharmacological and toxicological importance must be considered.

1.3. Permanence of a Maximum Residue Limit: Maximum residue limit is a value derived on the basis of levels of residues, toxicological data, food consumption levels, evaluation of hazard and scientific judgement. Since tolerance is a value derived from data that can be certified and from data that come from scientific judgement, maximum residue limit can be established, suspended or changed when circumstances so demand.

2. Chemical Aspects

2.1. Data Requirements:

i. Elucidation of the chemistry of the product. This includes physical and chemical properties, information on the manufacturing process, manufacturing impurities in the technical grade product and formulations.

ii. Description of the analytical methods used in obtaining the data.

iii. Complete information on the way the product should be used. Usually, mention is made of the information provided to obtain product registration.

iv. Information on the degradation and mobility of the product after application. This includes degradation in the soil, data on any change occurring in the crop in terms of its metabolism, oxidation, hydrolysis, photolysis and mobility as a result of leaching or runoff.

v. Data on residues from field experiments that show the magnitude of the final residue in products.

vi. Data on residues in food products derived from a harvest or forage.

vii. If the residue is present in animal feed, studies must be presented on feeding and residue determination in meat, milk, fowl, eggs, etc.

2.2. <u>Interpretation of Data</u>: Data interpretation of residues is a complex and subjective process. The aim of this interpretation is to make real estimates of the residues that can appear as the result of the commercial use of a pesticide. These estimates can be made by extrapolating data obtained in a representative number of field experiments.

3. Toxicological Aspects

3.1. Data Requirements:

i. The acute oral lethal half dose (LD_{50}) of the active ingredients.

ii. Data on sub-acute dose in two species of mammals.

iii. Data on reproduction in three generations.

iv. Teratological data.

v. Data on chronic dose.

vi. Data on oncogenic potential.

vii. Mutagenicity data.

viii. Data on neurotoxicity for products that inhibit cholinesterase.

xi. Metabolic data referring to metabolism degradation and storage in tissues and organs.

3.2. Concepts Used in the Evaluation of Safety

i. No Observable Effect Level (NOEL): The NOEL is defined as the level (quantity) of a substance administered to a group of experimental animals to which those effects observed or measured at higher levels are absent and to which no significant differences between the group of animals exposed to the quantity and an unexposed control group of animals maintained under identical conditions are produced.

The NOEL is determined on the basis of four factors:

a. the substance's intrinsic potential to produce cellular change;
b. the affinity between the substance and the receptor tissue;
c. the response of the tissue being treated when it comes in contact with the product; and
d. the effectiveness of cellular and systemic reflexes to resist or modify the changes induced by the substance.

ii. Food Factor: This is defined as the percentage of the total diet made up by the food or class of foods being evaluated.

The studies done by the World Health Organization (WHO) in 1970 demonstrate the usefulness of calculating potential daily consumption of pesticide residues on the basis of average food consumption figures for each country. For instance, in the United States, the conclusion has been reached that the daily diet for an adult weighing 60 kilos is approximately 1.5 kilos. This figure is used as the standard to calculate the contribution of any one food product in the daily diet.

iii. Acceptable Daily Intake (ADI): The ADI is defined as the daily exposure level of a pesticide residue which, during the entire lifetime of man, appears to be without appreciable risk on the basis of all facts known at the time. The ADI is expressed in milligrams of the pesticide as it appears in the diet, per kilogram of body weight per day (mg/kg/day). "Without appreciable risk" means the practical certainty that no adverse effect will result even after a lifetime of exposure.

To arrive at an Acceptable Daily Intake, the following information must be available:

a. The chemical nature of the residue. Pesticides can undergo chemical changes caused by environmental factors or they can be permanently metabolized in plant and animal tissues. Even though a simple chemical is applied, the residue can be made up from several derivatives having different properties and whose exact nature can differ in animals and plants and in different crops and products.

b. The toxicity of the significant compounds that make up the residue, based on acute short-term and long-term studies in animals.

c. Knowledge of metabolism, action mechanism, and the possibility of the residue having a deleterious effect when consumed.

If this information is available, the determination can be made in animals of the daily level of consumption that has no observable effect. Using this data, an ADI can be suggested for human beings by using a suitable safety factor. The magnitude of the factor affects the numerical value of the ADI. To extrapolate the maximum dietary level causing "no effect" in experimental animals, to the ADI for people, a safety factor of 100 has received wide acceptance, as long as the necessary toxicological data is available. This factor guarantees that no substance will appear in the total human diet in a quantity calculated in long-term studies done on animals. This factor is based on the fact that man is apparently 10 times more sensitive to the action of toxic substance when compared to rats and also due to the fact that the range of human susceptibility to these substances can vary by a factor of 10.

In practice, the safety factor can vary greatly. In the United States, for example, this factor has been applied anywhere from 10 to 2,000 depending on the grade and type of toxicological information available. Most tolerances on raw agricultural products have been established using a 100-fold factor on the NOEL in long-term feeding studies. A factor of 10 has been used for pesticides that inhibit cholinesterase because the anti-cholinesterase activity factor is the most sensitive criterion of toxicity for these compounds and the one most easily determined. As a policy, the maximum residue limit for cholinesterase inhibitors does not go beyond the level demonstrated in the NOEL. In this way, one may be sure of the absence of acute hazard.

The factor of 2,000 is applied to the NOEL in sub-acute studies and when temporary maximum residue limits have been established with experimental use permits. This factor is based on a series of comparisons of the NOEL taken from 90-day studies and with NOEL taken from long-term studies, using the same chemical product. The safety factor of 2,000 for a sub-acute NOEL is calculated by multiplying the factor 100 by an additional factor of 20.

4. Tolerance Acceptability

4.1. Determination: The following steps must be followed when accepting a tolerance:

i. The NOEL, if expressed in parts per million (ppm), must be convered into mg/kg of body weight/daily, on the basis of the weight of the experimental animal and the weight of the food consumed during the day.

ii. The ADI is determined by using the right safety factor.

iii. The Maximum Permissible Intake (MPI) of residue in the daily diet is calculated using the ADI and the average weight of an adult (60 kilos).

iv. The Theoretical Maximum Residue Contribution (TMRC) to the daily diet is determined by assuming that the amount represented by the proposed tolerance must be present in the food when it is consumed. This is done by using a food factor for each region or country.

v. The contribution to the daily diet from all established tolerances for the pesticide; they are then compared with the ADI.

4.2. When the ADI value is exceeded, the usual procedure is to reject the tolerance for the use of the pesticide, although there are possibly some exceptions to this because the calculation of the theoretical maximum contribution of a residue in the diet is based on two main considerations:

i. That every food contains some level of residue when it is consumed that is equal to the maximum residue limit. For example, every onion contains 7 ppm of lindane (permissible tolerance) when consumed; the truth is that this is inexact because when the products are harvested, they generally have a residue that is less than the established tolerance. Product storage, processing and preparation usually greatly reduce the amount of residue. Consequently, a person rarely consumes a maximum of 7 ppm when he eats onions.

ii. It is assumed that every agricultural product is treated with the pesticide for which a maximum residue limit has been established. This is not a correct assumption because not every onion is treated with lindane, and it is improbable that 100% of a crop is treated with the pesticide for which the tolerance has been established.

THE INTERNATIONAL DIMENSION OF THE RESIDUE AND MAXIMUM RESIDUE LIMIT QUESTION

The problem of pesticide residues is a topic that governments are becoming increasingly concerned about, and, as a result, international organizations have been created to deal with it. This can be clearly seen in Figure 1. This interest stems from considerations made at the international level with regard to the food-pesticide chain:

1. Food products are the articles of greatest interest in international trade. Since the pesticides used in one region might appear as food residues in another region, it is important to protect the consumer's health while at the same time it is

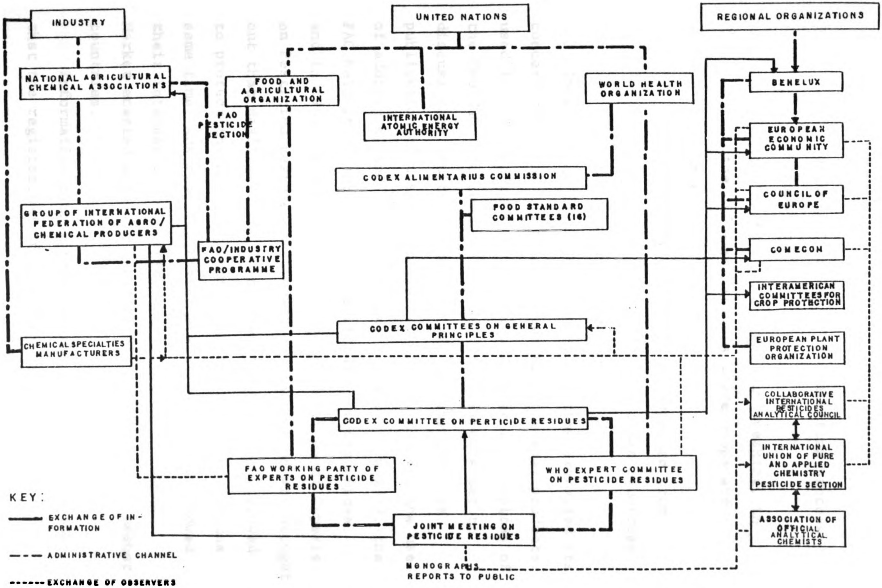


FIGURE 1. International Institutions involved with problems of residues and maximum residue limits (Kay, 1975)

essential to leave the marketing process unimpaired.

2. Pests are found, generally speaking, in the different regions where crops are grown.
3. The use of pesticides is expanded from their country of origin to other countries having similar problems.

In 1953, the Sixth World Health Meeting expressed its concern regarding the problem created by several products used in the food industry. In 1955, under the auspices of the FAO/WHO, the Committee of Nutrition Experts met to discuss food additives; out of this meeting came the publication of the FAO program on legislation and the use of additives, including pesticide residues. In 1959, the FAO held its first meeting specifically on pesticides, and in 1961, in conjunction with the Committee of Experts on Pesticide Residues of the WHO, a publication was brought out that dealt with the principles that must be followed to protect the consumer from pesticide residues. At the same time, Austria, the United States, and Canada showed their interest in this area, and the European Common Market enacted specific laws on this matter for its member countries.

Information coming from several countries indicates that the registration of a product varies significantly from one country to another. For instance, in the United States the Environmental Protection Agency (EPA) publishes a document with instructions for the registration of pesticides that has over 300 pages; the Federal Republic of Germany has 70 questions about pesticide composition, analytical methods, toxicology and crop residues that must be satisfactorily answered before a pesticide product may be registered. In Norway, on the other hand, there are only 15 questions of this type that must be answered. Japan requires long-term effects studies that must be conducted in Japan itself, even if this means repeating studies already done in other countries.

Countries also differ in terms of the legislation they have enacted to control residues in food. Countries like the United States and Canada have very detailed laws on this matter. In the U.S., responsibility for enforcing the law is shared by three agencies: the EPA--responsible for establishing tolerance; the USDA (Department of Agriculture)--responsible for seeing to it that pesticides are safely used; and the FDA (Federal Drug Administration)--responsible for controlling tolerances in food used for human and animal consumption. In the United Kingdom, pesticides are indirectly controlled by general requirements found in the Food and Drug Act which is part of the Voluntary Safety Precaution for Pesticides Plan.

There are other laws governing this matter in Austria, West Germany, Australia, Belgium, Canada, Czechoslovakia, Denmark, Finald, Holland, Luxemburg, Japan, New Zealand, Poland, Switzerland, Sweden and Russia.

As for Latin America, direct information was requested from each Latin American country in order to become more familiar with pesticide residue control programs in these countries. The answers received follow the summary of the questionnaire sent to them. The questionnaire included the following items:

1. mechanism adopted to control pesticide residues in food;
2. documents regulating maximum residue limits for pesticides in food;
3. name of the agency or institution responsible for implementing programs and action mechanisms;
4. personnel responsible for carrying out programs controlling pesticide residues in food;
5. type of facilities and equipment for residue analysis; and
6. connections the country has with the FAO Codex Alimentarius in the Pesticide Residue Program.

Republic of Ecuador

Work on agricultural pesticide residues in food began in this country in 1977 with the opening of the toxicology laboratory. There are no national tolerance standards which is why the FAO/WHO-established limits are used. The Ministry of Agriculture and Livestock is responsible for programs and activities through its Department of Agricultural Sanitation. The Department has a laboratory that is well-equiped for analyzing residues; it is located in Tumbaco. It maintains communication with the Codex Alimentarius in regard to these programs.

Republic of Paraguay

The information received indicates that there is no specific program on pesticide residues. Facilities for residue analysis are available; the country has no connection with the Codex Alimentarius.

Republic of Peru

The agencies involved in the control of pesticide residues in food are the Ministry of Health, which is responsible for control, and the Institute of Technological and Industrial Research and Technical Standards (ITINTEC).

The Ministry of Food is represented in these agencies by the Permanent Consulting Commission of the Food Sanitation Code. Decree-Law 196565 establishes that the

ITINTEC is the agency that shall maintain relations with the Codex Alimentarius. However, it seems that this agency has no laboratory to conduct residue analysis in, and up to the present time, programs are in a preliminary stage in which efforts are being made to create a Regional Coordinating Committee on Pesticide Residues with FAO/WHO advice.

Republic of Venezuela

The Environmental Control Division of the Ministry of Health and Social Welfare is in charge of pesticide residue control. Although this agency does have residue analysis laboratories, no information was provided on their work; nor was any information given on relations the country has with the Codex Alimentarius.

Republic of Chile

The work of food pesticide residue control is done by the National Health Service. The information received indicates that legislation is currently in the process of being enacted on this matter, however, it would seem that there are no laboratories for analysis and no relations maintained with the Codex Alimentarius.

Republic of El Salbador

The Department of Agricultural Chemistry of the National Center of Agricultural Technology established a research and quality control laboratory with a section devoted to food pesticide residue research. Work has been going on in this field since 1973, making this laboratory a definite leader in this area in Central America. Article 60 of Decree-Law 315 of 1973 on pesticide control, fertilizers and the use of agricultural products establishes maximum limits of pesticide residues in food coming from animal and vegetable sources. The agencies responsible for implementing these programs are the Ministry of Public Health and Social Welfare and the Ministry of Agriculture. Periodic information from the Codex Alimentarius is received regarding meetings and lists of tolerances; they are used as part of the criteria for establishing the country's own tolerances, especially as regards those products for exportation.

Republic of Guatemala

Research on pesticide residues in food is centralized in the Central American Institute of Research and Industrial Technology (ICAITI), which has its headquarters in Guatemala City; its radius of action, however, spreads to Costa Rica, El Salvador, Honduras, Nicaragua, Panama and Guatemala. The Institute was created in 1956 by the Central American Common Market countries; its aim is to apply modern technology to Central American industrialization effort. The ICAITI is an autonomous non-profit organization established by five Central American Republics. It receives technical assistance from the United Nations.

The ICAITI is developing plans and projects on the environmental effects of the use of pesticides, especially on cotton. Pesticides were studied in an early phase in which research was conducted on marine fauna in estuaries and tidelands on the Southern coast of Guatemala in order to determine the existence of pesticide residues in the fauna of this region. The second phase of this program is the service this organization provides for different companies in determining pesticide residues in various food products, principally in fats and meats coming from packers and producers. This same service is provided for tomatoes, tobacco and grains; an analysis was done to determine levels of contamination in several food products in Guatemala and El Salvador.

Republic of Mexico

The agency responsible for the control of pesticide residues in food is the Department of Agriculture through its Department of Pesticides of the Office of Plant Sanitation. In Mexico, a new system has been introduced for determining the maximum residue limits; it is called the Inter-American System and is established between Mexico, the United States and Canada. Its aim is to facilitate the exchange and marketing of food products with North America. To carry out this plan, the personnel analyzing residues receive training in the United States, and the techniques used in the system have been approved and learned in the U.S.; thus, the products exported comply with the established standards of the importing country.

Republic of Brazil

In this country, the policy on pesticide residue control is jointly handled by the Ministries of Agriculture and Health through the Instituto Biologico (Biological Institute) of Sao Paulo (UNDP/FAO/WHO/BTA-67-524). Several of the Institute's activities include: toxicological tests done on laboratory animals for new pesticides and new formulations; the evaluation of toxicological data to establish Acceptable Daily Intakes and maximum residue limits; the analysis of residues in food and biological material; the metabolism of pesticides, including radio-isotope techniques; chemical and physical analysis of pesticide formulations; field testing of efficacy tests for combatting agricultural pests; and training of personnel. Brazil also has an Inter-Ministerial Multi-Disciplinary Committee that evalues pesticides and establishes maximum residue limits of pesticides in food.

Republic of Argentina

Although no answer was received from this country in regards to the questionnaire sent out, it is widely known that Argentina is one of the pioneering countries in Latin America in the field of pesticide residues in food. It has established its own maximum residue limits, has control laboratories and actively participates in the FAO/WHO Joint Meetings and in the Codex Alimentarius Conference.

No other information on the control of pesticide residues in food was available for the rest of Latin America. It is apparent from the information available that in most countries some type of legislation has been enacted regarding the use of pesticides. In most cases, one or more control measures and procedures have been implemented in these countries.

PRINCIPAL INTERNATIONAL ORGANIZATIONS ON RESIDUES AND MAXIMUM RESIDUE LIMITS

Internationally speaking, besides the EPA procedure described in the foregoing pages, there are two other organizations which are of importance to this paper; they are the Codex Alimentarius and the Joint Meeting of FAO/WHO (JMPR). The first organization is responsible for implementing a policy on residues and tolerances worldwide. The second one conducts scientific evaluation and studies of the information received as the basis for establishing maximum permissible limits of residues.

Codex Alimentarius

This Commission was created in 1962 by the FAO/WHO with the aim of "protecting" the health of consumers and safeguarding food commerce with proper health standards. Its objective was also to promote the coordination of all work done on food standards by international, governmental and non-governmental organizations. It works to determine priorities, initiate and direct the preparation of standards with the help of organizations working in this field, and publishes and recommends these standards for specific regions or for international use.

The Codex Alimentarius Commission set up committees for most food groups, such as a committee for dairy products, oils and fats, and areas common to all food groups which includes the Codex Alimentarius Committee on Pesticide Residues (CCPR) established in 1963. The committee is responsible for international regulation of pesticide residues in food. The CCPR, like other Codex Committees, is "sponsored" by the government of the country that must appoint the chairman of the meetings and other leaders, in addition to inviting other members to the meetings. Meetings are held annually and are attended by the member countries of the FAO and WHO. CCPR headquarters are located in Norway.

As the Codex philosophy has it, the main function of the CCPR is to establish international maximum residue limits for pesticide residues in specific foods. The structure of the Codex provides a means for these standards to be established; this is a form having 10 basic points that gives countries an opportunity to comment on proposed standards (points 3-6) and to accept or reject them (point 9).

The points on the form are:

Point 1.

The Commission decides on working out the Codex standard and assigns the task of doing the actual work on the standard to one of the committees.

Point 2.

The committee or institution chosen prepares a proposed standard, taking into account the work previously done in this area by international agencies. The work committee head sends the draft of the proposal to the Commission Secretariat.

Point 3.

The Secretary of the Commission sends the proposed standard to the member states and the FAO and WHO members and to international organizations working in this field so that all of them can send the Commission their comments on the proposal.

Point 4.

The Secretary of the Commission sends the comments received to the working groups and to other related groups; these groups have the power to consider the comments and approve the proposal if they find it suitable.

Point 5.

The proposed standard is then submitted by the Secretariat to the Commission for its approval. The Commission may, at its discretion, send the proposed standard to a special group before approving it, or it may put the working group in charge of carrying out steps 5, 7 and 8 of this procedure.

Point 6.

The Secretary of the Commission sends the draft proposal to all member states or members of the FAO and WHO and other international organizations involved in this type of work so that they may comment on the proposal.

Point 7.

The Secretary of the Commission sends the comments received to the working group, which has the power to consider the comments and approve the draft proposal.

Point 8.

The Secretary of the Commission submits the draft of the standard to the Commission for its adoption as a recommendation.

Point 9.

The recommended standard is sent to the member states and the FAO and WHO members and all international organizations working in this field.

Point 10.

The recommended standard is published in the Codex Alimentarius as a worldwide Codex standard that has been established by the Commission on the basis of the acceptance of it.

Once a country has accepted a standard proposed by the Codex, it binds itself to allow the free distribution of the product within its borders as long as the product complies with established requirements. It also binds itself to applying the standard impartially to both national and imported products.

If a country cannot accept a standard recommended by the Codex, it must inform the Commission of the following items: 1) if the product for which the standard has been recommended can be freely distributed within the country, and 2) to what degree its current or proposed requirements differ from the standard and, if possible, the reasons for these differences.

The Codex system depends on countries in terms of compliance with the provisions of the recommendations. Figure 2 illustrates the way in which the CCPR works.

FAO/WHO Joint Meeting

Every year since 1966, the Joint Meeting of the Committee of Experts on Pesticide Residues of the WHO, and the Working Group of Experts on Pesticide Residues of the FAO (also called the Joint Meeting FAO/WHO on Pesticide Residues, or simply the Joint Meeting), has its two-week meetings. These meetings have been held in Geneva and Rome. This Joint Meeting carries out the scientific work for the CCPR. These committees are composed of expert scientists who are appointed by the Directors General of WHO and FAO in behalf of their individual capacities, not as national representatives. They have the competence in evaluating ADI's of pesticide residues and establishing maximum residue limits on foods, based on good agricultural practices when checked against the acceptable daily intake and methods of analysis.

From each meeting there is a report which summarize the conclusions and recommendations on the evaluation done on different chemical pesticides. There are supplementary volumes containing monographs of evaluation,

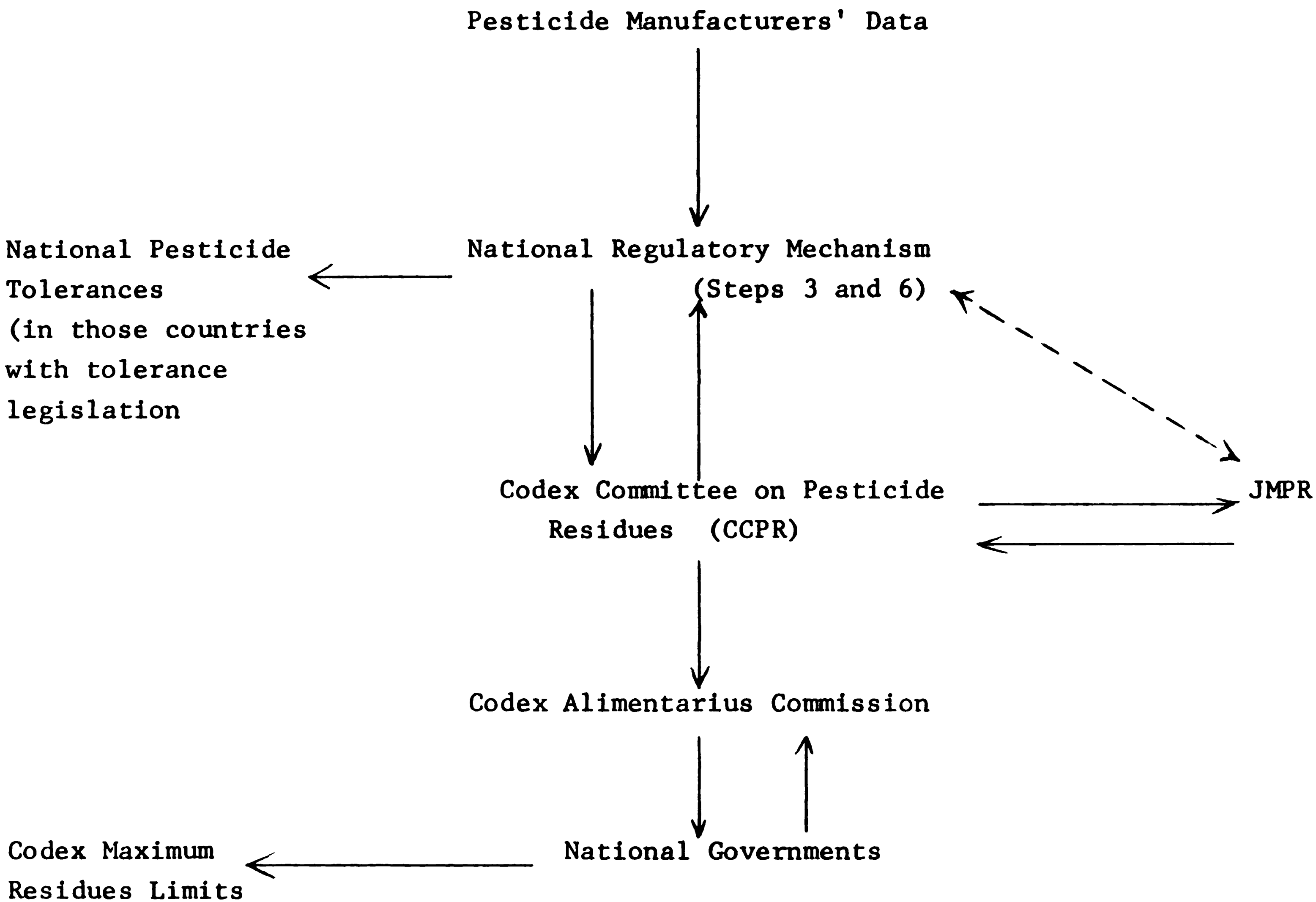


FIGURE 2. The CCPR procedure for establishing international tolerances (Kay, 1975)

commentaries, acceptable daily intakes and recommendations of residue limits in different foods. There are also summaries of toxicological studies and chemical data on all of the pesticides studied during the meeting.

In order to recommend an ADI, the JMPR generally requires six types of data:

1. biochemical studies: absorption, distribution, excretion, biotransformation and effects on enzymes and other biochemical parameters;
2. special studies: reproduction, carcinogenicity, mutagenicity and neurotoxicity potentiation;
3. acute toxicity studies: LD50's and other studies mainly involving single doses in several species of experimental animals;
4. short term studies: periodic administration of the pesticide for usually three months in rodents and 1-2 years in dogs or monkeys;
5. long term studies: administration of the pesticide over half the life span of the animal usually 80 weeks in mice, two years in rats, five years in dogs; and
6. observations in man: including volunteers, occupational works and accidental poisoning.

In making recommendations on residue limits the JMPR acts on the basis of five kinds of data:

1. use pattern: preharvest, postharvest treatment, and other uses; a general summary of the range of crops treated; the extent of these uses; and the number of countries involved;
2. residue resulting from supervised trials: this is to assess the levels of residues likely to occur after using the pesticide under the conditions that will control pests;
3. fate of residues: in farm animals and in plants, and the levels of residues in food at the time of consumption;
4. methods of residue analysis: to ensure the soundness of the data being reviewed and to evaluate the method of analysis for its use in eventual legislation; and
5. national pesticides tolerances.

Vettorazzi (1975) presents a review of the manner in which the JMPR operates. According to this document "the assessment of the toxicity of a pesticide chemical as carried out by the Joint Meeting should be thought of as a complex process having a dynamic rather than static character since new facts may at any time challenge the results of previous evaluations. This is particularly true with regard to the assessment of the toxicity of these pesticide chemicals which, because of their nature and use, need to be kept under constant review. This task has frequently required the adoption by the Joint Meeting of administrative attitudes designed to ensure the continuous awareness of parties interested in generating scientific data. The adoption of temporary ADI's and the establishment of dead lines for submission of further work are two examples of such administrative measures."

In assembling this review, Vettorazzi took as a main of information the monographs published after each meeting of JMPR particularly the sections under the heading of "Comments" and "Toxicological Evaluation" and the summaries of experimental studies from which the no-effect level has been taken.

A scientific summary generally contains the following elements: (a) designation of animal species employed in the test, (b) number of animals in test and control gropus, (c) sex, (d) identification of substance administered, (e) purpose or objective of the experiment, (f) dose level of treatment (levels in the diet as well as their equivalent in mg/kg body weight), (g) routes of administration, (h) duration of the treatment and/or of the experiment if they are different in length, (i) biological parameters examined, (j) effects observed, and (k) reference of the authors.

In assembling the review the following sequential steps were adopted: (1) to sort out those pesticides for which either an ADI or a temporary ADI has been allocated, (2) to list their common and chemical names as well as separate the compound according to tentative chemical categories, (3) to pinpoint the documents containing information related to decisions that have been taken on each compound, (4) to transcribe the no-effect level(s) indicated as having been served as a basis for establishing ADI's for man, (5) to identify the study/studies in which the no-effect level(s) has/have been demonstrated and to make reference of these studies as completely as possible, (6) to construe the safety factor employed in the extrapolation process, and (7) to indicate as many sources as possible which can supply additional information on the multifaceted process of toxicological and administrative decisions carried out by the Joint Meeting.

The elements involved in the process of toxicological evaluation of a chemical pesticide by the JMPR are:

1. no-effect level: based upon long term studies in animals or on observations on human subjects;
2. safety factor: to extrapolate from a safe level demonstrated in animals to a safe level for human intake;

3. Acceptable daily intake (ADI): the concept is based on the widely accepted fact that all chemicals are toxic but their toxicities vary markedly, not only in nature but also in amount required to produce signs of toxicity.
4. Temporary ADI: according to the provision of additional data within a stated period of time. This measure implies that the toxicological data are adequate to ensure the safety of the chemical during the time that temporary ADI applies.
5. Conditional ADI: These are given under special conditions. The JMPR has been allocated this kind of ADI for DDT and hexachlorobenzene under the condition to use suitable substitutes, and for amitrole should be restricted to where residues do not occur.

Figure 3 indicates some critical points of the operation of the JMPR in a sketchy manner.

As a result of the review done by Vettorazzi, three tables are presented here that objectively provide the toxicological information and the name of the pesticides that have been studied up to the present time.

Table 1 presents the list of chemical pesticides having ADIs established by the Joint Meeting, including

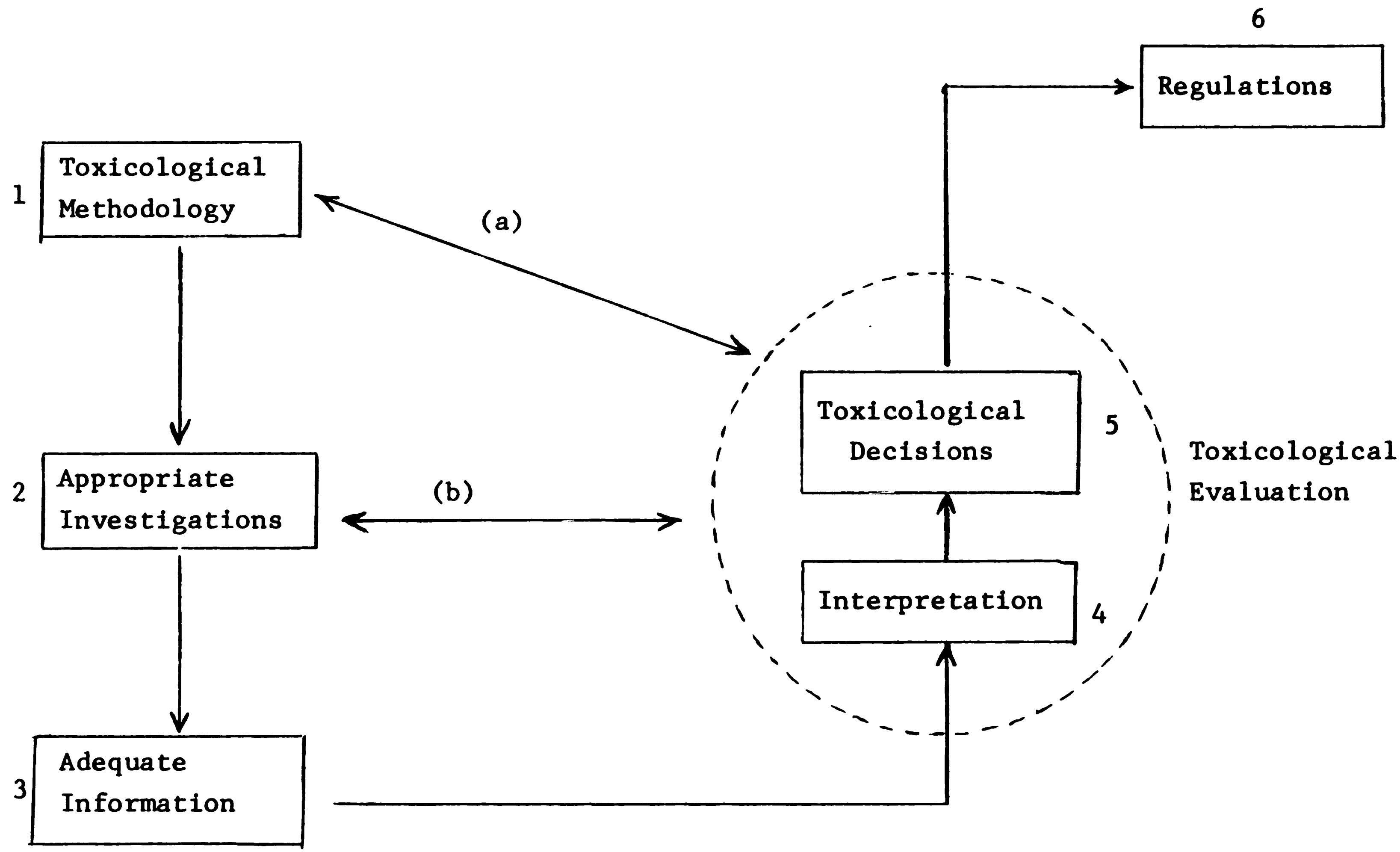


FIGURE 3. Flow diagram identifying the critical points and objectives of toxicological assessment of intentional and unintentional food additives (Vettorazzi, 1975).

those products studied in 1974 (WHO/FAO a,b). In addition, there are explanatory notes on the problems related to the group evaluation, the analytical limitations that existed when the ADIs were established and the nature of the evaluation (temporary, conditional, etc.). Information is also provided on the possible dates of the next evaluations, including detailed information on future work that the JMPR deems necessary before recommending or confirming an ADI. The overriding principle that has guided the JMPR in its evaluation of metabolites has been that the ADI is valid for the pesticide itself and its metabolites as long as the main metabolites present in the food products of plant and animal origin are identical with the main metabolites in experimental animals. If the metabolites do not comply with these specifications, the ADI will be valid only for the original pesticide (WHO/FAO, 1968a; 1974a).

Table 2 gives the chemical and common names of pesticides. The JMPR has selected the common names adopted by the International Standards Organization (ISO) for the titles of its monographs; they are marked in the table with an asterisk. All of the chemical names have been written in accordance with International Union of Pure and Applied Chemistry guidelines, as they have been interpreted and disseminated by the American Chemistry Society in its Chemical Abstracts. They are the only available rules that enable one to derive a simple name for a given compound (Lowe and Stiles, 1974).

Table 3 gives a summary of the no-effect level and other elements that the JMPR has chosen as the basis for the estimation of ADI's. This table should be interpreted in the light of the JMPR documents with their references which are found in columns 9 and 10. In construing the safety factors found in column 6, the following cases have been found:

1. The chosen no-effect level and the experimental study from which it was taken appear clearly indicated in the documents. In this case, there is a direct quotation in column 10 (example: diquat, propoxur, etc.).
2. A no-effect level has been demonstrated in only one animal (example: dicofol, methoxychlor, etc.).
3. A same level of effect has been demonstrated in more than one species of animal. In this case, the chosen safety factor is indicated in all species for which the no-effect level has been shown (example: diphenyl, aldrin/dieldrin, etc.).
4. No-effect levels have been demonstrated in more than one animal species. In this case,

the level of no effect which has been used as the basis of establishing the ADI is the one found in the most sensitive species (example: chlormequat, thiophanate-methyl, etc.).

5. A no-effect level has been demonstrated in one or more animal species and there are significant data in humans on safety levels. In this case, no-effect levels in the most sensitive animal species must be taken and the no-effect level in humans is used to lower the safety factor usually applied to animals no-effect levels (example: crufomate, disulfoton, etc.).

Safety factors have not been given for carbamodithioates, hexachlorobenzene and bromide ion. The documents themselves should be directly consulted for these compounds. The cases of folpet, captan and dimethoate-omethoate-formothion require cross consultation.

To get a clearer idea of the information presented in the preceding tables, the following section provides information on the pesticides discussed in this work: aldrin/dieldrin and dimethoate.

From the information given here we can conclude that most of the toxicological research that had been done in

TABLE 1. Listing of pesticides and their toxocological evaluation

Compound	Maximum acceptable daily intake for man (mg/kg bw)	Remarks
Aldrin/dieldrin	0.0001	The basis for the grouping is that the conversion of aldrin to dieldrin appears to be the primary metabolic step in all mammalian species studied. Consequently, the ADI is applicable to aldrin and dieldrin separately or to the sum of them if both are involved. (WHO/FAO, 1971b)
Dimethoate	0.02	As dimethoate and its oxygen analogue expressed as dimethoate (WHO/FAO, 1973 a - Annex 1)

TABLE 2. Listing of common and chemical names for pesticides

Common name (ISO Common names unless otherwise noted)	Chemical names
Aldrin	Product containing $\nless$ 95% of (1α,4α,4$\alpha\beta$,5α,8α,8$\alpha\beta$)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonaphtalene
Dieldrin	Product containing 85% of (1aα,2β,2aα,3β,6β,6aα,7β,7aα)-3,4,5,6,9,9,-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphtalene [2,3-b] oxirene
Dimethoate	Phosphorodithioic acid, 0,0-dimethyl S- [2-(methylamino)-2-oxoethyl] ester

TABLE 3. Summary of Toxicological Data

Compound (1)	Animal species (2)	Kind of toxicological test (3)	Levels tested (4)	Levels causing no toxicological effects (5)	Safety factor employed (6)	Maximum acceptable daily intake (ADI) mg/kg bw (7)	Brief indication of effects (8)	Refrences (9)	Remarks (10)
Aldrin / dieldrin	Rat	2 yr	0,0.5,2,10, 50,100,150 ppm	0.5 ppm in the diet(0.025 mg/kg bw)	>200	0.0001	Microscopic lesions in the liver; increased mortality rates and liver /body weight ratios were increased	Fitzhugh and Nelson,1963; WHO/FAO, 1976b	See also WHO/FAO, 1971a,p.15
	Dog	68 wk	0,1,3 ppm	1 ppm in the diet (0.025 mg/kg bw) (questionable effects)	>200		Increase in liver/body weight ratios	Treon and Cleveland 1955	
Dimethoate	Man	4 wk 14,59 day	0,0.04.0.13, 0.25 mg/kg bw/day, and 0,5,15,30,40, 60 mg/kg person/day	0.2 mg/kg bw/day	10	0.02	No significant change in blood cholinesterase activity	Sanderson and Edson, 1964; Edson et.al. 1967; WHO /FAO,1965b 1968b	"The findings now available from man provide a satisfactory basis for assessment" WHO/FAO, 1968b, p.120

aldrin, dieldrin and dimethoate is reported in the monographs of the JMPR. The relevant toxicological data included in this material had been summarized in Vettorazzi's review which presents a updated picture of the most important decision of the JMPR. This review can be considered as a basic document from which the ADI's to calculate the maximum residue limit for the insecticides in study can be taken.

Beside the above considerations, we must take into account the high scientific standards and the responsible work that the JMPR does in making the decision based on the Toxicological Evaluation of the pesticides.

Other International Organizations

These organizations can be divided into two groups:

1. those interested in establishing maximum residue limits and methods of analysis for regions, and
2. those interested in the coordination application of existing data and techniques related to pesticide residues.

Among the first type of organizations are:

1. The European Economic Community (EEC). Created in 1964 as a result of the EEC's decision to set up committees in order to establish maximum residue limits and accept

analytical methods that were legally recognized by the member countries in an effort to facilitate trade in foodstuffs such as vegetables, fruits, unrefined grains and animal products.

2. The European Council, which was established in 1949 as the first political institution of the post-World Ware era. It currently has 17 members. Since 1956, the Council has been working on pesticide hazards to human health. In 1960, it sponsored studies on residues and acceptable daily intakes; with the establishment of the Codex Alimentarius, the Council dropped this type of work. Today, it concentrates its efforts in this field on pesticide publicity and labelling, and other aspects not dealt with by the Codex.

Among the second type of organizations are:

1. Programs of Cooperation between the FAO and industry. These programs promote the exchange of ideas between industry and developing countries with regard to modern methods and suitable policies for the safe use of pesticides in agriculture. This program

operates mainly by means of regional seminars on pesticide production and use, and also on safety measures in the manufacture, handling, application, transportation and storage of pesticides. The Programs work with the Codex in marketing vegetable food products.

2. The German Agency for Technical Cooperation (GTZ). This Agency is interested in the environmental problems of Third World countries; for this reason, it created a specific program in 1973 in which the problems of pesticide residues in developing countries were to be studied and solutions to them sought. At present the Agency has projects in Algeria, Colombia, Egypt, El Salvador, the Philippines, India, Indonesia, Iran, Irak, Jordan, Morocco, Nicaragua, Nigeria, the Dominican Republic, Sri Lanka, the Sudan, Thailand, Tanzania, Togo, Tunisia, Turkey, and Uruguay. In these countries, the Agency is working on such things as planning and establishing laboratories, planning and implementing analysis programs to determine residues, organizing training programs, and providing advisory services on legislation and extension services in rural areas.

3. The International Union of Pure and Applied Chemistry. This organization advises international agencies on the standardization of analytical techniques; it has established a section of pesticides for this purpose.
4. Bilateral agreements are established between countries to monitor imported foods in terms of the presence of pesticide residues to avoid importer rejection of the food products. The maximum residue limits controlled by these agreements are the tolerance values adopted by the importers.

PARAMETERS THAT MUST BE CONSIDERED IN THE STUDY OF RESIDUES AND IN THE ESTABLISHMENT OF MAXIMUM RESIDUE LIMITS IN COLOMBIA

This section groups together those aspects of this question that are peculiar to each region or country due to the variability of each area. The parameters that must be considered are listed below.

1. Feasibility for Implementing a Residue Program for the Country

   1.1. Analysis of the Legal, Technical, and Economic Facts of Pesticide Policies: The national policy on pesticide use and its implications has a broad legislative groundwork. It involves several government agencies and sectors and, without diminishing technical autonomy, it adequately standardizes the trade in and use of agro-chemicals. When compared to similar policies adopted in other American countries or even to those adopted in other parts of the world, the Colombian policy is better than many of them because it is feasible to implement it and it does embrace important concepts; nevertheless, it does contain several negative and confusing points.

1.1.1. Pesticide Legislation: Before 1968, government intervention in the field of pesticides and other agro-chemical inputs was carried out by the Ministry of Agriculture with much good will but limited efficiency and effectiveness. Decree 557 of 1957 was the first practical measure taken in this area. The Decree established "the registration of pesticides used in agriculture," setting up minimum manufacturing requirements and a certificate with "the respective consular visa" on the free sale of the product in the country of origin. At the end of 1967, this Decree was repealed by Decree 779, which established, for the first time, the EFFICIENCY CERTIFICATE requirement. The CERTIFICATE was to be issued by a government or private agency especially authorized to do this. The Decree also established more specific definitions and toxicological requirements to be established by the Ministry of Health, as well as technical norms to be established by the Ministry of Development. The provisions of Decree 779 also established the idea of shared responsibility so that no decision would come from one person alone.

At the end of 1968, the Colombian agricultural sector underwent an entire restructuring established in Decree 2420. The standards created by Decree 779 were replaced by the provisions of Decree 843, 1969, "whereby the fertilizer, soil conditioners, animal feed, pesticide defoliant, physiological plant regulators, drugs and biological products for veterinary use industries are regulated." With this

Decree, the government establishes a complete series of regulations that included Resolution 108, 1974, issued by the Ministry of Agriculture. This Resolution "established regulations for the use of pesticides in animal and vegetable products." This Resolution also gave ICA the power to adopt the necessary regulations to place pesticides in categories: those pesticides thought to be toxicologically safe; those pesticides free from maximum residue limits; and those pesticides for which maximum residue limits must be established. Thus, in 1974, ICA issued Resolution 654, which established certain maximum residue limits for a large number of insecticides used for tobacco. These tolerances were the same ones used by the FDA. <u>Agricultural Topics</u> No. 135, 1978, contains the other measures taken in this field.

Colombian legislation in this area will take on another dimension with the adoption of Law 007, 1979 passed by the Colombian Congress.

1.1.2. The Pesticide Industry: The pesticide industry emerged in the 1950's. The first plant was established in Barranquilla in 1953. The work done by the plant was to physically mix active and inert materials.

The industry grew slowly but steadily, despite certain difficulties. Nineteen-Hundred and Sixty Three was an important year for this industry for it was in that year that the importation of most of the finished pesticides was substituted by national formulation. The government stimulated this sector by establishing 30% protective tariffs on finished pesticide products.

The decade of the 1960's saw tremendous expansion in this sector. All solvents and most emulsifiers and other inert ingredients were produced in Colombia. In 1964, the production or synthesis of fungicides from the bisdithiocarbamate group was begun, along with the production of herbicides such as diuron and propanile.

At present, there are 26 companies formulating and distributing pesticides in Colombia. Their work and operations are based on concessions or patents they have obtained from U.S., European and Japanese firms.

In regard to specifications and technical norms, local production is regulated by international standards. The high quality of pesticides formulated in Colombia has enabled them to be accepted in U.S., Taiwanese, Japanese, Brazilian and other markets; this is in addition to meeting local consumption needs which are estimated to be between 20,000 and 25,000 tons of active ingredients worth approximately 100-125 million dollars. The Colombian pesticide market represents almost half of the total consumption of Andean Pact countries. The production and consumption of pesticides in Colombia involves more than 100 active ingredients in close to 900 commercial formulations; 50% of them are for insecticides and 25% for herbicides.

1.1.3. The Use of Pesticides: Pesticide use in Colombia is a professional type of activity carried out under strict government norms. Unlike other countries, pesticides in Colombia can only be prescribed by professionals, no aerial spraying can be done without the authorization or prescription of a professional. The extent of aerial pesticide spraying in Colombia can be seen in the fact that there are approximately 300 aircraft for this purpose, and 3-4 million hectares are sprayed annually.

Laws established strict parameters for providing agricultural technical assistance. They establish obligatory civil liability and limit the amount of area of each crop that one professional may have under his control and work on.

Agri-businessmen must contract technical assistance; this requirement is complied with because it is an essential requirement for obtaining agricultural credit or government financing. More detailed information on the standardized use of pesticides in Colombia may be found in Volume XXXI, No. 10, 1979 of the magazine Nueva Agricultura Tropical.

1.2. Studies Conducted in Colombia on Residues and the Resources Available for the Analysis of these Residues: Up to the present, studies done on pesticide residues have focused on detecting residues in food products and not on the establishment of maximum residue limits. Most of this analytical work has been done by the Institute of Technological Research (IIT). The other studies done have been graduate theses done by students from the ICA Graduate School - National University and other universities in Colombia. There follows here a summary of the results obtained from these studies.

1.2.1. Institute of Technological Research (IIT): Studies have been conducted on the determination of residues in the products sold in the marketplace in Bogota. The results of this study are found in Table 4.

1.2.2. Masters thesis done in the ICA Graduate School - National University program on pesticide residues in tomato crops in the Valle del Cauca area (1975): A survey was done in this study on the utilization of pesticides in this crop; then the residues themselves were analyzed. The

TABLE 4. Summary of residue data of organochlorides obtained from different food products

Products (number of samples analyzed)	Endrin (ppm)			Dieldrin (ppm)			DDT (ppm)			Heptachlor (ppm)			Chlordane (ppm)			Toxaphene (ppm)		
	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA
Potatoes (100)	.01	*	.20	.03	.10	.10	.02			.02	.05	0	.01	.30	.30		*	.10
Tomatoes (125)	.02	*	.02	.01	*	*	.01			.02	.02	.02	.03	.10	.10	NO	*	.01
Corn (25)	NO	*		.08	.02	0	.01	*	*	.01	0	.02			*	NO	.50	*
Corn flour (25)	NO	*	.02		*	.02	.01	*	*	.01	.02	0		.02	*	NO		
Beans (50)	.006		.10	.007	.02	0	.04	*	7	.009		.01	.01	.20	.30	NO		.10
Rice (50)	NO	.02	.01		.02	.05	.03	*	*	.009			.005	.02	*	NO		
Beef (25)	.04	*	*	.08	.20	*	.14	7	7	.17	.20	0	.03	.05	*	NO		
Pork (25)	NO			.11	.20	*	1.83	7	7	.02	.20	0	.06	.05		NO		
Chicken (25)	.04	1.0	*	.42	.20	*	.93	7	*	.02	.20	0	.08	.05	*			
Milk (50)	.08	.02		.65	.15			1.25		.11	.15		.11	.15	0	.32	.50	
Butter (25)	NO	.02		.25	.15	*	1.15	1.25	*	.03	.15	0	.18	.05	*	NO		

TABLE 4. (cont.)

Products (number of sample analyzed)	Endrin (ppm)			Dieldrin (ppm)			DDT (ppm)			Heptachlor (ppm)			Chlordane (ppm)			Toxaphene (ppm)		
	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA	IIT	FAO WHO	FDA
Cheese (25)	NO	.02		.19	.15	*	1.48	1.25	*	.04	.15	0	.12	.05	*	NO		
Eggs (50)	.003	.20		.07	.10		.01	.50		.04	.05			.02		`NO		
Vegetal oil (27)	.22	.02	.01			*				.15	.02	.01	.19	.02		NO	.50	
Vegetal grease (28)	.04	*	*			*				.06			.08	*				
Animal feed (50)	.04	.02	0	.073	.02	0	.32	*	*	.006	*	0	.03	.05	.03	NO		
River fish	.01	*	*	1.79	*	*	1.79	*	*	.66	*	*	.06	*	*		*	*

* without tolerance

SOURCES: Mckormic, N.A., G.Z. Vargas. 1976. Tecnologia, Instituto Investigaciones Tecnologicas, numeros 102 y 103'.

Codex Alimentarius Commision, FAO/WHO. Alinorm 76/24. La Haya, march 3-8, 1975.

FDA tolerances.

findings of this study on the determination of residues in 74 samples analyzed are found in Table 5.

Table 5. Pesticide residues found in 74 tomato samples collected in the Valle del Cauea.

Pesticide	No. of Samples Having Residues	Average Amount of Residues (ppm)	FDA Tolerances (ppm)
Bisdithiocarbamates	47	29.7	7
Copper oxychloride	8	14.7	0
Parathion	20	0.32	1
EPN	29	2.2	3
DDT (total)	28	0.01	7
Endrin	10	0.39	0

1.2.3. <u>Graduate Thesis Done by the Chemists Ines Toro S. and Marta Pena P. in ICA, Tibaitata, 1974 as Part of the Requirements for Graduation from the National University</u>: DDT and heptachlor residues in cabbage and beets were analyzed in this study. The experimental basis of this study used three different application doses of the insecticides; the maximum dose was 2 kilograms of active ingredient per hectare. Analyses were also done on samples coming from marketplaces. The same insecticide residues were determined. The results obtained from samples taken from field test products, after having applied proper agricultural practices in growing cabbage and beets showed amounts of residues very much below the maximum residue limits established by the FAO/WHO, which are 7ppm for DDT and 0.1 for heptachlor.

The amounts found were:

Cabbage:	Highest concentration of DDT -- 0.297 ppm.
Cabbage:	Highest concentration of heptachlor -- 0.038 ppm.
Beets:	Highest concentration of DDT without metabolites -- 0.301 ppm.
Beets:	Highest concentration of heptachlor -- 0.041 ppm.

The sample taken in the marketplace yielded far lower analytical data than the data reported at the experimental level.

1.2.4. Graduate Thesis Submitted to the Universidad del Valle by Gilberto Hernan Gallego A., 1973, on Organochlorides in Agriculture Products for Human Consumption: The thesis was done in Cali, Colombia. Samples were taken in three marketplaces. The finding of the residue analyses are shown in Table 6.

Table 6. Organochloride residues found in several products sold in three marketplaces in Cali (ppb).

Product	BHC	Heptacho.	Aldrin	DDE	TDE	DDT	Endrin
Tomato	18.8	30.6		33.1	193	339	
Grapes			105*	179	44	306	
Lulo			29.6			234	
Blackberry ("mora")		81.0	76.7*				100*
Orange	20.3		15.3			88	
Potato		32.0	48.5	10.3	44.5	54.8	
Cabbage	155		230	59.5		1320	
Lettuce	26.3			22.6	22.6		

*Above FAO/WHO tolerances

1.2.5. Graduate Thesis Presented by Carlos Enrique Restrepo G. and Jose Jesus Jaramillo P. at the Universidad de Caldas, 1975: The thesis is a study of the utilization of pesticides in the horticultural zone of Villamaria. The study then takes samples and analyzes the residues present in four crops. The results obtained are found in Table 7.

Table 7. Average values of organochloride insecticide residues in four crops in the Villamaria zone (in ppm).

Crop	Aldrin	DDD	DDT	Dieldrin	Endrin	BHC	Endosulfan
Cabbage		.0348	.1424		.033	.043	
Cauliflower	.002	.029	.054	.005	.0088	.0012	
Lettuce	.0067	.0123	.0223	.0852	.1695	.0048	.0474
Carrots	.0071	.0280	.0613	.0297	.0790	.0014	
FAO/WHO Tolerance	0	none	7.0	0	0	3.0	2.0

As to the resources available for analyzing residues, there are three institutions in Colombia that have specific residue programs:

-- The Institute of Technological Research (IIT) works in residue analysis of organochlorides in food products, taking samples from marketplaces; and determines residues of pesticides in coffee samples for export for the National Federation of Coffee Growers.

-- The National Health Institute (INS) has conducted residue studies on blood serums, determined mercury in fish and in the Bay of Cartagena. It has plans to determine residues in the average family diet and to do toxicological studies on pesticides.

-- The Colombian Institute of Agriculture (ICA). This is the most recent program; it was established in 1976, and from the outset, has been oriented towards the program of establishing maximum residue limits for the conditions existing in Colombia.

The infrastructure and equipment these Institutes have provides the basis for carrying out the initial phases of determining pesticide residues. Although specific programs have yet to be created, other national institutes are interested in beginning this type of work in cooperation with others so that efforts will not be duplicated. However, there would be a certain separation of activities at the practical level. For instance, Coltabaco (the national tobacco/ cigarettes manufacturer) would be in charge of analyzing residues in the tobacco crop; the INS would be in charge of working on residues in people; the Institute of Municipal Development (INSFOPAL) would analyze water for aquaducts; universities would conduct research and studies on residues; ICA would work on residues in agricultural products and soils; thus, each institute and institution would make its own special contribution to a national residue program.

An inter-institutional group has been set up to work on residues. COLCIENCIAS (The Colombian Fund for Scientific Research and Special Projects, "Francisco Jose de Caldas") sees it as a pilot program for Colombia that will obtain the financial assistance needed to carry out different projects. The section on Residues and Tolerances from ICA has set up and coordinated this group, which is made up of the following people:

Institute	No. of Representatives
Institute of Municipal Development (INSFOPAL)	2
Colombian Tobacco Company (COLTOBACO)	2
Fumigation Company (FUMIGAX)	1
National Health Institute (INS)	3
National School of Health	1
Autonomous Regional Corporation from the Valle del Cauca (CVC)	2
Institute of Technological Research (IIT)	2
Colombian Institute of Hydrology, Meteorology and Land Adaptation (HIMAT)	1
Colombian Company of Dairy Products (CICOLAC)	1
School of Medicine, Universidad de Santander	1
Department of Pharmacy, National University	1
Department of Chemistry, National University	1
Department of Pharmacology, National University	1
Department of Processes, Universidad del Valle	1
School of Agronomy, Universidad de Caldas	1
School of Agronomy, Universidad de Narino	1
ICA, Section on Residues and Tolerances	4

2. Analysis of Per Capita Food Consumption

To find out about person/day consumption of food in general, and specifically of potatoes--which is the food product being studied in this paper--one must analyze the data obtained from the only two sources of information there are on this subject: the Colombian Institute of Family Welfare (ICBF) and the National Planning Department (DPN), with its National Food and Nutrition Program (PAN). The information presented here is a summary of what these two agencies are and the role they play in developing programs, plans and policies relating to the food and nutrition of the Colombian people.

According to Varela Velasquez, 1979, work in the field of nutrition began in 1942, when a group of Colombian professionals initiated specialization courses in nutrition and promoted technical and scientific exchange. In 1944, the Laboratory of Dietetics was created; it would later become the Institute of Nutrition, created in 1947 as part of what was then called the Ministry of Hygiene. The Institute was responsible for nutritional research in Colombia.

In 1963, the national government strengthened the Institute and transformed it into the National

Institute of Nutrition, which is an autonomous agency with its own facilities and budget. The Institute then organized the Integrated Nutrition Programs (PINA). Through them, the Institute formed and coordinated at the local level health activities, agricultural production and community education and action. It also began to integrate international organizations into its programs. Among them were the Pan-American Health Organization (PHO/WHO), the FAO and the United Nations Children's Fund (UNICEF).

There are 67 articles in the 1968 law. It is divided into three chapters: chapter three creates the ICBF (the Colombian Institute of Family Welfare). It is a public agency having its own judicial status. It is administratively autonomous, has its own facilities and has, as part of it, the National Nutrition Institute. The Nutrition Institute became part of the ICBF as of May 1, 1969 by virtue of Decree 398 and Agreement 37. The Institute works out of the Department of Nutrition of the ICBF.

The Institute's activities include the Integrated Program of Applied Nutrition (PINA), which coordinates the resources and work done by agencies working to improve the community's nutritional and food situation. It has conducted studies in areas representing different socio-anthropological groups in Colombia. The overall aims of these studies have been to contribute to making a national diagnosis of the nutritional level of Colombians and to provide the groundwork for planning and implementing nutrition programs.

The PAN (National Food and Nutrition Plan) being carried out by the Department of Nutrition was formally approved by the Council on Economic and Social Policy on March 5, 1975. Varela Vasquez (1979) states that the PAN is oriented towards those groups in the population who are most vulnerable to malnutrition and who live in rural and poor urban areas.

2.1. <u>ICBF Surveys</u>: The national diet survey conducted in 1972 and 1973 provides the basis of the studies done by ICBF. Three types of surveys were devised: the Food Survey, the Clinical Anthropometric Survey for Pre-school Children and the Anthropometric Survey of School Children. The Food Survey, which is the survey of greatest interest for the present study, included questions on the purchase and consumption of food according to local customs. The number of families studied and the length of the survey made it possible to obtain information for every day of the week for two weeks, with each day being studied (surveyed) twice. The questionnaire or format used in the survey is found in Appendix A, Table A1.

The ICBF established the following zones which were studied:

Zone 1: The Atlantic Coast--includes the cities of Barranquilla, Cartagena, Monteria and Riohacha.

Zone 2: Antioquia--includes the cities of Medellin, Rionegro, Girardota, Manizales, Chinchina, Armenia and Pereira.

Zone 3: Caucana--includes the cities of Cali, Buenaventura, Puerto Tejada, Popayan and Quibdo.

Zone 4: Cundinamarca-Boyaca--includes the cities of Bogota, Girardot, La Mesa, Tunja and Duitama.

Zone 5: Villavicencio

Zone 6: Narino--includes the cities of Pasto and La Union.

Zone 7: Santandereana--includes the cities of Bucaramanga, San Gil, Cucuta and Pamplona.

Zone 8: Tolima--includes the cities of Ibague, Guamo and Neiva.

Zone 9: National Territories--includes Florencia.

Zone 10: The Islands of San Andres and Providencia.

To select the families to be surveyed, the population was divided into sectors according to the census survey done by health workers employed by the Health Service. In each sector, the families were chosen randomly and in proportion (in terms of numbers) to the concentration of families in the sector.

2.2. The PAN Surveys: To have a realistic basis for carrying out PAN activities, a study was done on PAN areas regarding population make-up, nutritional condition, food consumption, availability of nutrients and income, breastfeeding, health and environmental health. These surveys were done during July and August, 1977 in 11 departments in Colombia: Atlantico, Bolivar, Caldas, Cauca, Huila, Magdalena, Norte de Santander, Risaralda, Tolima, Valle and Bogota, D.E.

The survey sample was made up of 44 communities randomly selected. One hundred families were chosen from each city, trying to keep a balance between rural and urban areas. Sample size and selection of families were based on statistical principles involving population size, number of standard deviations, standard deviation and tolerated sample error (DNP-PAN document, May, 1978). Appendix A, Table A2 shows a comparison of the zones included in each survey (ICBF and PAN surveys) and includes the number of families and people interviewed.

2.3. Data Analysis: The Institute analyzed the data obtained from the ICBF survey. The report is presented for each zone in Appendix A, Table A3. The data obtained from the PAN survey were analyzed by computer. The results of this analysis are presented in Appendix A, Table A4; in this annex, only those products that are part of the total food consumption (up to 1%) are included. This is why the totals that appear at the bottom do not correspond to the sum of the figures, but rather to the average total obtained in the complete tabulation of the survey. This is also true for Table 10.

Table 8 and Figures 4 and 5 show in a comparative form the food consumption per person/day in general and of potatoes in particular, which are principal data as far as this study is concerned.

TABLE 8. Food consumption per person/day in general and of potatoes in particular, in grams (ICBF Survey, 1972 and PAN, 1977)

Zones	ICBF Interviews			PAN Interviews		
	Food Cons.	Potatoes Cons.	% Total	Food Cons.	Potatoes Cons.	% Total
Costa Atlantica	743	23	3.1	926	28	3.0
Antioquena	770	89	11.5	902	66	7.3
Caucana	824	87	10.6	871	129	14.8
Cundinamarca	1,057	357	33.8	863	277	32.1
Villavicencio	860	186	21.6	-	-	-
Narino	965	247	25.6	-	-	-
Santandereana	951	175	18.4	994	89	9.0
Tolimense	773	118	15.3	934	108	15.3
Territorios Nales	909	77	8.5	-	-	-
San Andres Islas	1,134	49	4.3	-	-	-
TOTAL FOR COUNTRY	8,986	1,408		5,490	696	
AVERAGE FOR COUNTRY	899	141		915	116	

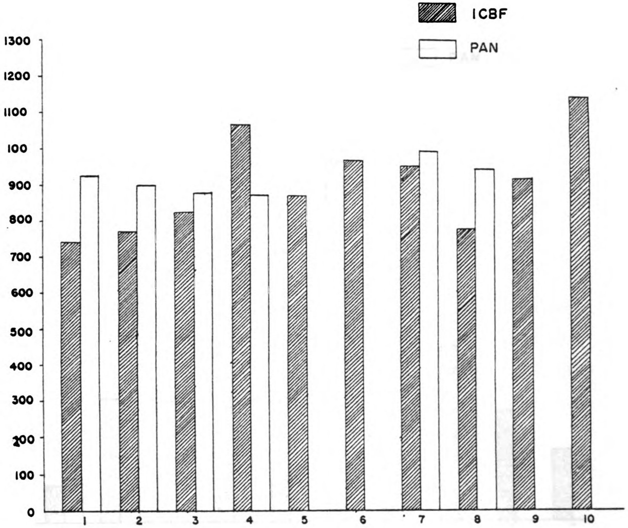


FIGURE 4. Per capita daily consumption of food by zones in Colombia (grams/day/person)

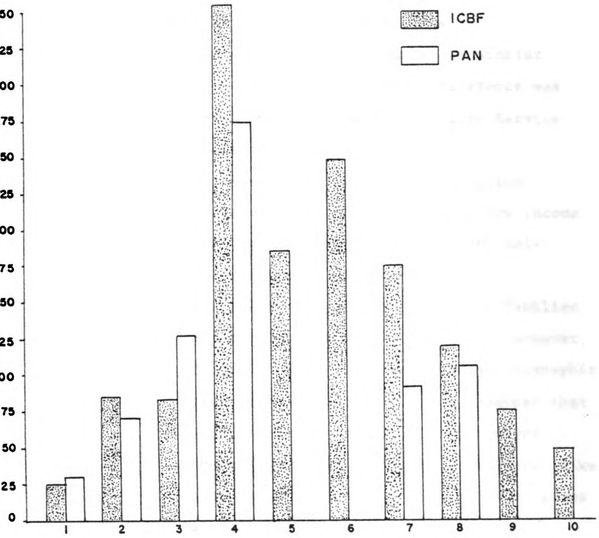


FIGURE 5. Per capita daily consumption of potatoes by zones in Colombia (grams/day/person)

Tables 9 and 10 give the order of importance of the main foods in the Nation according to the average daily intake.

2.4. Discussion of the Results: The results obtained in these two surveys (ICBF-PAN) make it possible to make the following observations:

-- The surveys were conducted in similar areas and in both cases, preference was given to zones where the Health Service operated.

-- The social strata of the population surveyed in both surveys was a low income one that is affected by food and malnutrition problems.

-- The PAN survey covered many more families and people than the ICBF survey. However, the ICBF survey covered a larger geographic area than the PAN. One must remember that ICBF conducted surveys in areas where there is high consumption of potatoes, like Narino and Villavicencio. This fact gives a more realistic situation since the calculation of the maximum residue limit can be made upon the higher potato consumption rather than the lower one. Consequently,

TABLE 9. Order of importance of the principal foods in nation according to average daily intake (I.C.B.F. 1972)

No. list	Foods	Average Cons. (grams)	Percent on average
1	Potatoes	140.8	15.66
2	Milk	115.1	12.90
3	Plantain	92.0	10.42
4	Rice	82.0	9.23
5	Beef	75.0	8.47
6	Brown sugar	70.7	7.97
7	Wheat	65.0	7.34
8	Yucca	43.0	4.89
9	Sugar cane	42.3	4.81
10	Corn	36.7	4.19
11	Tomatoes	17.5	2.05
12	Fish	17.8	1.98
13	Vegetal grease	11.8	1.31
14	Eggs	10.0	1.11
15	Oranges	9.4	1.04
16	Bananas	9.3	1.03
17	Onion	9.2	1.02
18	Peas	8.2	0.91
19	Vegetal oil	7.7	0.85
20	Arracacha	7.2	0.80
21	Carrots	7.1	0.79
22	Beans	6.8	0.75
23	Cabbage	5.4	0.60
24	Animal grease	4.5	0.50
25	Guava	3.2	0.35

TABLE 10. Order of importance of the principal foods in the nation according to average daily intake (P.A.N., 1977).

No. list	Foods	Average Cons. (grams)	Percent on Average
1	Potatoes	116.268	12.71
2	Milk	114.612	12.53
3	Brown sugar	101.596	11.10
4	Rice	80.037	8.75
5	Yucca	76.563	8.75
6	Plantain	64.789	7.08
7	Corn	42.966	4.69
8	Beef	39.196	4.28
9	Sugar cane	26.782	2.93
10	Salt	18.840	2.06
11	Beans	15.713	1.72
12	Oranges	13.851	1.51
13	Fish	13.468	1.47
14	Bread	12.745	1.39
15	Cocoa	12.471	1.36
16	Cheese	12.205	1.33
17	Wheat pasta	11.964	1.31
18	Vegetal grease	11.711	1.28
19	Coffee	10.915	1.19
20	Bananas	10.203	1.11
21	Carrots	10.058	1.10
22	Tomatoes	9.709	1.06
23	Squash	9.226	1.01
24	Corn flour	8.816	1.00
25	Onion	8.800	1.00

this constitutes an additional safety factor in establishing the maximum residue limit in the daily intake.

-- The areas surveyed in both surveys are different in terms of the number of families and towns; except for Cundinamarca, these numbers are always larger or the same as the PAN figures. As far as Cundinamarca is concerned, the PAN only conducted four surveys in the District of Bogota; one of these surveys does not correspond to the strata defined by the PAN for conducting the surveys.

-- As for making a list in the order of importance of the food consumed, potatoes occupy first place in both surveys; for this reason, potatoes can be considered the priority food in the study of residues and establishment of maximum residue limits.

-- The variation of data in terms of total consumption of food/person/day is not very large and does not much differ from the data obtained in the two surveys. Thus, one may take 907 grams/person/day as the average value and round this figure off to 1,000 grams without any difficulty.

-- One could object to this value in terms of its representing the entire Colombian population by saying that it is based on a low-income sector of the population. Nevertheless, as long as there is no data on a broader sector of the population, the value obtained in the ICBF and PAN surveys will have to be used.

-- In defining the per capita/day consumption of potatoes, the FAO/WHO concept shall be taken in account in terms of using the average of total consumption for a country or region. In the present case, the figure obtained in the ICBF survey will be used because it is higher than the PAN one and because it corresponds to the average of the total obtained in the survey and includes the value of an important zone like Narino. Consequently, the figure 141 grams of potato/person/day will be used.

-- The data on the per capita consumption/day of potatoes may be considered representative and valid. This corresponds to a sector of the population whose consumption of potatoes is very high and consequently they are more exposed to the chemical pesticides applied to this product. The preference for potatoes is based on:

-- the comparatively low price of this product,

-- the constant availability of the product on the market,

-- the acceptable nutritional value of the product compared with its cost,

-- traditional food habits that make potatoes the product most eaten by the population,

-- the ease of its preparation,

-- the savings of time, seasonings and fuel in the cooking of potatoes,

-- the volume of potatoes eaten replaces other more nutritious foods which are more expensive, and

-- the smallholding characteristics of potato growing determines that part of the potato crop will be consumed by the producer and his family.

3. The Average Weight of Colombian Consumers

The Sectional Growth, Development and Nutrition Study done on 12,138 children in Bogota in 1965-1968 by the ICBF is the only document containing information on the average weight of Colombians. The study was done on both sexes between the ages of 0-20 years. The data published is of 2,979 people from the upper classes in Bogota. The authors of this study propose that the average values obtained for weight and height be used as standards of reference in the evaluation of the growth of Colombian children. There lies their importance for the studies done on the maximum residue limits. The average weight is 60 kilograms, which is the same figure used by FAO/WHO when calculating the pesticide intake per kilogram body weight.

4. Analysis of Agricultural Practices Used in Growing Potatoes with Special Emphasis on the Utilization of Pesticides

4.1. General Information on Potato Crop: Because potatoes are one of the basic staples in the Colombian diet they are then one of the most important and technicalized crops in the country. The importance of this crop can be seen in the statistics on it shown in Table 11.

TABLE 11. Area, production and yield of the potatoe crop in Colombia (period between 1970-1980

Year	Area (thous. ha)	Variation indice 1970: 100	Production (thous. ton)	Variation indice 1970:100	Yield Tons/ha
1970	84.1	100	913.1	100	10.8
1971	83.8	99	824.6	90	9.8
1972	85.0	101	782.0	86	9.2
1973	94.1	112	983.5	108	10.4
1974	87.5	104	902.5	99	10.3
1975	110.0	130	1,320.0	144	12.0
1976	125.0	148	1,515.8	166	12.1
1977	127.9	152	1,608.6	176	12.5
1978	128.9	153	1,754.9	192	13.6
1979	70.0	83	902.6	99	12.9
1980*	67.0	80	923.9	101	13.8

* Proyections calculated by Potato Growers Federation

SOURCES: Documento de trabajo No 13, Seccion Estudios Agroeconomicos del ICA. - Ministerio de Agricultura, OPSA, 1977-1979. Programas Agricolas 1977.

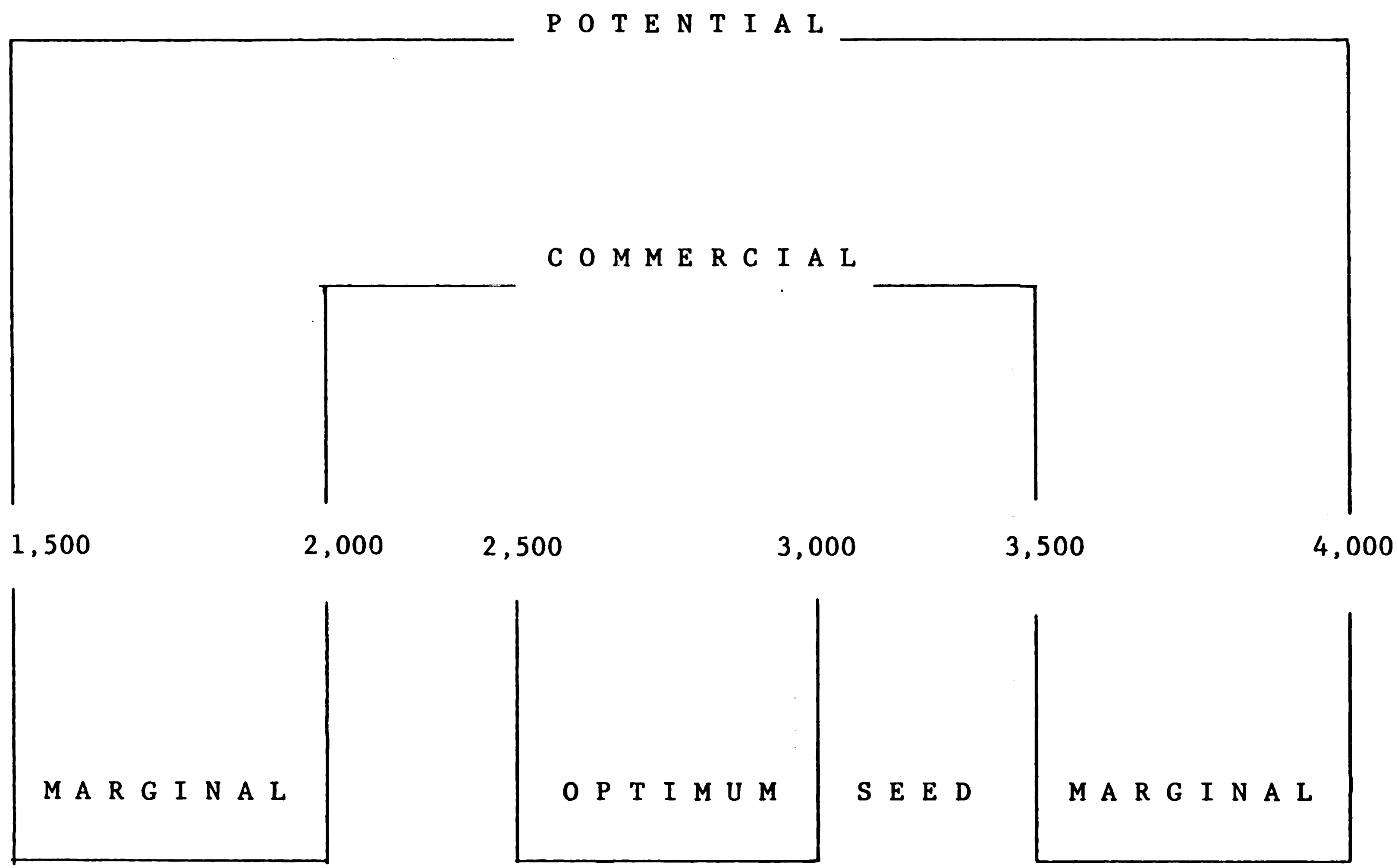


FIGURE 6. Potato producing zones in Colombia (height in meters above sea level (Manual de papa, 1977)

TABLE 12. Area seeded and potato production, 1976

State	Area Has	Area % on tot.	Production Tons.	Production % on tot.
Boyaca	30,000		360,000	
Cundinamarca	29,000		377,000	
Narino	25,000		331,600	
	84,000	67	1'068,600	70
Antioquia	13,500		135,000	
Santander	8,000		80,000	
Tolima	7,200		104,000	
Norte Sant.	5,800		58,000	
Caldas	4,100		44,100	
Cauca	1,800		19,900	
Quindio	400		4,050	
Risaralda	150		1,700	
	40,950	33	447,750	30
TOTAL	124,950		1'515,750	

SOURCE: Ministerio de Agricultura, OPSA Programas Agricolas, 1977.

The potato growing areas are well defined and found in areas that satisfy their ecological needs, as shown in Figure 6.

Table 12 includes the areas of greatest production in 1976 and Figure 7 shows the geographical location of the three departments that produce the most potatoes.

There are approximately 70,850 potato producers. The comparison between the area seeded with potatoes (124,950 hectares in 1976) and the number of producers reveals that small growers predominate; 95% of the area where potatoes are grown is on plots of less than 7 hectares even though this type of potato farming accounts for 81% of the total area under cultivation. This is shown in Table 13.

Table 13. Number of potato farms, area and production for small, medium and larger producers in Colombia, 1976 (ICA, 1970).

Producer	Area (hectares)	Production (tons)	Number of Farms
Small	69,340	632,045	64,893
Medium	32,395	482,590	5,120
Large	23,215	410,705	837
TOTAL	124,950	1,525,340	70,850

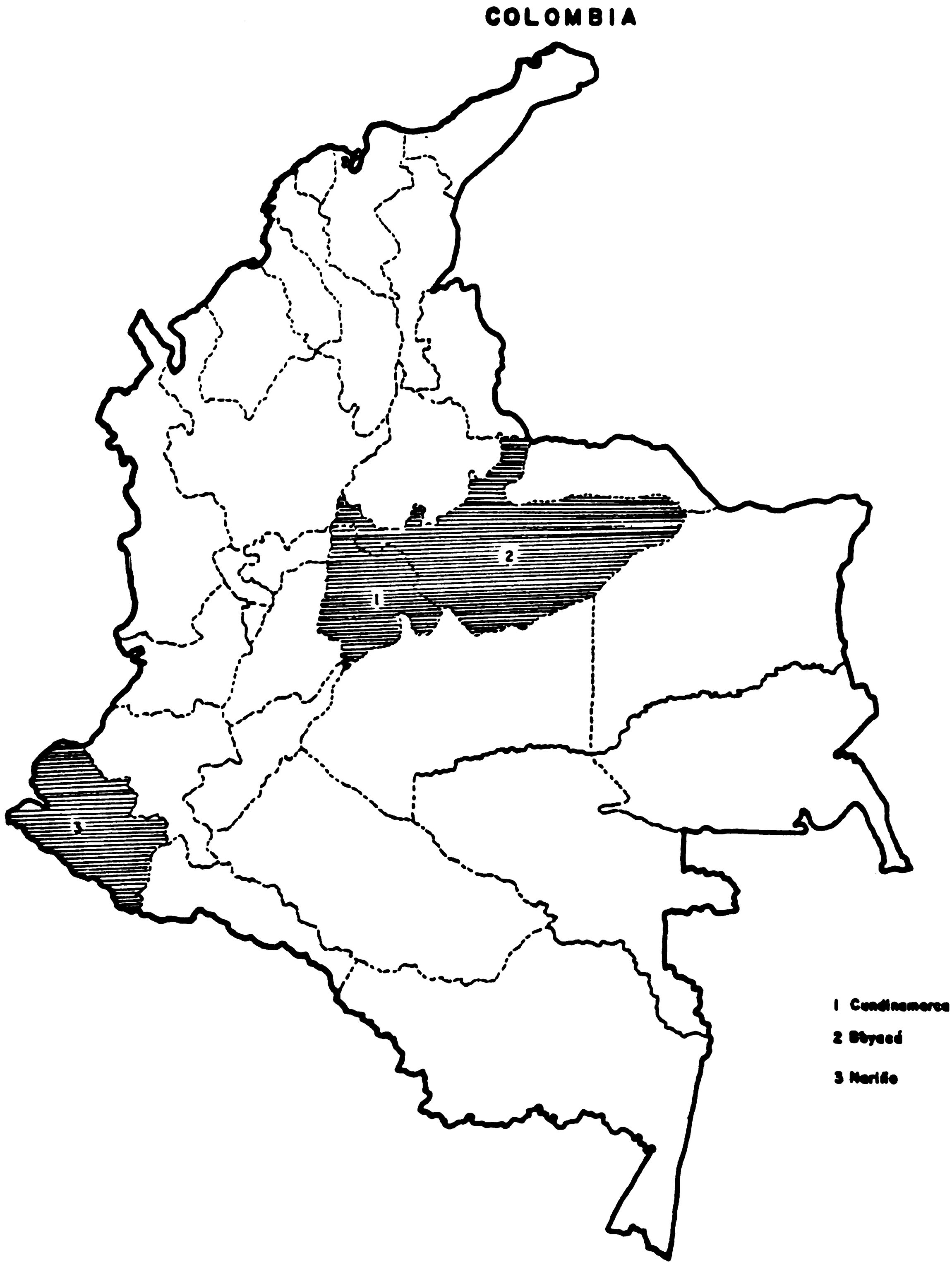


FIGURE 7. Principal potato producing departments of Colombia

The most important point to be considered in this paper is related to the use of pesticides for controlling different pests attacking the potato crop. This analysis includes the technology officially recommended by ICA and the technology used by the farmer. The summarized and objective presentation of this information was done on the questionnaire on "Good Agricultural Practices" prepared by the Canadian delegation during the X Meeting of the Codex on Pesticides, held in The Hague from May 29 to June 5, 1978.

4.2. Official Agronomic Practices Recommended in Potatoes: The official technology recommended by ICA appears in the different publications on potato crops put out by the Institute. These articles are summarized in the Potato Manuel, number 130, 1977 and in the Pest Control Guide prepared by ICA in 1975. A summary of this information is found in Appendix B, Table B1.

4.3. Analysis of the Agronomic Practices Used by the Potato Growers: To obtain information on the technology used by farmers, a regional survey was done in the most important potato zones that are most representative of the country; 82% of the surveys were done in the departments of

Boyaca, Cundinamarca and Narino, and 18% were done in Antioquia, Caldas and Tolima. The size of the potato farms surveyed was under 6 hectares in 93% of the cases, 50 hectares in 6% of the cases and 90 hectares in 1% of the cases. The distribution of the surveys by department is found in Table 14.

Table 14. Distribution of the surveys done on the use of pesticides in potato crops.

Department	No. Surveyed	No. Towns	% Surveys
Boyaca	228	18	43.68
Cundinamarea	133	11	25.48
Narino	67	5	12.84
Antioquia	42	6	8.05
Caldas	34	3	6.51
Tolima	18	2	3.45
TOTAL	522	45	100

A model of the format used in the surveys is found in Appendix B, Table B2. The tabulation and analysis of the information obtained was done by a computer from the Division of Statistics and Biometry, ICA. A study of the tables provided the following information:

-- The average area farmed among those surveyed was 3.18 hectares; the maximum area was 84 hectares in the Department of Caldas.

-- Pesticides were applied by sprayers carried on the back; the average sprayer had a 20 liter capacity with a maximum capacity of 50 liters.

-- 96.4% of those surveyed used hoes to control weeds.

-- The most commonly controlled diseases are late blight of potato, Phitophtora infestans and to a far lesser extent potato rust, Puccinia pittieriana.

-- The most widely used fungicides in controlling these two diseases are the bisdithiocarbamates (manzate, dithane, M-22 and M-45). They made lesser use of fentin hydroxide (duter), fentin acetate (brestan), sulphur (elosal) and copper oxychloride.

-- The average number of applications of these fungicides was eight per crop.

-- The most commonly controlled insect pests were:

Insects	% of Those Interviewed Who Control Them
White worm, Prenomtrypes vorax	80.08
Toxton, Liriomyza quadrata	46.16
Pulguilla, Epitrix spp.	41.96
Trozador or Rosquilla, Agrotis ipsilon	27.76
Aphids or plant lice, Myzus persicae	20.68
"Mosco" or Minador de follaje, Scrobipalpula absoluta	18.96
Muque, Copitarsia consueta	10.52

-- In the order of their use, the most widely used insecticides were:

Insecticides	% of Those Interviewed Who Use Them
Carbofuran (furadan), applied to soil	71.65
Dimethoate (roxion), applied to foliage	41.76
Parathion 50, applied to foliage	37.36
Metamidofos (tamaron, monitor), applied to foliage	14.56
Diazinon (basudin), applied to foliage	12.28
Aldrin, applied to soil	10.72
Aldicarb (temik), applied to soil	8.43
Metil parathion, applied to foliage	7.08

- -- The average number of applications of insecticides to the growing crop was eight; the departments of Caldas and Tolima had the lowest number of applications: 5.
- -- The pesticides most widely used in mixtures were bisdithiocarbamates, dimethoate, parathion, and diazinon.
- -- Most of those interviewed suspended the use of pesticides 52 days before harvest. The last pesticide products they applied were manzate, dimethoate and parathion.
- -- The main sources of information the farmer has for making decisions as to which pesticides to use and the dosage were:

Pesticide to be Used		Application Dose	
Source	% Interviewed	Source	% Interviewed
Neighbor	36.78	Label	34.10
Salesman	23.75	Neighbor	20.88
Agronomist	14.76	Salesman	15.71
SENA	2.30	Agronomist	10.54
Agrarian Bank	2.11	Radio	3.45
Cooperatives	1.72	SENA	1.53
Radio	1.34	Cooperatives	.96
		Agrarian Bank	.77

-- The main agricultural practices used on the crops were:

  -- first weeding--45 days after sowing (average),

  -- half earthing over--62 days after sowing (average),

  -- earthing over--72 days after sowing (average), and

  -- harvest--184 days after sowing (average).

Semi-earthing over and earthing over appear to be done at very short intervals; however, this only appears that way because the farmer does one of these procedures, but not both of them.

-- 87.74% of those interviewed market the potatoes immediately after harvest; they market them in small neighboring markets and marketplaces, and one may assume that consumption was also immediate.

-- The most objective summary of the technology used by the farmers is found in Appendix B, Table B3.

-- A comparison of Table B1 (recommended use of pesticides) and Table B3 (use of pesticides by farmers) makes it possible to see the differences found in Table 15.

On the basis of the foregoing information, the following conclusions can be reached:

- -- Farmers use pesticides to control pests that affect the potato crop and do not follow the recommendations made by ICA as regards products, doses and application frequency.
- -- Nevertheless, the study on residues conducted with a view to establishing maximum residue limits, must take in account the pesticides and doses used by farmers.
- -- Mindful of the products used by the farmer, a study on residues must have the following priorities:
  - -- bisdithiocarbamates (fungicides); and
  - -- dimethoate, parathion, metamidofos, diazinon, metil parathion (organophosphorate insecticides); aldrin (organochlorides); carbofuran and aldicarb (carbamates).
- -- Due to the chemical nature of bisdithiocarbamates, they do not pose the same type

TABLE 15. Comparison of the use of pesticides in farmers potatoe crops and the recommendations made by ICA.

Farmer's used pesticides	Recommended kg a.i./ha	Recommended No appl.	Used kga.i./ha	Used No appl.
Aldrin	1.0-2.0	1 soil	0.62	2 soil
Aldicarb	2.0	2 soil	6.18	2 soil
Bux	No recommended		0.67	3
Canphechlor-DDT	20 kg. bait	soil	.66-.33 E	3 soil
Carbofuran	1.0	2 soil	1.62	3 soil
DDT	No recommended		1.48	5
Dieldrin	No recommended		0.20	8
Diazinon	No recommended		0.50	6
Dimethoate	0.50	3 - 4	0.40	6
HCH (BHC)	No recommended		0.14	4
HCH-DDT-CuO	No recommended		.04-.02 -.2	3
Malathion	0.50 - 1.0	3 - 4	0.46	5
Metamidophos	0.50	3	0.53	6
Methyl parathion	No recommended		0.30	6
Meth. parath.-parath.	No recommended		.54-.27	5
Methomyl	0.25 - 0.50	3 - 4	0.73	7
Parathion	No recommended		0.46	5
Trichlorphon	No recommended		0.79	6

of problem encountered with organophosphorated pesticides, organochlorides and carbamates.

-- Despite its high toxicity, the widely used carbofuran is an important product in the study of residues. Much the same can be said for aldicarb.

-- The information obtained determined the study of one organophosphorated insecticide (dimethoate) and one organochloride pesticide (aldrin); they are both used extensively by farmers.

-- Mention has already been made of the fact that farmers use these two insecticides in spite of the official recommendations. Aldrin is only used on the soil; the dose is 0.62 kg. active ingredients per hectare; it is applied twice although the official recommendation says it should be applied once in a 1-2 kg. dose of active ingredients per hectare. Thus, the dose applied by farmers falls within the limits set by ICA.

-- Dimethoate is applied to foliage as per official recommendation, but the farmers are applying it six times in 0.4 kg. active ingredient doses per hectare. The result is that the farmer is applying 0.4 kg. ai/hec more than the dose recommended by ICA.

-- The farmer applies aldrin for the last time 105 days before harvest even though the official recommendations say he should do so at the time of sowing. ICA recommends applying dimethoate 60 days before harvest while farmers apply it 46 days before harvest.

5. Experiments and Sampling That Must Be Done to Help Establish Maximum Permissible Residue Limits

5.1. Experimental Design: This is an important aspect if you wish to obtain samples having a residue content that is representative of the level one hopes to find in the crop as the result of the use of a pesticide. The experimental design should follow an outline made by:

i. staff that has suggested technically and officially the handling of the pesticide to be studied and the crop it will be applied to;

ii. staff that will be in charge of handling the crop in field conditions; and

iii. chemists or analytical chemists.

The sampling systems to be used should be planned (with alternate systems provided for) taking into consideration the variables that will arise as a result of a representative sample.

When making the experimental design, it is important to understand the object of determining residues. When, as in the present case, the aim is to establish maximum residue limits, one important consideration is that the experiment must be exclusively designed for this purpose since the introduction of other variables into the study, such as efficacy tests, might invalidate a sample and make it difficult to execute a sample suitable for obtaining representative data.

The size and location of the experimental plots must be defined keeping in mind the officially recommended practices on the use of the pesticide, crop practices (distance between rows sown, cultural practices, pest control, etc.) and considerations on the size of the gross sample that must be obtained when harvest occurs. One must also think about the meteorological conditions of the plot location.

With these considerations in mind, the experiment for establishing tolerance for dimethoate and aldrin in potato crops was designed like this:

Location: Agricultural Research Center, Tibaita, Municipality of Mosquera, Department of Cundinamarca

Meteorological Conditions:

Height: 2,550 meters above sea level; an optimal height for growing potatoes

Meteorological Temperature: 13.5 debrees C

Relative Humidity: 76.4%

Annual Precipitation: 668 m.m.

Two separate experiments were done for the study for each of the insecticides. The experimental designs were discussed beforehand with the Biometry and Statistics Division of ICA.

Experiment 1:

Seed: San Jorge variety, second class

Pesticide: Aldrin 2.5% in powder form to be sprinkled

Application: To soil and sown land

Dose: 500-1,000-1,500-2,000 grams active ingredient per hectare and an untreated control area. These doses include both official recommendations and the average dose used by farmers.

Experimental Design: Random blocks. The field plan is found in Figure 8.

Experiment 2:

Seed: San Jorge variety, second class

Pesticide: Dimethoate 400 grams/litre formulation, emulsifiable concentration

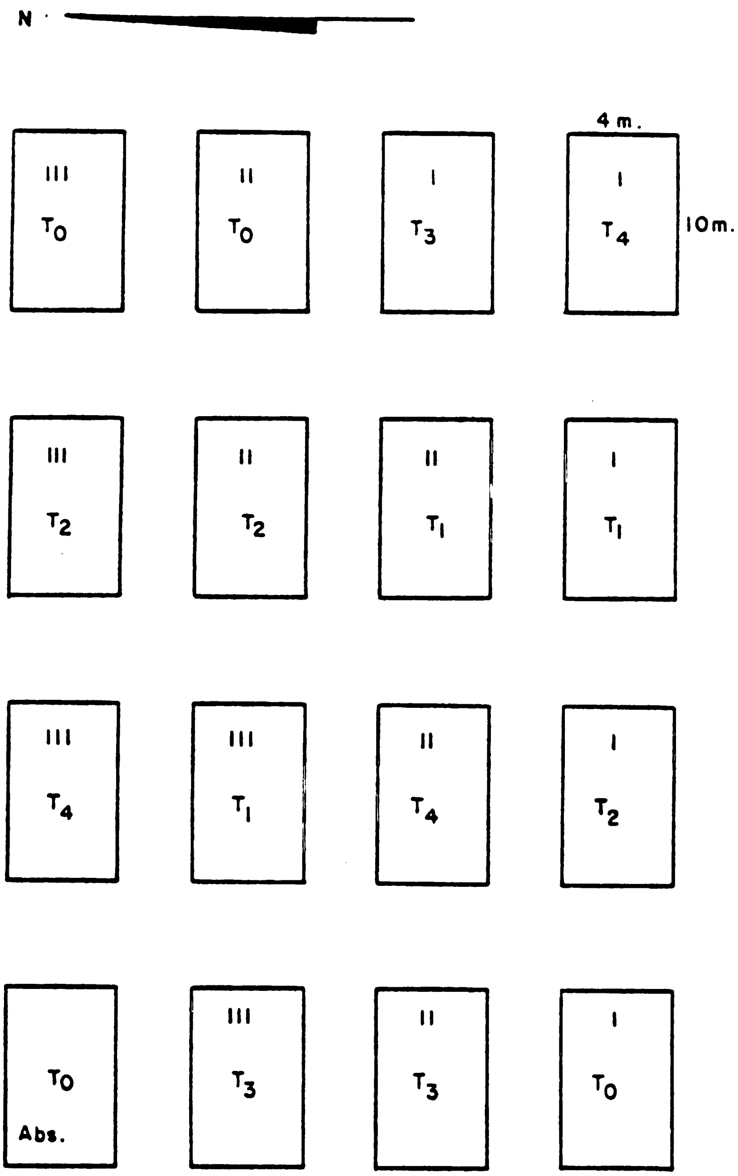
Application: To foliage. Three application frequencies during growing period: 4-6-8 applications between germination and flowering. These frequencies include official recommendations and methods used by farmers.

Dose: 500-750-1,000 cubic centimeters active ingredient per hectare and an untreated control area. These doses include both official recommendations and two higher ones as a safety factor in the determination of residue since the product undergoes relatively rapid degradation.

Experimental Design: Divided plots. The field plan of the design is found in Figure 9.

Each plot in the experiment was 10 meters long and 4 meters wide. Each plot was made up of four rows, one meter apart and the distance between plants was 30 centimeters.

EXPERIMENT No.I



Treatments:

T_0: Control

T_1: 500 g a.i./ha

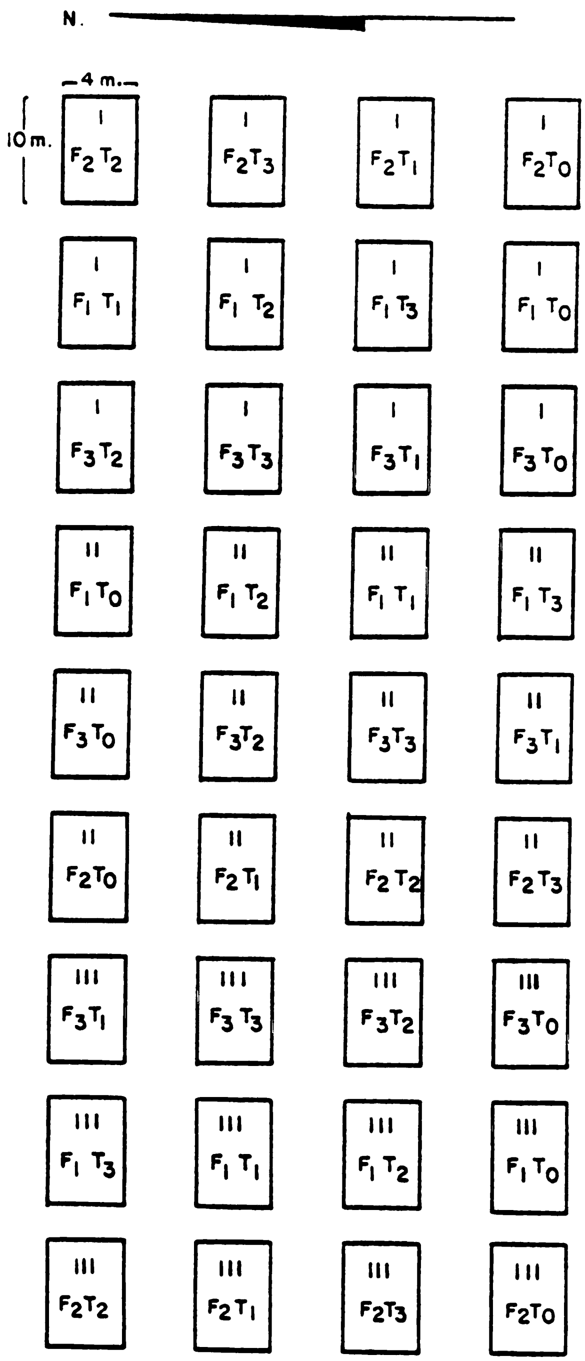
T_2: 1,000 g a.i./ha

T_3: 1,500 g a.i./ha

T_4: 2,000 g a.i./ha

FIGURE 8. Plan of the aldrin potato experiment conducted on lot 7 of the CNIA - Tibaitata, ICA

EXPERIMENT No. 2



Treatments:

T_0: Control

T_1: 500 cc a.i./ha

T_2: 750 cc a.i./ha

T_3: 1,000 cc a.i./ha

Frecuencies:

F_1: 4 applications

F_2: 6 applications

F_3: 8 applications

FIGURE 9. Plan of the dimethoate potato experiment conducted on lot 7 of the CNIA - Tibaitata, ICA

The agricultural practices used were those recommended by the ICA Tuberose Program for commercial crops.

5.2. Sampling: The first sample taken was of the soil in the plots where the experiments were done. The sample was taken before sowing occurred. The purpose of the sample was to determine aldrin residues. The sample was taken by moving in zig-zag fashion over the plot; approximately 20 small samples were taken at random from different places. A thin drill runner was used to take the samples; the drill runner extracted soil from a depth of 15 centimeters. The sample was divided into three and was stored for 20 days at a temperature of 15 degrees centigrade below zero before it was analyzed.

The sampling of the potatoes from the experimental plots by taking potatoes (harvesting them) from the center row of each treated plot until a sample of approximately 20 kilograms was obtained. Then, each one of these samples was reduced by quartering it until samples of three kilograms each were obtained. The samples were quick frozen by submerging them in liquid nitrogen and keeping them at a temperature of

20 degrees centigrade below zero for one week for dimethoate and one month for aldrin before taking them into the laboratory for analysis. The sampling done in the untreated control plots was done and handled in the same way.

The sampling of farmer's potato crops was done to determine aldrin and dimethoate residues in samples from crops in which these insecticides had been used; they would then be compared with the results obtained experimentally. Samples were taken in four potato growing zones as shown in Table 16.

The samples were taken at harvest time, collected at random moving across the plot in a zig-zag fashion during the harvest. The field sample in each sample site weighed 50 kilograms; the sample was divided in two and reduced by quartering it to obtain laboratory samples of three kilograms each.

After quick freezing the samples in liquid nitrogen, they were taken to the laboratory the day they were harvested and handled exactly like the experimental samples.

In all cases the potato samples were washed to remove the soil. This was done because it is the first thing the consumer does before

TABLE 16. potato sampling sites in four potato growing zones

State	No sample	Rural area	Aldrin* k a.i./ ha	Dimeth** k a.i./ ha	No app dimeth
Boyaca	1	Baron Germania-Tunja	.50	1.20	15
2,700-2800	2	Chorro Blanco-Tunja	-	1.45	14
a.s.l.	3	Motavita - Tunja	-	0.30	8
Cundinamarca	1	San Jorge-Zipaquira	-	0.30	3
2,800-3,100	2	Llano Grande-Tausa	-	0.35	6
a.s.l.	3	El Destino - Usme	-	0.40	6
Caldas 3,200-3.300	1	Santa Teresa-Villa Maria	1.25	0.20	6
a.s.l.	2	El Desquite- Marulanda	0.93	-	-
	3	El Desquita- Marulanda	0.62	-	-
Antioquia	1	Las Palmas-Envigado	1.87	-	-
2,400-2,700 a.s.l.	2	Llano Grande-Rionegro	-	0.64	6
	3	La Lomita-San Pedro	1.25	0.45	8

* Preplanting soil application

** Foliage application

a.s.l. above sea level

consumption. However, the skin of the potatoes was not removed because very often people eat potatoes without pealing. Besides that, the maximum residue limit must be established in base of the residue determined on the total edible part of the food.

6. Discussion of the Analytical Methods Used in the Analysis of Aldrin and Dimethoate Residues and Some Comments on the Results

6.1. Aldrin Residue Analysis: The analysis of the aldrin residues in potatoes was carried out using the technique for the crop products that have a low fat and a high water content (AOAC, 1975). The cleaning-up technique used was the procedure developed by the Hessische Landwirtshaftliche Verschsanstalt Institute, (Steinwandter and Schluter, 1977), which has some advantages if compared with the traditional method using florisil. Some of these advantages are: all the organochlorines pesticides come out in only one elution, with a recuperation of 95%; it is more economic, since the silica-gel is cheaper and faster than florisil.

6.1.1. Cleaning-Up of the Extract:

1. Equipment:

-- Rotary evaporator

-- Round flasks, 10 to 500 ml.
-- Chromatography column of 25 mm inner diameter, 300 mm long, with teflon key
-- Wood glass
-- Disposable Pasteur pipets
-- Concentrator tube (joints 19/22) with three balls
-- Water simmer to keep the temperature between 95 to 100^{o}C

2. <u>Reagents</u>:

-- Petroleum ether, grade pesticide, with a boiling point between 40 to 60^{o}C.
-- Silica-gel 60, 70 - 230 mesh (Art. 7754 Merck), deactivated with 30% of water. In order to do this, the silica-gel is dried up at a temperature of 130^{o}C, during 6 hours. After that is cooled down in a desecator and 30 ml. of water for every 70 grams of silica-gel must be added.
-- Anhydrous sodium sulfate.
-- Hexane, pesticide grade.

3. Procedure:

-- The chromatography column is prepared by mixing 20 grams of moistured, deactivated silica-gel with petroleum ether. This mixture is put inside of the glass column, where previously has been placed a small amount of glass wool. Add anhydrous sodium sulfate until 2.5 centimeters layer is formed. The petroleum ether level must be the same as the sodium sulfate, so that the silica-gel does not crash.

-- The petroleum ether pass-out through the column until it just reaches the sodium sulfate level. This extract is transferred into the column with a Pateur disposable pipet.

-- When the last solvent reaches the Na_2SO_4 top level, begin the elution of the column in which case 300 ml of petroleum ether is used.

- The extract is concentrated to 10 ml., in the rotary evaporator. The concentration process continues using a modified K-D until the extract is almost dry. Then it is diluted to a volume that permit chromatographic analysis.
- Conditions of the chromatographic analysis. This analysis was carried out under the following conditions and by the external standard method:
  - Stationary phase, 4% silicon GE - SE 30 plus 6% OV - 210 on chromosorb W.H.P. 100 - 120 mesh
  - Glass column, six feet long and ¼ inch inner diameter
  - Temperatures:

Column	224°C
Injector	250°C
Detector (ECD Ni^{63})	300°C

  - Carrier gas, N_2
  - Flow rate, 15 ml. per minute
  - Equipment, G.L.C. Varian A.E. Series 2100

-- Conditions of the confirmation analysis:

- -- Stationary phase, 1.5% OV - 17 plus 1.95% Q.F. - 1 on chromosorb W.H.P. 100 - 120 mesh
- -- Glass column, six feet long and ¼ inch inner diameter
- -- Temperatures:

Column	210°C
Detector	300°C
Foil (Sc - H^3)	275°C
Injector	250°C

- -- Carrier gas, N_2
- -- Flow rate, 30 ml. per minute
- -- Equipment, G.L.C. Varian A.E. Series 2100

The analysis of the aldrin residues in the samples that were taken in the farms were done following the same method used in the experimental samples of potatoes.

The analysis of aldrin residues in soil samples used the A.O.A.C. method which is described in the Training in Pesticide Analysis Manual (Mann, 1978), II-C section, pg. 1 by removing sulfur, II-C-2.

6.2. Dimethoate Residues Analysis: For the analysis of dimethoate and dimethoxon residues was used the Cela Merck Method* but with some modifications. The changes introduced were the following: the polyamide clean-up was eliminated, since the detector characteristics used for determination makes no use of this step; the internal standard for quantification was eliminated too. Added was a filtration step for the chloroform phase through sodium sulfate in order to remove any water from the partition step. The method used was as follows:

6.2.1. Principles: Dimethoate and dimethoxon are extracted from macerated plant tissues with acetone. The extract was filtered and the solvent evaporated. The aqueous residue was cleared over Hyflo-Super-Cel. Dimethoate and dimethoxon were taken up by chloroform, the solution was concentrated to dryness and the residue was disolved in acetone. The determination was carried out by gas chromatography.

6.2.2. Reagents:

-- Acetone distilled

*Unpublished, confidential, personal communication.

-- Chloroform distilled

-- Dimethoate purest

-- Dimethoxon purest

-- Hyflo-Super-Cel (Lehmann u. Voss, Hamburg)

6.2.3. <u>Procedure</u>:

-- 100 grams of finely macerated plant tissue were homogenized in a mixer with a 250 ml acetone for approximately 2 minutes. The mixture was filtered through glass filter funnel (G 2). The filtrate was extracted once again according to the procedure with an additional 150 ml acetone. The extracts were then cleaned up.

-- The acetone was distilled under vacuum in a rotary evaporator. The remaining aqueous solution over a aqueous suspension of approximately 8 g Hyflo-Super-Cel was filtered on a 7 centimeters porcelin suction funnel and the residue was washed with approximately 100 ml water. The aqueous solution was reduced to approximately 20 ml under vacuum in a rotary evaporator at 60°C.

-- The aquous phase + 22 g sodium chloride was extracted for three times with 50 ml chloroform each time. The combined chloroform phases were filtered through a filter moistered with chloroform that contains 2 grams of anhydrous sodium sulfate and were reduced to dryness at 50°C under vacuum in a rotary evaporator.

-- The distillation residue was quantitatively transferred with acetone into a 10 ml measuring flask and filled up to the mark.

-- The gas chromatographic determination was carried out under the following conditions:

  -- Aparatus, Perkin Elmer Model 900

  -- Column, 5% OV 210 on chromosorb W-HP 80/100 mesh

  -- Detector, flame photometric

  -- Temperatures:

Column	180°C
Detector	200°C
Injector	225°C

  -- Transfer line 10^2 x 8

-- Full scale deflection (recorder-1 mv), 8 x 10^{-10} amp.

-- Recorder chart speed, 1 centimeter or 2/5 inches/min.

-- Gases flow:

Carrier gas (N_2)	70 ml/min.
Hydrogen (H_2)	40 ml/min.
Air	100 ml/min.

6.3. Comments on the Results:

6.3.1. Aldrin:

1. Standardization of the Column:

-- Standard mixture chromatogram under analytic conditions, Appendix C, Figure C1.

-- Chromatogram of an extract of potatoes treated with 0.5 k active ingedient (a.i.) per hectare (ha), under analytical conditions, Appendix C, Figure C2.

-- Efficiency (theoretical plates in base of pp' DDT) = 3,500

-- Elution time for pp' DDT = 19 minutes

-- Linearity curves for aldrin and dieldrin, Appendix C, Figures C3 and C4.

-- Standards mixture chromatogram under confirmation analytical conditions, Appendix C, Figure C5.

-- Chromatogram of an extract of potatoes treated with 0.5 k a.i. per ha, of aldrin, under confirmation analytical conditions, Appendix C, Figure C6.

2. Results: The analysis of the soil samples did not show any residue of aldrin or dieldrin. Appendix C, Figure C7 is an example of the chromatogram obtained in these analyses. The results obtained in the analysis of aldrin in the experimental samples of potatoes are shown in Appendix C, Table C1. The averages of these residue values are presented in Table 17.

   An example of the chromatograms under analytic conditions is the one presented as Appendix C, Figure C8, which corresponds to an extract of potatoes treated with 1.5 k a.i./ha of aldrin.

Table 17. Averages of aldrin and dieldrin residues in experimental samples of potatoes expressed in micrograms per kilogram (ug/kg).

Treatment k a.i./ha	Aldrin	Dieldrin	Aldrin + Dieldrin
0.0	0.30	2.25	2.55
0.5	1.48	6.22	7.70
1.0	1.36	5.85	7.21
1.5	2.06	8.69*	10.75*
2.0	2.03	9.08	11.11

*Estimated for missing plot.

The variance analysis of the data gave no significant differences between treatments. The regression analysis was carried out for the total amount (Aldrin + dieldrin) and it showed a significant correlation between the treatments and the residue present in the samples with the following results:

Regression Analysis:

$r = 0.653$ * Significant

$a = 3.83$

$b = 4.04$ (residue increase per kg a.i./ha added)

$\bar{X} = 1.00$

$\bar{Y} = 7.86$

The amount of residues of aldrin + dieldrin present in the experimental samples analyzed were very little and in some cases the quantification was not possible because they were in the no detectable level or gave just traces as a result. However, in order to make some statistical appreciation the data were transformed to micrograms per kilogram.

The regression analysis confirm the expected result of an increase in the residue present as the doses of aldrin applied increases. The no significant difference between treatments allow us to say that when the aldrin is used between 0.5 to 2.0 k of a.i./ha, applied to soil, pre-planting, there is no probability that the residue will be present, in a significant amount, in the harvested product.

In order to calculate the maximum residue limit under Colombian conditions, the average value of the residue in treatment three (0.01 mg/kg), will be taking in account, since this residue comes from the most representative doses used in potato crops (1.5 k a.i./ha). This average corresponds to the summation of aldrin and dieldrin, since the residue is expressed in terms of the parent product and its metabolite. The average values obtained in the residue analysis of aldrin and dieldrin in farmer's samples are presented in Table 18.

Table 18. Averages of aldrin and dieldrin residues in farmer's samples of potatoes expressed in ug/kg.

Zones	Doses a.i. k/ha	Aldrin	Dieldrin	Aldrin + Dieldrin
Boyaca	0.50	2.86	30.26	33.10
Cundinamarca	0.00	0.00	5.52	5.52
Caldas	1.25	35.80	29.80	68.93
	0.93	8.50	14.50	23.00
	0.62	11.90	8.30	20.20
Antioquia	1.87	1.00	2.00	3.00
	1.25	2.76	11.90	14.60
AVERAGE				24.05

As in the experimental samples, the residues of aldrin and dieldrin present in the farmer's samples are low. The value which will be used to calculate the tolerance using these results will be the general average, which is 0.02 miligrams per kilogram. The original data from where these averages were taken is presented in Appendix C, Table C2.

6.3.2. Dimethoate-Dimethoxon:

1. Standardization of the Analytical Method:

Table 19. Data to standardize the analytical method for dimethoate*.

No Sample	Standard Injection Vol.	Standard Peak Height	Spiked Potato Sample Injection Vol.	Spiked Potato Sample Peak Height	ug per 100 g
1	5.6	149	5.0	157.0	118.0
2	5.1	118	5.1	121.4	105.0
3	5.6	130	5.1	130.6	110.3
4	5.6	130	5.1	134.5	113.6
5	5.3	127	5.6	145.2	108.2
6	5.3	127	5.1	134.6	106.0
					661.1

*Standard concentration: 100 pg/ul

Amount of spiked sample: 100 gr

Concentration in sample: 1 ppm of dimethoate

Sample final dilution volume: 1,000 ml

Standardization results:

% of recuperation: 110.18

Average error: 10.18%

Absolute deviation: 4.49

Minimum detectable amount: 80 pg.

Table 20. Data to standardize the analytical method for dimethoxon*

No Sample	Standard Injection Vol.	Standard Peak Height	Spiked Potato Sample Injection Vol.	Spiked Potato Sample Peak Height	ug per 100 gr
1	5.1	225	5.6	200.00	81.0
2	5.1	225	5.4	183.44	77.0
3	5.1	225	5.2	191.56	83.5
4	5.0	204	5.1	187.69	90.2
6	5.0	204	5.6	189.00	82.7
5**					
					414.1

*Standard concentration: 0.5 ng/ul

Amount of spiked sample: 100 gr

Concentration of sample: 1 ppm of dimethoxon

Sample final diluation volume: 200 ml

**Masked by solvent front

Standardization results:

% of recuperation: 82.88

Average error: 17.12%

St. deviation: 4.81

Minimum detectable amount: 255 pg

The chromatograms of the dimethoate standard and dimethoate in potato spiked sample are shown in Appendix C, Figure C9. The chromatogram for dimethoxon standard and dimethoxon in potato spiked sample is shown in Appendix C, Figure C10.

2. Results for Sample Analysis: The analysis of potato samples under the experimental conditions and in farmer's samples did not present any detectable residue of dimethoate or dimethoxon.

7. Proposed Maximum Residue Limits for Aldrin and Dimethoate in Potatoes Based on Both Sets of Data as Applied to Colombia

7.1. International Data:

Acceptable Daily Intake (ADI) for Aldrin:	0.0001 mg/kg/day
Codex Maximum Residue Limit for Aldrin in Potatoes:	0.1 mg/kg
Acceptable Daily Intake (ADI) for Dimethoate:	0.02 mg/kg/day
Codex Maximum Residue Limit for Dimethoate:	2 mg/kg

7.2. Colombian Data:

Food Daily Intake:	1/kg/person/day
Potatoes Daily Intake:	0.141 kg/person/ day
Average Body Weight:	60 kg
Mean of Aldrin Residues in Experimental Samples of Potatoes:	0.01 mg/kg
Mean of Aldrin Residues in Farmer's Samples of Potatoes:	0.02 mg/kg
Mean of Dimethoate Residues in Experimental Samples of Potatoes:	No detectable residue
Mean of Dimethoate Residues in Farmer's Samples of Potatoes:	No detectable residue

7.3. Calculation of the Maximum Residue Limit:

Maximum Permissible Intake = ADI x kg body weight

Theoretical Maximum Residue Contribution (T.M.R.C.) = Residue present in harvested crop x food factor x food daily intake

Acceptance of the Tolerance: Comparison between M.P.I. and T.M.R.C.

7.4. Aldrin:

-- Experimental samples:

M.P.I. = 0.0001 x 60 = 0.006 mg/kg

T.M.R.C. = 0.01 x 0.141 x 1.0 = 0.001 mg/kg

Comparison M.P.I. and T.M.R.C.:

0.006 0.001

-- Farmer's samples:

M.P.I. = 0.0001 x 60 = 0.006 mg/kg

T.M.R.C. = 0.02 x 0.141 x 1.0 = 0.00282

0.003 mg/kg

Comparison M.P.I. and T.M.R.C.:

0.006 0.003

7.5. <u>Dimethoate</u>:

-- Experimental samples:

No detectable residue

-- Farmer's samples:

No detectable residue

7.6. <u>Proposed Maximum Residue Limits</u>: According to the results it will be wise for the country to accept the Codex maximum residue limits for aldrin and dimethoate in potatoes which are: 0.01 mg/kg for aldrin and 2.0 mg/kg for dimethoate.

SUMMARY

The object of this paper was to describe the parameters or variables that must be taken into consideration in the establishment of the maximum reside limits of pesticides in harvested food products.

The fundamental reason for this description is to present jointly those parameters which, at a given moment,

due to the available infrastructure in Colombia and the nature of the research done internationally, could be accepted as valid for Colombia without undermining those parameters which, due to their specific nature must be studied in the conditions of the country.

The importance of this study lies in the fact that it is a basic document that makes it possible to formulate a policy on pesticide residues and tolerances for Colombia on the basis of international research and discussion of such questions as was described earlier in this paper.

The suggested parameters for the country in establishing the maximum permissible limits of pesticide residues are:

1. The methodology used by the Environmental Protection Agency and by FAO/WHO in the establishment of tolerances.
2. The Acceptable Daily Intake's (ADI's) proposed by the Joint Meeting FAO/WHO (JMPR) because of the serious and responsible toxicological evaluation done by the Meeting of scientific research submitted for its consideration.
3. The maximum residue limits suggested at the international level by the Codex Alimentarius of the FAO; they are based on JMPR suggestions. One may accept or reject these suggestions, once the ranges of oscillation of residues in food products have been verified and once

the tolerance in the food consumption conditions for Colombia have been calculated.

The parameters studied in the conditions in Colombia are:

1. A legal and administrative groundwork for pesticides as the basis for developing a program on residues and maximum residue limits.
2. A compendium of studies on pesticide residues and available resources as the basis for the possible implementation of this type of study in Coloubia.
3. Per capita/day consumption of food to define the food factor in local conditions; this is important for calculating the "theoretical maximum contribution of the residue."
4. The average weight of the Colombian consumer in order to calculate the Maximum Permissible Intake in individuals.
5. Agricultural practices used in growing potatoes as recommended officially and as actually done by farmers. This would serve as the basis for making a suitable experimental design for residues, including those most widely used pesticides in Colombia.
6. Field experiments and sampling that must be done because it is the most important source

of information on residues present in food products; this would be done with a view to establishing maximum residue limits.

7. Methods of residue analysis for the validity of the results obtained and the recommendation made on the basis of the results.

8. Suggestion of the maximum residue limit for aldrin and dimethoate; the respective calculation would be done to do this, including the toxicological parameters adopted in international studies and those obtained at the national level. On the basis of the study done and adjustment made on the resulting parameters, it is possible to suggest that the maximum residue limits of aldrin and dimethoate residues in potatoes for Colombia are 0.1 mg/kg for aldrin and 2.0 mg/kg for dimethoate.

The following table shows a summary of the parameters described in this paper, their source and objective.

Parameters Involved in the Establishment of
the Maximum Permissible Limits of Pesticide Residues

Information Source	Parameter	Parameter Objectives
INTERNATIONAL LEVEL:		
EPA-FAO/WHO	Discussion of chemical and toxicological variables	Procedure followed to establish maximum residue limits
JOINT MEETING FAO/WHO (JMPR)	Toxicological evaluation of international information submitted	Establishment of ADI's for different pesticides
CODEX Committee on Pesticide Residues (CCPR), FAO	Studies proposed internationally	Recommendation of maximum residue limits to governments
NATIONAL LEVEL:		
Ministries-Agriculture-Health	Legislation on pesticides	Legal and administrative groundwork
Institutes-Universities	Current state of studies on residues	Basic to the approach to the activity to be undertaken
IIT, INS, ICA Pesticide Group	Resources for the analysis and the approach to research	Possibility of implementing the activity in the country
ICBP-PAM	Per capita consumption of food	Determine the food factor in the conditions of the country

ICBF	Average weight of Colombian consumer	Calculation of daily intake per kg of weight
ICA-Farmers	Utilization of pesticides on crops	Determine correct agricultural practices that minimize presence of residues
ICA	Experimentation and sampling	Source of information on pesticides and pesticide residues
ICA AOAC Pesticide Industry	Analytical techniques for pesticides	Validity of results obtained
ICA	Proposed maximum residue limits to Ministry of Health	Bringing together toxicological information obtained internationally and nationally defined parameters

CONCLUSIONS AND RECOMMENDATIONS

1. International interest in pesticide residues in food has lead to governments designing administrative and technical methods that can provide information on, and solutions to, this problem.
2. It must be mentioned that as far as the standardization of residues and maximum residue limits, with the exception of Brazil and Argentina, all of the other Latin American countries have not gone very far in this area even though some of them, like Colombia, already have the means to make significant development in this area in the short term.
3. There are good possibilities for developing residues related work in Colombia if you remember that the laws on pesticides are workable, and there is an effective infrastructure and a history of work done in this field. The interest demonstrated by the Inter-Institution Residue Group and the ICA residue program that has been turned into a pilot program by COLOCIENCIAS are promising signs.
4. Agencies like the World Health Organization (WHO), the FAO and the Environmental Protection Agency have done basic far-reaching work that is scientifically serious and responsible. For this reason, they are sources of information on the procedures and evaluations of

toxicological data in the process of establishing maximum residue limits.

5. The parameters and variables that have been defined by the three agencies mentioned in the preceding point in the area of maximum residue limits (and that are recommended her to be accepted in Colombia for the calculation of maximum residue limits) are:

   -- The procedures for establishing maximum residue limits employed by the EPA, FAO/WHO. These procedures include all of those aspects related to the toxicological research for the study and establishment of these maximum residue limits.

   -- The Acceptable Daily Intakes (ADI's) suggested by the FAO/WHO Joint Meeting. For those products not having an ADI defined by the meeting for which a maximum residue limit must be established for Colombia, the suggestion is made that the Ministry of Health be responsible for defining the parameter, preferably following the methodology used by the JMPR to evaluate toxicological questions.

   -- The international maximum residue limits suggested by the CODEX ALIMENTARIUS. These maximum residue limits should be accepted with the condition that the limits of residues found in experiments conducted in Colombia be verified and the maximum residue limit intake be calculated in accordance with local food consumption.

6. Among those parameters studied in Colombia, the following ones may be considered permanent until new studies are completed or new surveys conducted:
   - -- Per capita food consumption -- one kilogram
   - -- Average weight of Colombian consumer -- 60 kilograms
7. Parameters such as the per capita/day/food consumption under study. In this case: potatoes, 0.141 kilograms; this parameter can be obtained by doing the necessary calculation using the data found in this paper.
8. The parameter "good agricultural practice" must be defined in accordance with the technical recommendations tested in the country for the handling of the crop with special emphasis on the use of pesticides. The priority of the pesticides to be studied should be established through surveys done among farmers; these surveys are useful for finding out the way farmers use pesticides, especially in terms of doses and frequency of application. The purpose of this is to include a series of treatments that include the ones used by farmers in the experimental design. The format for

surveys presented in Appendix B, Table B4 which could be modified to adapt itself to different crops can be used for conducting surveys and would make it easier to do tabulation and computer work.

9. The field experiments for determining the levels of residues and the samples produced from those experiments must conform to internationally recognized methodologies and norms that are considered valid for this type of work.
10. The sampling of the product must follow a previous accepted methodology according to the nature of the product. Almost for every product there is a different methodology. It is important to establish the conditions in which the sample will be treated specifically: reduction, transportation and storage. One must keep in mind that the analysis is carried out in the edible part of the product.
11. The analytical methods used to determine residues must be specific for each pesticide studied; preferably, internationally recommended methods should be employed or those methods that clearly prove that they satisfy the requirements for a valid analysis.
12. The level of residues found in experimental and farmer potato samples analyzed for aldrin and dimethoate had no significant quantification even with higher doses

and application frequencies. The average levels obtained were:

Experimental Sample:	Aldrin 0.01 mg/kg	
	Dimethoate -	no detectable residue
Farmer Samples:	Aldrin 0.02 mg/kg	
	Dimethoate -	no detectable residue

13. On the basis of observing all of the parameters discussed in this paper and on the calculation of maximum residue limits using the results obtained, in Colombia, an acceptable maximum residue limit for aldrin in potatoes is 0.1 mg/kg and for dimethoate in potatoes is 2.0 mg/kg.

The final evaluation that can be given to the present work and to the developmental activities in Colombia to obtain a beginning of a program of residues and maximum residue limits can be summarized by the following points:

a. Preparation of the first study on residues and tolerances that was made considering Colombian conditions.

b. Achieving the announced objectives of the project which final ends were to fix value to certain parameters, present precise conclusions and recommendations, and to present a proposal for maximum residue limits for aldrin and dimethoate in potatoes.

c. The proposal of these maximum residue limits implies the beginning in this country of a series of studies can be made for the establishment of new maximum residue limits of other pesticides and crops, to detect problems in the use of the pesticides in crops, to advance programs for greater utilization of those products that tend to reduce residues, and to establisha control over the appearance of residues on products in the markets.

d. This work is a basic document for the elaboration of legislature concerning residues in that it clarifies concepts that until now have been ignored in large part by persons involved in the agricultural and health fields.

e. Even though the work until now has been done by the Ministry of Agriculture, means have been shown of coordination with other institutions particularly the Ministry of Health, the entity that ultimately has the authority to legalize the maximum residue limits in the country and to enforce them.

f. The evaluation of activities advanced to obtain the beginning of the program of residues and tolerances in Colombia can be summarized by the fact that, starting from nothing, the three years of study, organization and coordination with other national and international institutions have been raised to a "pilot project for the country" as recognized by COLCIENCIAS, the most prestigious research institution in the country. This indicates a good future for research on pesticide residues and the necessary support to obtain the program of residues and maximum residue limits at the national level that was desired from the start.

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APPENDICES

APPENDIX A

DATA TO DEFINE COLOMBIAN FOOD CONSUMPTION

APPENDIX A

TABLE A1. Individual interview for food consumption by students

Place__________________ Date_______ Interview Nº_______

Head of the family____

Student's name________________ Age____ Sex_____________

Menu	Ingredients	Amount	Consumption in grams
Breakfast			
Morning snacks			
Lunch			
Afternoon snacks			
Dinner			

Observations: ____

____

____

APPENDIX A

TABLE A2. Zones, towns and number of families and persons in each one of the interviewes:

(ICBF, 1972) and (PAN, 1977)

Colombian Institute of Family WAlfere (ICBF) Interviews

Zones	Cities	No families	No persons
Atlantic Coast			
Atlantico	Barranquilla	33	279.5
Bolivar	Cartagena	38	304.5
Cordoba	Monteria	39	296.7
Guajira	Riohacha	38	241.5
TOTAL	4	148	1,122.0
Antioquena			
Caldas	Medellin	38	313.9
Antioquia	Rionegro	37	288.0

National Plan for Food and Nutrition (PAN) Interviews

Zones	Cities	No families	No persons
Atlantic Coast			
Atlantico	Magangue	100	767.0
Bolivar	Carmen de B.	95	731.5
Magdalena	Pinillos	100	726.0
	Barranquilla	99	800.0
	Sabanalarga	99	752.4
	Campo de la C.	98	758.5
	Manati	98	863.4
	Repelon	100	778.0
	Cienaga	100	732.0
	Pivijay	100	686.0
	Aracataca	100	746.0
	Tenerife	100	658.0
	Guamal	100	813.0
	Pueblo Viejo	100	778.0
	14	1,389	10.590.7
Antioquena			
Caldas	Guatica	98	683.1
Risaralda	mistrato	99	728.6

TABLE A2. (cont.)

Zones	Cities	No families	No persons
Antioquena			
Quindio	Girardota	37	314.7
Risaralda	Manizales	37	303.0
	Chinchina	38	306.1
	Armenia	37	277.1
	Pereira	37	289.0
TOTAL	7	261	2,091.9
Caucana			
Valle del Cauca	Cali	38	274.0
Cauca	Buenaventura	37	271.0
Choco	Puerto Tejada	37	240.0
	Popayan	37	230.3
	Quibdo	38	306.0
	5	187	1,322.0
Cundinamarca /Boyaca			
	Bogota	36	460.9
	Girardot	36	220.4
	La Mesa	37	230.6
	Tunja	35	231.9

Zones	Cities	No families	No persons
Antioquena			
	Quinchia	101	723.2
	Arma-Aguadas	99	653.4
	El Tablazo	100	724.0
	La Cabana	100	691.0
	Marmato	100	700.0
	7	697	4,093.3
Caucana			
Valle del Cauca	Piendamo	100	632.0
	Rosas	100	691.0
	Coconuco	100	655.0
	Zarzal	100	746.0
	Buenaventura	100	679.0
	Bolivar	100	655.0
	6	600	4,038.0
Cundinamarca /Bogota D.E.			
	Bogota-Usme	100	631.0
	Bogota-Paulo VI	99	598.9
	Bogota-Chircales	100	711.0
	Bogota-Tunjuelito	100	568.0

TABLE A2. (cont.)

Zones	Cities	No families	No persons
Cundinamarca			
	Duitama	38	260.5
TOTAL	5	182	1,404.3
Villavicencio	Villavicencio	-	253.3
Narino	Pasto	-	291.3
	La Union		220.5
TOTAL	2	-	511.8
Santandereana			
Santanderes	Bucaramanga	37	242.7
	San Gil	37	270.6
	Cucuta	38	296.1
	Pamplona	38	278.3
TOTAL	4	150	1,087.8
Tolimense			
Tolima	Ibague	38	284.1

Zones	Cities	No families	No persons
Cundinamarca			
TOTAL	4	399	2,508.9
Santandereana			
Santander Norte	Zulia	100	750.0
	Tachira	100	782.0
	Ragonvalia	100	724.0
	Teorama	100	701.0
TOTAL	4	400	2,957.0
Tolimense			
Tolima	Dolores	100	601.0

TABLE A2. (cont.)

Zones	Cities	No families	No persons
Tolimense			
Huila	Guamo	37	249.1
	Neiva	38	279.0
TOTAL	3	112	812.3
Territorios Nacionales	Florencia	-	289.6
San Andres Islas	Islenos	88	675.0
	Continentales	66	450.0
TOTAL		154	1,125.0

Zones	Cities	No families	No persons
Tolimense			
Huila	Purificacion	99	648.4
	Casabianca	100	638.0
	Chaparral	98	608.6
	Planadas	98	642.9
	San Agustin	95	648.9
	Baraya	100	710.0
	Salado Blanco	100	719.0
TOTAL	8	790	5,216.0

APPENDIX A

TABLE A3. The most widely consumed food in the different zones in the country with their corresponding percentages (national diet survey, ICBF, 1972)

	Zone 1. Costa Atlantica			Zone 2. Antioquena		
No	Food	Consump. g/d/p*	% on the total	Food	Consump. g/d/p	% on the total
1	Rice	142	19.1	Brown sugar	143	18.6
2	Milk	141	18.9	Plantain	96	12.5
3	Plantain	74	9.9	Corn	90	11.7
4	Yuca	67	9.0	Potatoe	89	11.5
5	Beef	64	8.6	Milk	87	11.3
6	Sugar cane	48	6.4	Beef	60	7.8
7	Corn	41	5.5	Rice	59	7.7
8	Fish	30	4.0	Yuca	32	4.1
9	Wheat	29	3.9	Wheat	20	2.6
10	Potatoe	23	3.1	Beans	20	2,6
11	Brown sugar	16	2.1	Tomatoe	13	1.7
12	Veg. oil	14	1.8	Veg. grease	11	1.4
13	Tomatoe	13	1.7	Anim. grease	8	1.0
14	Onion	13	1.7	Eggs	7	
15	Anim. grease	8	1.0	Banana	6	
16	Veg. grease	6		Arracacha	6	
17	Eggs	5		Oranges	5	
18	Carrots	3		Sugar cane	4	
19	Cabbage	3		Cabbage	4	
20	Beans	3		Peas	3	
21				Guava	3	
22				Carrots	2	
23				Veg. oil	2	
	TOTAL	743		TOTAL	770	

TABLE A3. (cont.)

	Zone 3. Caucana			Zone 4. Cundinamarca		
No	Food	Consump. g/d/p	% on the total	Food	Consump. g/d/p	% on the total
1	Rice	120	14.6	Potatoe	357	33.8
2	Plantain	119	14.4	Milk	204	19.3
3	Milk	93	11.3	Wheat	80	7.6
4	Potatoes	87	10.6	Brown sugar	79	7.5
5	Wheat	83	10.1	Beef	61	5.8
6	Sugar cane	66	8.0	Rice	61	5.8
7	Brown sugar	46	5.6	Plantain	32	3.0
8	Beef	37	4.5	Banana	28	2.6
9	Tomatoe	31	3.8	Corn	26	2.5
10	Veg. grease	25	3.0	Yuca	23	2.1
11	Corn	24	2.9	Sugar cane	15	1.4
12	Yuca	17	2.1	Orange	11	1.0
13	Fish	13	1.6	Peas	10	
14	Eggs	12	1.5	Tomatoe	10	
15	Onion	11	1.3	Carrots	9	
16	Beans	7	0.8	Arracacha	9	
17	Banana	7		Eggs	7	
18	Carrot	6		Onion	7	
19	Oil	6		Fish	6	
20	Cabbage	5		Cabbage	5	
21	Orange	5		Oil	5	
22	Peas	2		Lima beans	4	
23	Lenteja	2		Veg. grease	3	
24				Beans	3	
25				Guava	2	
	TOTAL	824		TOTAL	1,057	

TABLE A3. (cont.)

Zone 5. Villavicencio | Zone 6. Narino

No	Food	Consump. g/d/p	% on the total	Food	Consump. g/d/p	% on the total
1	Potatoes	186	21.6	Potatoes	247	25.6
2	Brown sugar	109	12.7	Wheat	105	10.9
3	Milk	95	11.0	Plantain	84	8.7
4	Beef	82	9.5	Sugar cane	82	8.5
5	Plantain	71	8.3	Milk	81	8.4
6	Wheat	67	7.8	Beef	79	8.2
7	Rice	53	6.2	Rice	71	7.4
8	Corn	35	4.1	Yuca	57	5.9
9	Yuca	18	2.1	Brown sugar	38	3.9
10	Sugar cane	15	1.7	Lima Beans	29	3.0
11	Eggs	15	1.7	Peas	14	1.4
12	Tomatoes	14	1.6	Tomatoes	14	1.4
13	Carrots	13	1.5	Corn	12	1.2
14	Peas	12	1.4	Eggs	10	1.0
15	Bananas	12	1.4	Cabbage	9	
16	Veg. grease	11	1.3	Veg. oil	7	
17	Veg. oil	8	0.9	Veg. oil	7	
18	Lenteja	7		Onion	6	
19	Cabbage	7		Veg. grease	4	
20	Guava	7		Arracacha	3	
21	Arracacha	6		Animal grease	3	
22	Oranges	6		Bananas	2	
23	Onion	5		Beans	1	
24	Beans	4				
25	Animal grease	2				
	TOTAL	860		TOTAL	965	

TABLE A3. (cont.)

No	Zone 7. Santandereana Food	Consump. g/d/p	% on the total	Zone 8. Tolimense Food	Consump. g/d/p	% on the total
1	Potatoes	175	18.4	Potatoes	118	15.3
2	Milk	165	17.3	Milk	99	12.8
3	Brown sugar	101	10.6	Plantain	99	12.8
4	Wheat	93	9.8	Beef	69	8.9
5	Beef	70	7.4	Rice	69	8.4
6	Plantain	70	7.4	Brown sugar	66	8.5
7	Yuca	67	7.0	Wheat	46	6.0
8	Rice	53	5.6	Corn	40	5.2
9	Corn	28	2.9	Yuca	33	4.3
10	Sugar	23	2.4	Sugar	25	3.2
11	Tomatoes	19	2.0	Tomatoes	23	3.0
12	Banana	16	1.7	Veg. grease	12	1.5
13	Onion	11	1.2	Arracacha	11	1.4
14	Eggs	9	0.9	Peas	9	1.2
15	Peas	9		Carrots	9	1.2
16	Carrots	8		Beans	8	1.0
17	Veg. oil	6		Onion	8	
18	Veg. grease	6		Bananas	7	
19	Cabbage	5		Guava	5	
20	Arracacha	5		Eggs	4	
21	Fish	4		Fish	4	
22	Lima beans	4		Veg. oil	4	
23	Guava	4		Cabbage	3	
24				Oranges	2	
	TOTAL	951		TOTAL	773	

TABLE A3. (cont.)

	Zone 9 Territorios Nales.			Zone 10. San Andres Islas		
No	Food	Consump. g/d/p	% on the total	Food	Consump. g/d/p	% on the total
1	Plantain	192	21.1	Sugar cane	146	12.9
2	Beef	116	12.8	Rice	131	11.5
3	Milk	114	12.5	Beef	124	10.9
4	Brown sugar	91	10.0	Wheat	104	9.1
5	Potatoes	77	8.5	Plantain	100	8.8
6	Rice	71	7.8	Yuca	85	7.5
7	Corn	61	6.7	Milk	81	7.1
8	Yuca	41	4.5	Coconut	56	4.9
9	Wheat	33	3.6	Fish	50	4.4
10	Tomatoes	25	2.7	Potatoes	49	4.3
11	Veg. grease	23	2.5	Oranges	30	2.6
12	Arracacha	11	1.2	Brown sugar	28	2.5
13	Onion	10	1.1	Eggs	24	2.1
14	Sugar cane	9	0.9	Tomatoes	23	2.0
15	Eggs	7		Corn	20	1.8
16	Peas	7		Veg. oil	18	1.6
17	Oranges	7		Veg. grease	17	1.5
18	Carrots	5		Onion	12	1.1
19	Cabbage	3		Cabbage	10	
20	Animal grease	3		Beans	9	
21	Guava	2		Carrots	9	
22	Bananas	1		Bananas	5	
23				Animal grease	3	
	TOTAL	909		TOTAL	1,134	

* gram/day/person

APPENDIX A

TABLE A4. The most widely consumed foods in the different zones of the country with their corresponding percentages (food habits survey, PAN, 1977)

	Zone 1. Costa Atlantica			Zone 2 Antioquena		
No	Food	Consump.* g/d/p	% on total	Food	Consump. g/d/p	% on the total
1	Yuca	163.48	17.66	Brown sugar	227.64	25.75
2	Milk	162.09	17.51	Plantain	91.89	10.19
3	Rice	151.26	16.34	Corn	90.20	10.00
4	Sugar cane	64.12	6.93	Potatoes	65.81	7.29
5	Plantain	42.50	4.56	Milk	54.02	5.99
6	Beef	34.29	3.70	Beef	48.68	5.40
7	Yuca bread	31.56	3.41	Rice	45.00	4.99
8	Potatoes	28.20	3.04	Oranges	37.85	4.20
9	Suero	22.61	2.44	Yuca	24.76	2.75
10	Fish	21.90	2.36	Beans	24.18	2.68
11	Salt	20.51	2.22	Salt	18.35	2.03
12	Veg. oil	16.95	1.83	Bananas	17.48	1.94
13	Brown sugar	16.71	1.80	Cocoa	16.94	1.84
14	Squash	16.61	1.79	Sugar cane	12.30	1.36
15	Cheese	15,48	1.67	Veg. grease	11.59	1.28
16	Coffee	14.64	1.58	Corn flour	8.82	1.00
17	Wheat flour	12.65	1.37			
18	Wheat pasta	11.77	1.27			
19	Corn	10.68	1.15			
20	Tomatoes	9.46	1.02			
21	Eggs	8.75	1.00			
	TOTAL	925.87		TOTAL	902.07	

TABLE A4. (cont.)

	Zone 3. Valle - Cauca			Zone 4. Cundinamarca		
No	Food	Consump. g/d/p	% on total	Food	Consump. g/d/p	% on the total
1	Potatoes	128.75	14.79	Potatoes	277.21	32.10
2	Brown sugar	107.56	12.35	Milk	121.28	14.03
3	Milk	106.13	12.19	Brown sugar	88.37	10.24
4	Rice	77.16	8.86	Rice	61.03	7.90
5	Plantain	59.05	6.78	Yuca	27.43	3.10
6	Yuca	57.73	6.63	Corn	20.65	2.30
7	Corn	44.27	5.08	Bread	19.89	2.30
8	Sugar cane	35.60	4.10	Kidney bean	17.61	2.0
9	Beef	34.26	3.97	Salt	17.43	2.0
10	Salt	19.10	2.19	Onion	16.07	1.80
11	Beans	17.43	2.00	Wheat pasta	15.41	1.7
12	Veg. grease	13.72	1.58	Carrots	13.56	1.3
13	Bread	12.63	1.45	Beef	10.31	1.10
14	Coffee	10.77	1.24	Sugar cane	9.67	1.10
15	Onion	10.15	1.12	Cocoa	9.47	1.10
16	Squash	9.18	1.05	Plantain	9.42	1.00
17	Fish	9.00	1.03	Veg. grease	9.13	1.00
18	Wheat pasta	9.00	1.03	Caffee	8.22	1.00
19	Bananas	8.66	1.00			
20	Carrots	8.66	1.00			
21	Tomatoes	8.35	1.00			
	TOTAL	850.55		TOTAL	863.15	

TABLE A4. (cont.)

	Zone 5. Santander Norte			Zone 6. Tolima - Huila		
No	Food	Consump. g/d/p	% on total	Food	Consump. g/d/p	% on the total
1	Yuca	130.43	13.12	Plantain	115.11	12.32
2	Milk	129.54	13.03	Potatoes	108.29	11.59
3	Potatoes	89.35	8.99	Brown sugar	85.44	9.15
4	Brown sugar	83.76	8.42	Rice	76.66	8.21
5	Plantain	71.00	7.14	Beef	66.47	7.12
6	Rice	69.12	6.95	Yuca	55.55	5.95
7	Corn	51.18	5.15	Corn	40.81	4.37
8	Beef	41.17	4.14	Sugar	28.06	3.00
9	Salt	22.48	2.26	Beans	20.54	2.20
10	Bread	20.77	2.09	Arracacha	19.70	2.11
11	Beans	19.90	2.00	Veg. grease	15.49	1.66
12	Coffee	18.43	1.86	Salt	15.18	1.62
13	Wheat pasta	17.78	1.79	Carrots	14.48	1.55
14	Corn floue	16.42	1.66	Wheat pasta	13.77	1.47
15	Oranges	14.91	1.50	Tomatoes	13.52	1.45
16	Sugar cane	10.95	1.10	Bread	11.58	1.24
17	Tomatoes	10.55	1.06	Cocoa	11.00	1.18
18	Eggs	10.45	1.05	Eggs	10.59	1.13
19	Fish	9.50	1.00			
	TOTAL	994.20		TOTAL	934.13	

* Average gams/day/person

APPENDIX B

DATA TO DEFINE "GOOD AGRICULTURAL PRACTICE"

APPENDIX B

TABLE B1. Pesticide recommended by ICA in potato crop

Major Pests	Pesticides	Prehavest Applications: Rate of Active Ingredient Kg./Ha.	Number of Aplications	Days between Applications	Interval to Harvest(Days)	Rate of Active Ingredient	Formulation
WEEDS	HERBICIDES						
Amarantus sp.	Linuron	1.5	1	pre-emerg		47%	W.P.
Capsella bursa-pastoris	Terbutrina	2.0	1			47%	W.P.
Chenopodium paniculatum	Metobromuron	2.0	1	pre-emerg		50%	W.P.
Polypogum segetum	Diuron	1.2	1	pre-emerg		80%	W.P.
Rumex sp.							
Malva silvestris	Metribuzin	0.6	1	pre-emeg.		35%	W.P.
Lepidium bipinarifidium	Prometrina	1.0	1	pre-emerg		48.5%	W.P.
Sperguia arvenis						80%	W.P.
						500 g/1	E.C.
Veronica persica	Dinoseb acetate	2.5	1	pre-emerg		500 g/1	E.C.
	Alachlor	3.0	1	pre-emerg		480 g/1	E.C.
DISEASES	FUNGICIDES						
Phitophthora infestans	Zineb	4.0	10	10	50	70%	W.P.

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest (Days) [6]	Rate of Active Ingredient	Formulation
Phitoptora infestans	Maneb	4.0	10	10	50	80%	W.P.
Puccinia pittieriana	Propineb	4.0	10	10	50	70%	W.P.
	Phentin hidroxide	0.2	10	10	50	20%	W.P.
	Phentin acetate + Maneb	0.2	10	10	50	60+20 %	W.P.
	Cooper oxichlor	2.5	10	10	50	35% Cu	W.P.
	Captaphol	0.2	10	10	50	80%	W.P.
	Captan	0.5	10	10	50	50%	W.P.
Rhizoctonia solani	Tiabendazol	0.3%	seed treat.			450 g/1	F.W.
INSECTS	INSECTICIDES						
Premnotrypes vorax	Carbofuran	1.0	3, plant. germi. hilli.	30	100	3% 5% 10% 360 g/1 480 g/1 75%	G. F.W. F.W. W.P.
Ancognatha scarabaeoides Agrotis ipsilon	Aldrin	1.0	1, plant.		150	2.5% 5% 238 g/1 38%	D E.C. W.P.

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest (Days) [6]	Rate of Active Ingredient	Formulation
Agrotis ipsilon Euxoa sp	Chlordane	2.0	1, plant.		150	420 g/1 583 g/1 958 g/1 5% 10% 26% 40%	E.C. E.C. E.C. D W.P.
	Heptachlor	1.0	1, plant.		150	2.5% 5% 3% 259 g/1 25%	D G E.C. W.P.
	Trichlorfon	1.0	1, germ. to soil		120	3% 80% 95% 3.4 %	G S.P. B
	Canphechlor-DDT	2.0	1, germ. to soil		120	480-240 g/1 170-69g/1 7-3% 20%	E.C. E.C. D B
Copitarsia consueta	Aldicarb	2.0	2, plant. Hilli.	60	100	10% 15%	G
Peridroma sp. (post-saucia)	Phorato	1.5	1, plant.	the effect still for 40 days. New applic. only when there are 50 larvae/plant		916 g/1 5%	E.C. G.

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest(Days) [6]	Rate of Active Ingredient	Formulation
Copitarsia consueta Peridroma sp (post-saucia)	Disulfoton	2.0	1,plant.	the effect still for 40 days. New applic. only when there are 50 larvae /plant.		5%	G
	Methomyl	1.0	1, plant.	I d e m		90% 216 g/1 1.25%	S.P. E.C. G
	Endosulfan	1.0	1,plant.	I d e m		350 g/1 245 g/1 3% 4% 50 % 4%	E.C. E.C. G W.P. D
	Dichloro-di(ethyl-phenyl)ethane	1.5	1. plant.	I d e m		480 g/1	E.C.
	Azinphosmethyl	0.5	1, plant.	I d e m		250 g/1	E.C.
Epitrix sp	Aldicarb	2.0	2, plant. hilli.	60	100	10% 15%	G
	Phorato	1.5	3	15	60	916 g/1 5%	E.C. G
	Disulfoton	2.0	3	15	60	5%	G
	Carbaryl	0.5	3	15	60	370 g/1	F.W.

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest (Days) [6]	Rate of Active Ingredient	Formulation
Epitrix sp.	Carbaryl	0.5	3	15	60	3% 4.5% 5% 80%	G D W.P.
	Bromophos ethyl	1.5	3	15	60	800 g/1	E.C.
	Dichloro-di(ethyl-fenhyl)ethane	1.5	3	15	60	480 g/1	E.C.
	Chlorpiriphos	0.5	3	15	60	480 g/1 360 g/1 5%	E.C. E.C. G
	Methamidophos	0.5	3	15	60	600 g/1	S.C.
	Carbofuran	0.75	3, plant. germi. hilli.	30	100	480 g/1 360 g/1 5% 10% 75%	F.W. F.W. G W.P.
	Methomyl	0.25	3	15	60	216 g/1 90% 1.25%	F.W. S.P. G
	Azinphosmethyl	0.5	3	15	60	250 g/1	E.C.
Liriomyza quadrata	Aldicarb	2.0	2, plant. hilli.	60	100	10% 15%	G

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest (Days) [6]	Rate of Active Ingredient	Formulation
Liriomyza quadrata	Phorato	1.5	3	15	60	916 g/1 5%	E.C. G
	Disulfoton	2.0	2-4 if there are more than 20 adults/10 swiips net				
	EPN	0.5	I d e m		60	480 g/1	E.C.
	Dichloro-di(ethyl-fenyl)ethane	1.5	I d e m		60	480 g/1	E.C.
	Chlorpirifos	0.5	I d e m		60	480 g/1 360 g/1 5%	E.C. E.C. G
	Bromophos ethyl	1.5	I d e m		60	800 g/1	E.C.
	Metamidofos	0.5	3	15	60	600 g/1	S.C.
	Carbofuran	0.75	3, plant. germi. hilli.	30	100	480 g/1 5% 10% 75%	F.W. G
	Methomyl	0.25	3	15	60	216 g/1 90% 1.25%	F.M. S.P. G
	Azinphosmethyl	0.5	3	15	60	250 g/1	E.C.

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest(Days) [6]	Rate of Active Ingredient	Formulation
Mysus persicae *Macrosiphum euphorbiae*	Malathion	0.5	3	15	60	604 g/1 1000 g/1 1180 g/1 4%	E.C. E.C. ULV D
	Dimethoate	0.5	3	15	60	400 g/1 500 g/1	E.C. E.C.
	Oxidemethon methyl	0.7	3	15	60	250 g/1 500 g/1	E.C. E.C.
	Phosphamidon	0.7	3	15	60	500 g/1 1000 g/1 250 g/1	S.C. S.C. ULV
	Endosulfan	0.75	3	15	60	300 g/1 245 g/1 300 g/1 3% 4% 50% 4%	E.C. E.C. ULV G W.P. D
	Thiomethon	0.5	3	15	60	250 g/1	E.C.
	Dsulfoton	1.5	3	15	60	5%	G
	Azinphosmethyl	0.5	3	15	60	250 g/1	E.C.

TABLE B1. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest (Days) [6]	Rate of Active Ingredient	Formulation
Scrobipalpula absoluta	Dichloro-di(ethylfenyl)ethane	1.5	3	15	60	480 g/1	E.C.
	EPN	0.5	3	15	60	480 g/1	E.C.
Liriomyza ecuadorensis	Chlorpiriphos	0.5	3	15	60	480 g/1 360 g/1 5%	E.C. ULV G
	EPN	0.5	4	15	60	480 g/1	E.C.
	Dichloro-di(ethylfenyl)ethane	1.5	4	15	60	480 g/1	E.C.
Deroceras reticulatum	Methaldhido	7%	baits applied near the plant in soil		60	7%	G
Milax gagates	Methiocarb	2%	I d e m		60	2%	G
	Carbaryl	4%	I d e m		60	370 g/1 3% 4.5% 5% 80% 85%	F.M. G D W.P.

APPENDIX B

TABLE B2. Interview on pesticide use in potato crop

State________________ City______________ Date______

Rural area____________ Farm__________ Planting area_______

Pesticide application method

Manual equipment: Yes________ No ______

Description Capacity

________________________ ________________

________________________ ________________

Mechanical equipment: Yes______ No_____

Description Capacity

________________________ ________________

________________________ ________________

Weed Control: Manual______
Mechanical ______
Chemical ______

Herbicides used (commercial names and active ingredient concentration)

Name	Doses	App. time	Controlled weeds
________________	_____	_________	________________
________________	_____	_________	________________

Number of herbicide applications: Weekly______
Monthly _____
Seasonal ____

Diseases control: Yes_____ No_____

Fungicides used (commercial name and active ingredient concentration)

Name	Doses	App. time	Controlled diseases
_________________	____	_________	_______________
_________________	____	_________	_______________

TABLE B2. (cont.)

Number of fungicide applications: Weekly_______
Monthly______
Seasonal_____

Insect control: Yes____ No ____

Insecticides used (commercial names and active ingredient concentration)

Name	Doses	App. time	Controlled insects
________________	_____	_________	__________________
________________	_____	_________	__________________

Number of insecticide applications: Weekly _____
Monthly ____
Seasonal ____

Mixture of pesticides: Yes ____ No ____

Mixtures used	Doses	Application time
________________________	_____	________________
________________________	_____	________________

Number of mixture applications: Weekly _____
Monthly_____
Seasonal _____

Last pesticide used in the crop

Name - concentration	Doses	App. time (before harvesting)
____________________	_____	_________________________
____________________	_____	_________________________

Who did recommend the used pesticide in the crop: Neighbor___
Agronomist_____________ Dealer________ Other_______

Who did recommend the used pesticide doses: Label__________
Neighbor_________ Dealer______ Agronomist_____ Other_______

Do you use temik (Aldicarb) Yes_____ No _______

TABLE B2. (cont.)

When do you use temik: Planting time_____ Hilling_____

Doses of temik used_______________________________

Do you use furadan (Carbofuran) Yes____ No ____

When do you use furadan: planting time____ germination____
Hilling____ Doses used________________

Additional information:

Labor during the season	Days after planting
First manual weed control	________________
Hilling	________________
Harvesting	________________

Use given to the product:

Storage Yes____ No ____ How long ________

Marketing Yes____ No ____ Where________________

Processing Yes____ No ____ Where________________

Exportation Yes____ No ____ Where________________

Own consumption Yes ____ No ____ How: pealing______
without pealing____

Observations:_______________________________________

____

____

APPENDIX B

TABLE B3. Pesticides used by farmers in potato crop

Major Pests 1	Pesticides 2	Prehavest Applications: Rate of Active Ingredient Kg./Ha. 3	Prehavest Applications: Number of Aplications 4	Prehavest Applications: Days between Applications 5	Prehavest Applications: Interval to Harvest (Days) 6	Rate of Active Ingredient	Formulation
DISEASES							
<u>Phitophtora infestans</u>	Maneb	1.92	5	19	51	80%	W.P.
	Mancozeb	2.00	4	25	51	80%	W.P.
	Fentin hidroxide	0.33	7	13	47	20%	W.P.
	Fentin acetate	0.88	4	23	50	54%	W.P.
	Cooper oxichloride	0.78	10	14	46	35%	W.P.
<u>Puccinia pittieriana</u>	Sulphur	1.56	3	38	68	80%	W.P.
INSECTS	INSECTICIDES						
<u>Premnotrypes vorax</u>	Carbofuran	1.62	3, plant. germ. hilli.	39	72	3%	G.
	Aldicarb	6.18	3, plant. hilli.	73	85	10%	G.
	Metalkamate	0.67	3	37	58	360g/1	E.C.
<u>Agrotis ipsilon</u>	Aldrin	0.62	2, soil	64	105	2.5%	D.
	Methamidophos	0.53	6	16	51	600g/1	F.W.
	DDT	1.48	5	22	70	75%	W.P.

TABLE B3. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Number of Aplications [4]	Days between Applications [5]	Interval to Harvest(Days) [6]	Rate of Active Ingredient	Formulation
Agrotis ipsilon	Diazinon	0.50	6	16	43	600 g/1	E.C.
	Trichlorfon	0.79	6	15	60	80%	S.P.
	Metalkamate	0.67	3	37	58	360 g/1	E.C.
	Canfechloro-DDT	0.99	3	29	45	480-240 g/1 bait	E.C.
Ancognatha scarabaeoides	Aldrin	0.62	2	64	105	2.5%	W.P.
Epitrix sp.	Methamidofos	0.50	5	21	52	600 g/1	E.C.
	BHC	1.14	4	27	56	12%	W.P.
	DDT	1.48	5	22	70	10%	D.
	Diazinon	0.50	6	16	43	540 g/1	E.C.
	Dieldrin	0.20	8	12	30	153 g/1	E.C.
	Dimethoate	0.40	6	17	37	400 g/1	E.C.
	Malathion	0.46	5	16	47	600 g/1	E.C.
	Methyl parathion	0.30	6	17	37	480 g/1	E.C.
	Canfechlor-DDT	0.99	3	29	45	480-240	E.C.
Mysus persicae Macrosiphum euphorb.	Methamidofos	1.14	4	27	56	12%	W.P.

TABLE B3. (cont.)

Major Pests	Pesticides	Prehavest Applications: Rate of Active Ingredient Kg./Ha.	Number of Aplications	Days between Applications	Interval to Harvest(Days)	Rate of Active Ingredient	Formulation
1	2	3	4	5	6		
Mysus persicae							
Macrosiphum euphorbiae	BHC	1.14	4	27	56	12%	W.P.
	DDT	1.48	5	22	70	10%	D.
	Dimethoate	0.40	6	17	37	400 g/1	E.C.
	Methyl paration	0.30	6	17	37	480 g/1	E.C.
	Parathion	0.46	5	18	54	500 g/1	E.C.
	Methomyl	0.73	7	14	50	90%	S.P.
	Diazinon	0.50	6	16	43	540 g/1	E.C.
	Dieldrin	0.20	8	12	30	153 g/1	E.C.
	Metalkamate	0.67	3	37	58	360 g/1	E.C.
Scrobipalpula absoluta	Methamidofos	0.50	5	21	52	600 g/1	E.C.
	Dimethoate	0.40	6	17	37	400 g/1	E.C.
	Dieldrin	0.20	8	12	30	153 g/1	E.C.
	Mehyl parathion	0.30	6	17	37	480 g/1	E.C.
	Parathion	0.46	5	18	54	500 g/1	E.C.
	Methomyl	0.73	7	14	50	90%	S.P.
	Metalkamate	0.67	3	37	58	360 g/1	E.C.

TABLE B3. (cont.)

Major Pests [1]	Pesticides [2]	Prehavest Applications: Rate of Active Ingredient Kg./Ha. [3]	Prehavest Applications: Number of Aplications [4]	Prehavest Applications: Days between Applications [5]	Prehavest Applications: Interval to Harvest (Days) [6]	Rate of Active Ingredient	Formulation
Copitarsia consueta	Diazinon	0.50	6	16	43	540 g/1	E.C.
Peridroma sp. _pos-saucia_	Dimethoate	0.40	6	17	37	400 g/1	E.C.
	Methyl parathion	0.30	6	17	37	480 g/1	E.C.
	Parathion	0.46	5	18	54	500 g/1	E.C.
	Methomyl	0.73	7	14	50	90%	S.P.
	Trichlorfon	0.79	6	15	60	80%	S.P.
	Metalkamate	0.67	3	37	58	360 g/1	E.C.

APPENDIX B

TABLE B4. Survey on pesticide use in crops

Year |_|_| Est. order |_|_|_|_| Sheet No |_|_| Inerview |_|_|_|_|_|

State, Intendencia ________________ |_|_| Town ________ |_|_|_|

Rural area ______________ |_|_| Farm's name __________________

Crop ________________ |_|_| Crop area |_|_|_|_|_|

A. Data about the crop

1. Natural region |_|_|
2. Heigh above sea level |_|_|_|_|
3. Average temperature |_|_| °C
4. Crop variety __________________ |_|_|
5. Length of seasonal period |_|_|_|_| days

B. Pesticide application

1. kind of equipment used ____________________ |_|
2. Capacity of the equipment |_|_|_|
3. Applied volume per hectar |_|_|

C. Weed control

1. How the control is made

   (if herbicides are used fill out the following table)

Name and conc. of herbicide	Doses k/ha or lt/ha	Applic. time	No applic. per season
__________ |_|_|	__________ |_|_|_|	__________ |_|	|_|_|
__________ |_|_|	__________ |_|_|_|	__________ |_|	|_|_|
__________ |_|_|	__________ |_|_|_|	__________ |_|	|_|_|

TABLE B4 (cont.)

Year |__|__| Est. order |__|__|__| Sheet No |__|__| Interview |__|__|__|__|__|__|

D. Diseases control

Name and conc. of fungicide	Doses k/ha or lt/ha	Appl. fre quency	Main disease controled	No appl. per season

E. Insect control

Name and conc. of insecticide	Doses k/ha or lt/ha	Appl. fre quency	Main Insect controled	No appl. per season

F. Mixture of pesticides

Name and conc. of pesticides	Doses k/ha or lt/ha	Appl. frequency	No appl. per season

TABLE B4. (cont.)

Year |_|_| Est. order |_|_|_| Sheet No |_|_| Interview |_|_|_|_|_|_|_|

G. Last applied pesticides

Name and conc. of the last applied pesticide	Doses k/ha or lt/ha	Pre-harvest days application
________ |_|_|_|	________ |_|_|_|	|_|_|_|
________ |_|_|_|	________ |_|_|_|	|_|_|_|
________ |_|_|_|	________ |_|_|_|	|_|_|_|
________ |_|_|_|	________ |_|_|_|	|_|_|_|

H. Crop management

1. Transplant yes [1] no [0] days after plant. |_|_|
2. Planting distance between furrows |_|_|_| cms.
3. Planting distance between plants |_|_|_| cms.
4. First weed control yes [1] no [0] days after plant. |_|_|
5. Second weed control yes [1] no [0] days after palnt. |_|_|
6. Hilling yes [1] no [0] days after plant. |_|_|
7. Harvest days after planting |_|_|
8. Yield of the crop |_|_|_| tons./ha

I. Post-harvest use of the product

1. Storage yes [1] no [0] lenght of storage |_|_|_| days

TABLE B4 (cont.)

Year ____ Est. order _______ Sheet No ______ Interview ________________

2. Marketing	yes	1	Where:	in the farm	1
	no	0		in local maket	2
3. Processing	yes	1		in neighborwood market	3
	no	0			
4. Exportation	yes	1	Where ________________		
	no	0			
5. Family consumption	yes	1			
	no	0			
6. Marketing and family consumption	yes	1			
	no	0			

OBSERVATION

____

____

____

____

APPENDIX C

DATA CONCERNING TO THE ANALYSIS OF ALDRIN AND DIMETHOATE RESIDUES IN POTATO

APPENDIX C

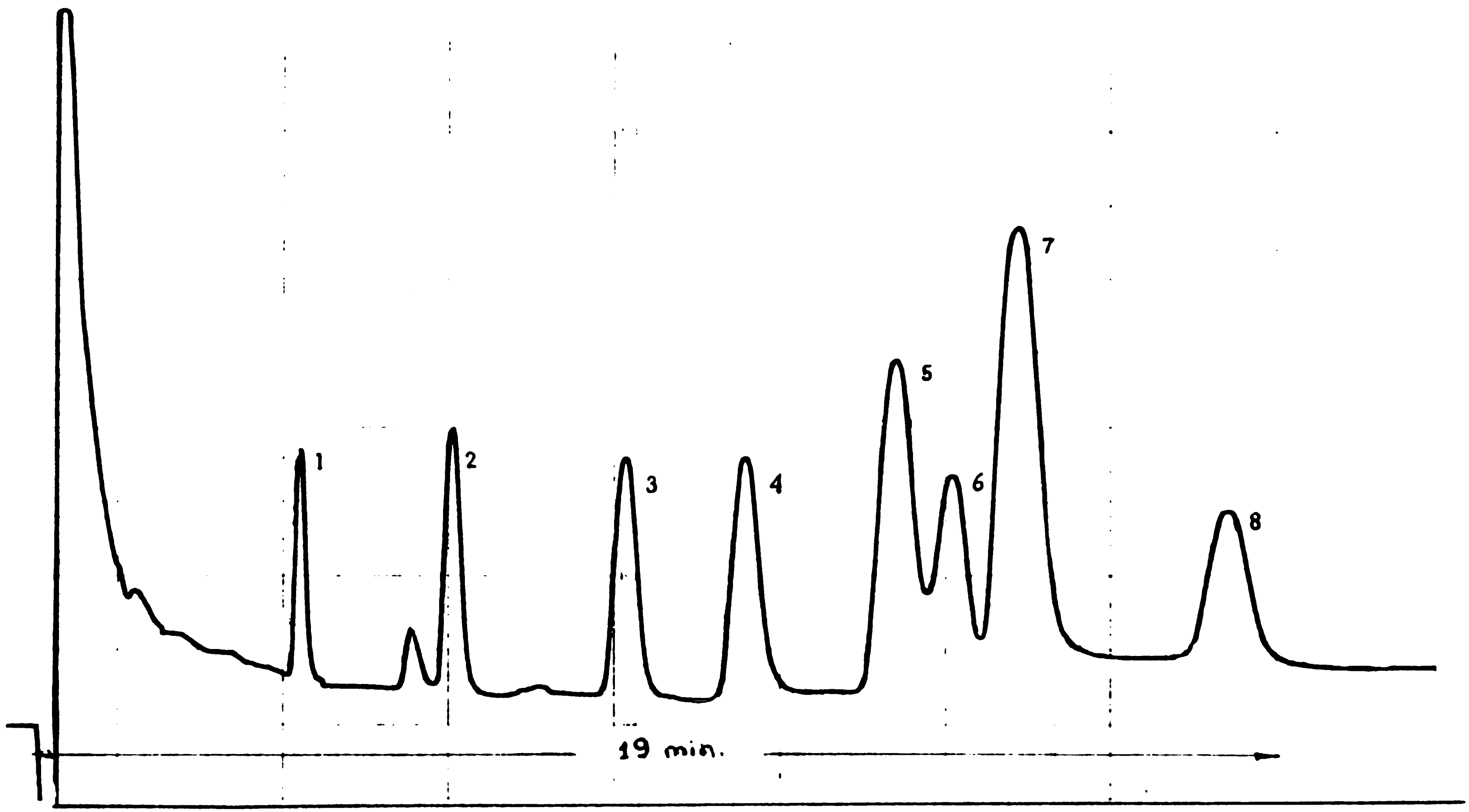

FIGURE C1. Chromatogram of organochloride standard mixture (analysis conditions)
1. lindane 2. aldrin 3. hepatachlor epoxide 4. pp' DDE 5. dieldrin 6. op'DDT 7. endrin 8. pp'DDT.- Stationary phase: 4% silicon GE-SE 30 + 6% OV-210 on chromosorb W.H.P. (100-120 mesh)

APPENDIX C

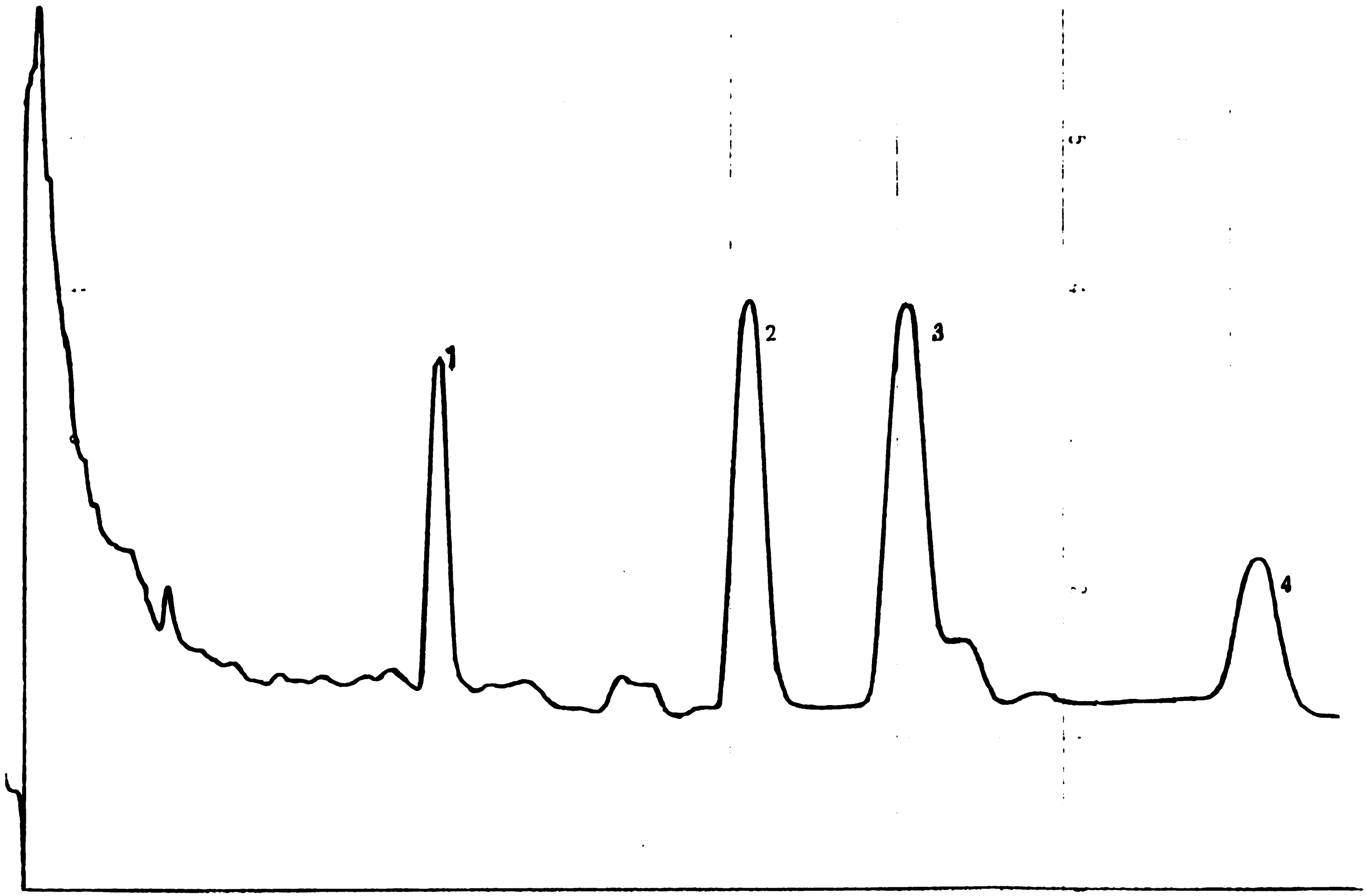

FIGURE C2. Chromatogram of an extract of potatoes treated with 0.5 kg a.i./ha of aldrin.

1. aldrin 2. pp'DDE 3. dieldrin 4. pp'DDT (analysis conditions)

APPENDIX C

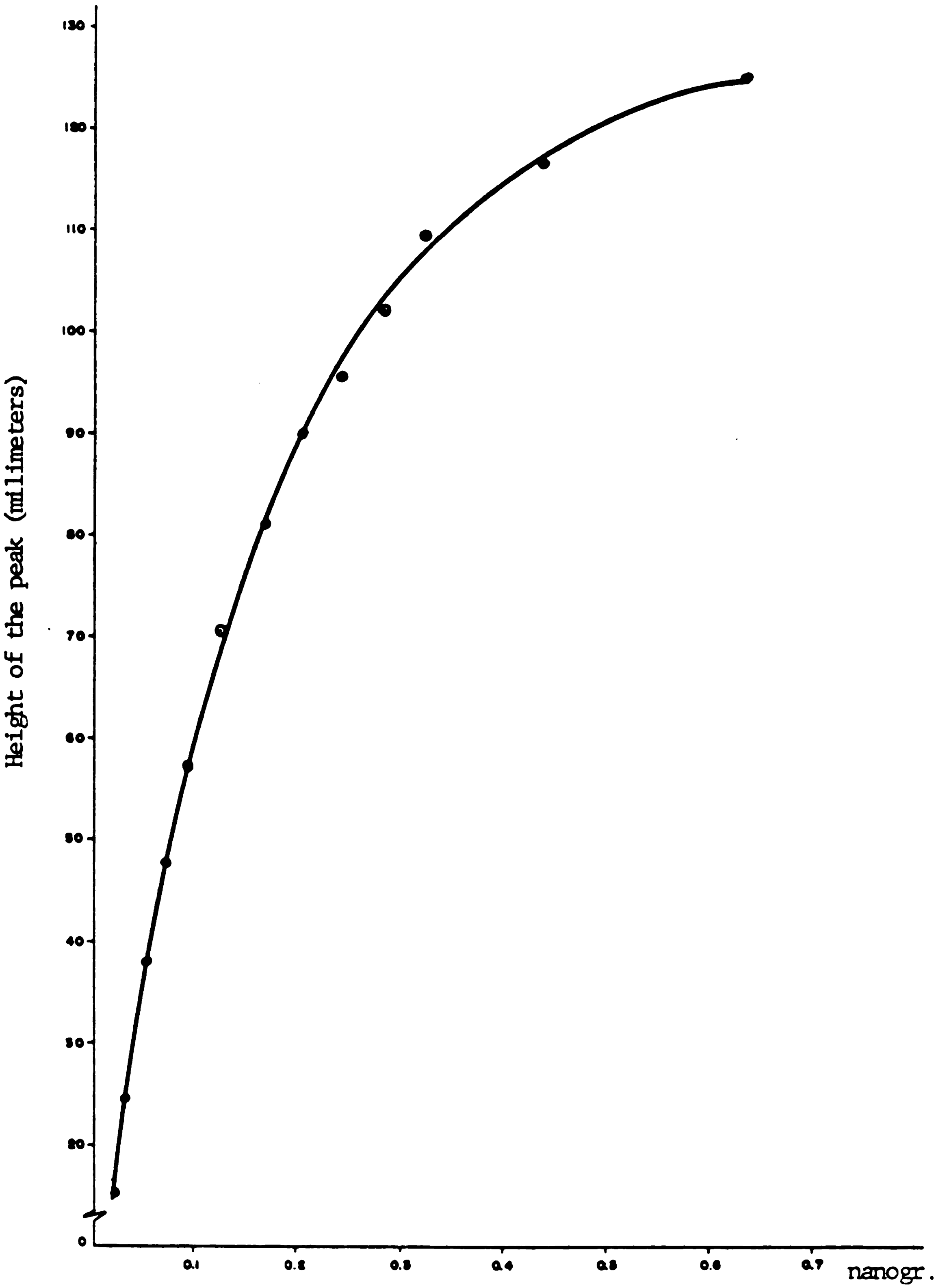

FIGURE C3. Curve of linearity for aldrin

APPENDIX C

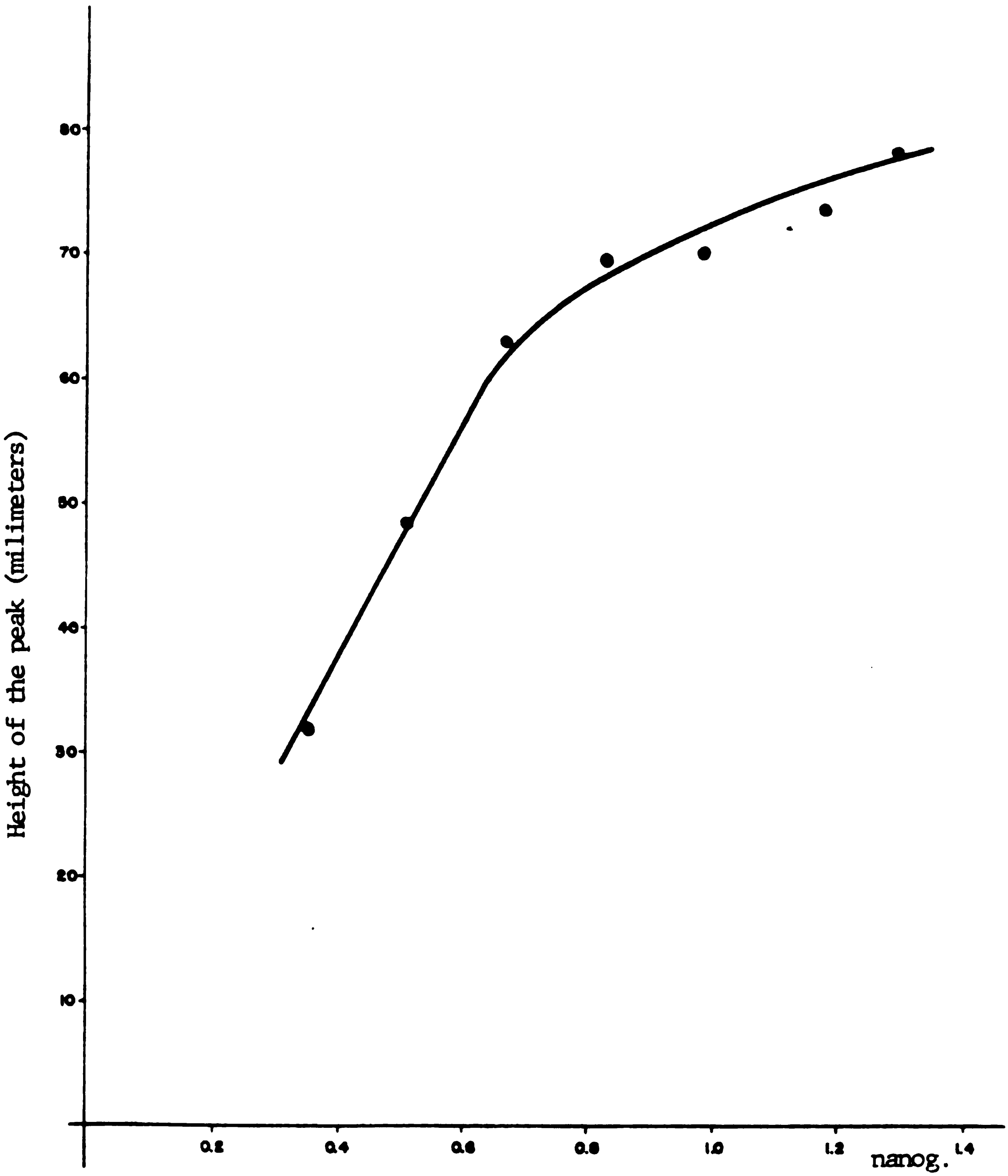

FIGURE C4. Curve of linearity for dieldrin.

APPENDIX C

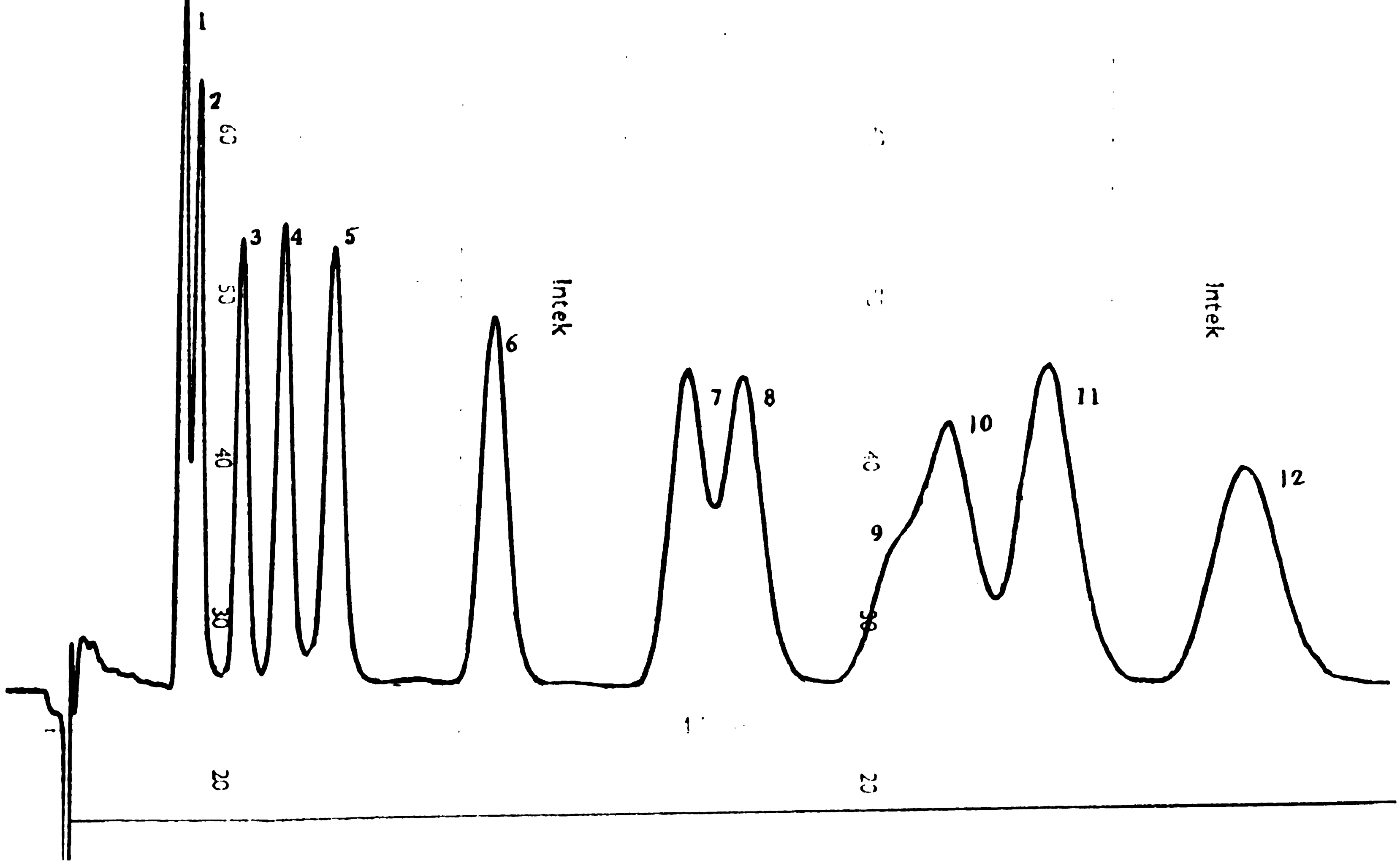

FIGURE C5. Chromatogram of organochloride insecticide standard mixture (confirmation conditions)
1. HCB 2. BHC 3. lindane 4. heptachlor 5. aldrin 6. heptachlor epoxide 7. pp'DDE
8. dieldrin 9. endrin 10. op'DDD 11. pp'DDD 12 pp'DDT.

APPENDIX C

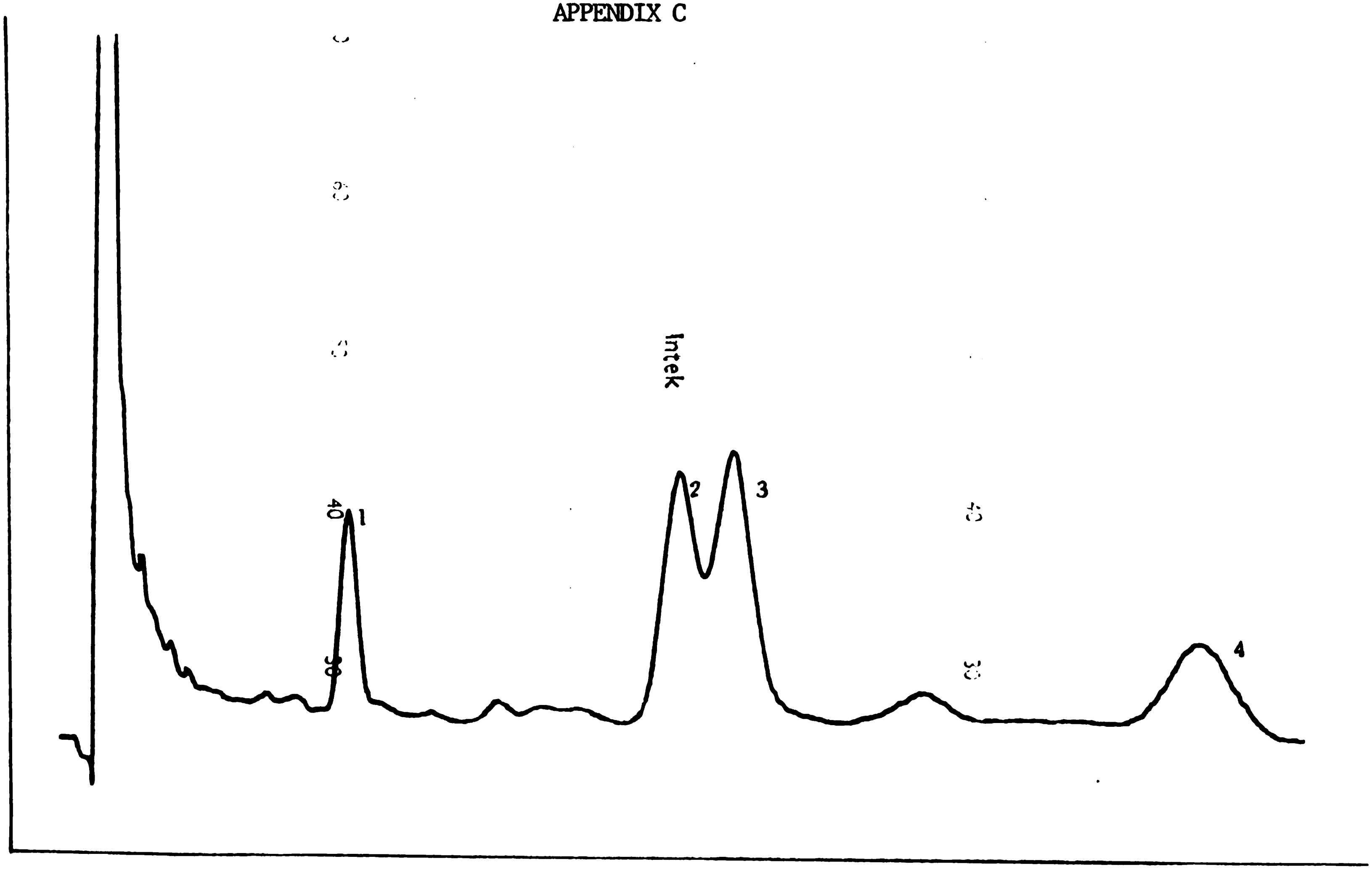

FIGURE C6. Chromatogram of an extract of potatoes treated with 0.5 kg a.i./ha of aldrin (confirmation conditions). 1. aldrin 2. pp'DDE 3. dieldrin 4. pp'DDT.

APPENDIX C

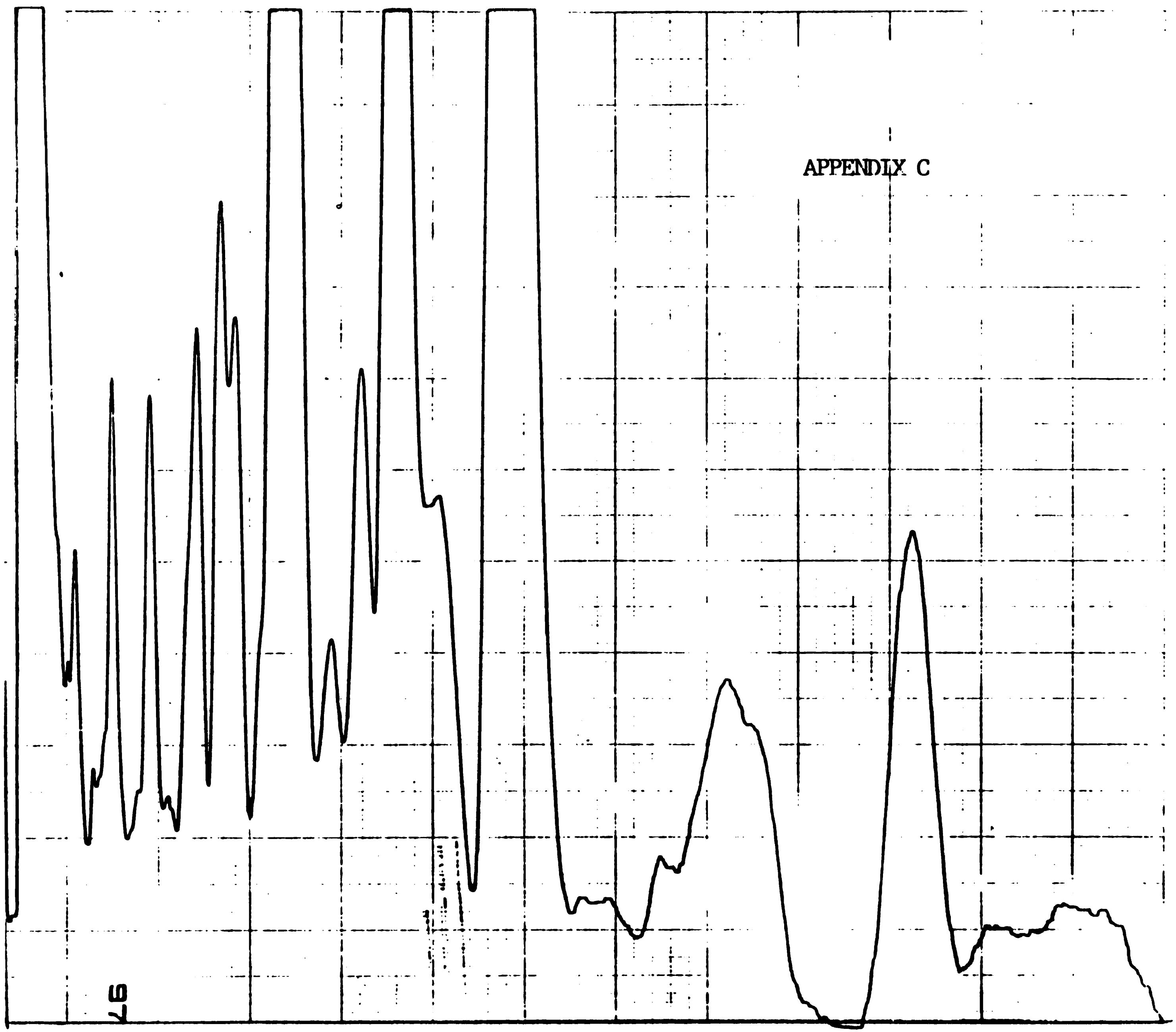

FIGURE C7. Chromatogram of an extract of soil from the experimental plots.

APPENDIX C

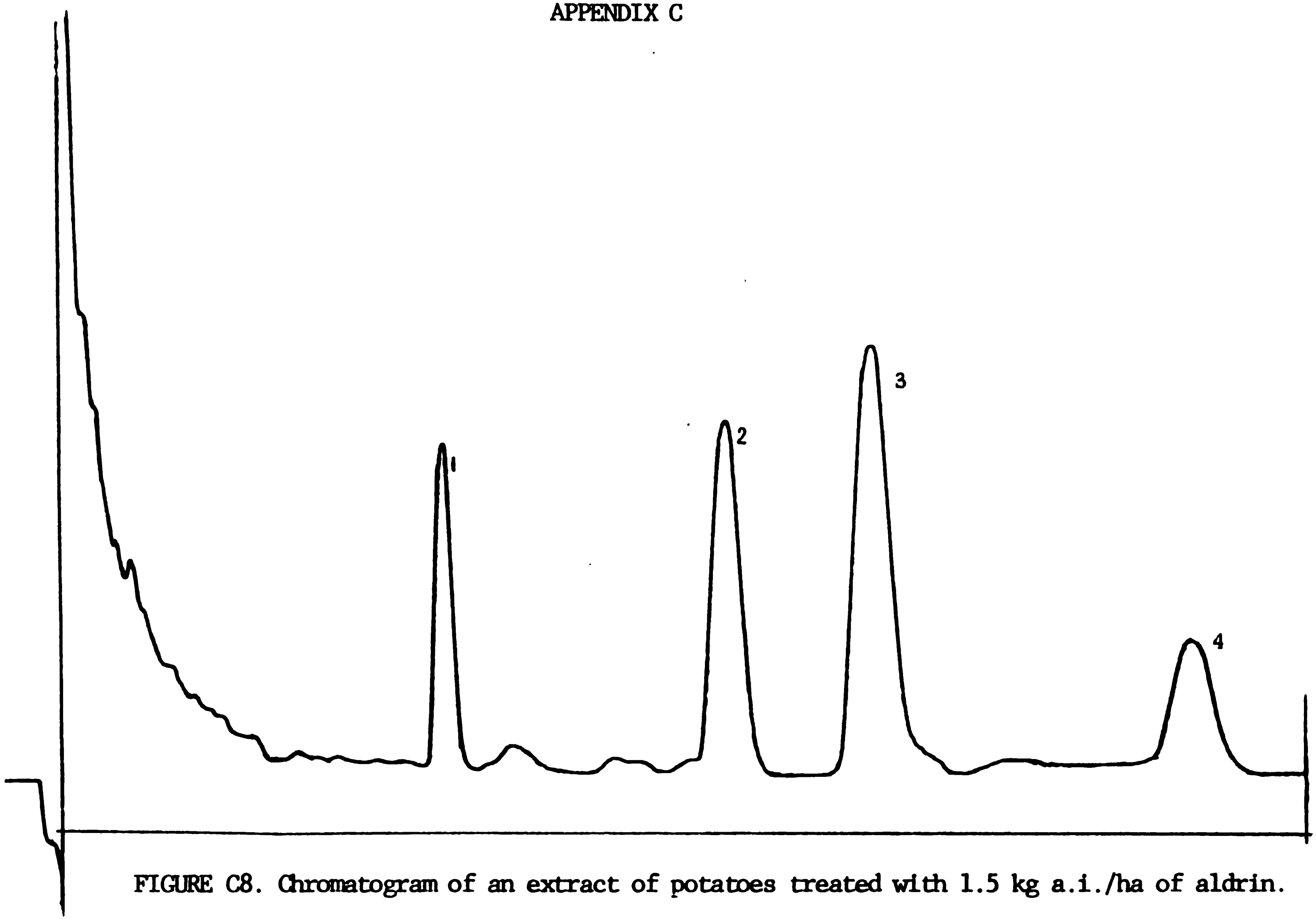

FIGURE C8. Chromatogram of an extract of potatoes treated with 1.5 kg a.i./ha of aldrin.

1. aldrin 2. pp'DDE 3. dieldrin 4. pp'DDT (analysis conditions)

APPENDIX C

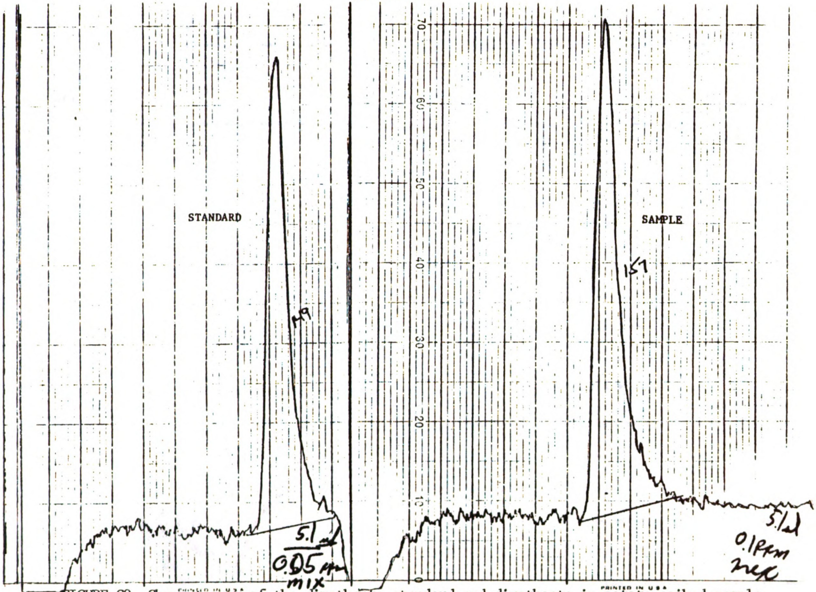

FIGURE C9. Chromatogram of the dimethoate standard and dimethoate in potato spiked sample

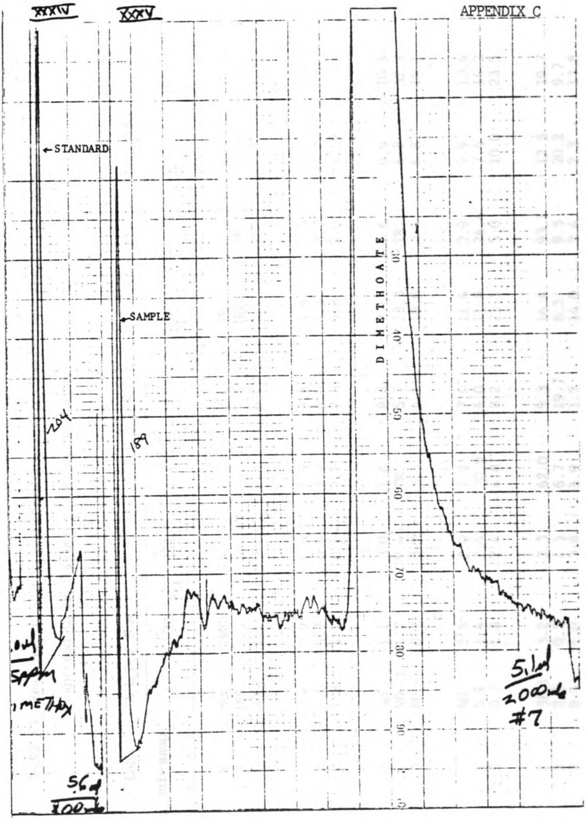

FIGURE C10. Chromatogram of the dimethoxon standard and dimethoxon in potato spiked sample.

APPENDIX C

TABLE C1. Residues of aldrin and dieldrin in experimental samples of potatoes expresed in micrograms per kilogram (ug/kg)

Treat.	Lab.	A L D R I N			D I E L D R I N			ALDRIN + DIELDRIN		
K ai/ha	sub-samp.	I	II	III	I	II	III	I	II	III
0.0	1	ND*	TR**	ND	1.0	2.4	TR	1.0	2.4	TR
	2	ND	1.0	ND	TR	9.5	ND	TR	10.5	ND
	3	ND	1.1	0.6	TR	6.2	1.2	TR	7.3	1.8
0.5	1	0.6	2.7	0.4	1.9	8.6	5.8	2.5	11.3	6.2
	2	1.0	0.7	0.4	7.7	6.0	4.2	8.7	6.7	4.6
	3	1.8	5.1	0.6	7.2	7.8	6.8	9.0	12.9	7.4
1.0	1	ND	1.1	3.0	1.6	8.8	7.1	1.6	9.9	10.1
	2	ND	1.1	9.4	TR	5.7	23.3	TR	6.8	32.7
	3	ND	0.7	3.2	3.4	6.1	10.9	3.4	6.8	14.1
1.5	1	ND	2.9	2.0	2.9	7.0	11.4	2.9	9.9	13.4
	2	5.5	1.4	2.4	20.9	6.0	11.8	26.4	7.4	14.2
	3	0.2	1.8	2.4	4.8	8.2	21.1	5.0	10.0	23.5
2.0	1	31.1	3.2	3.3	62.0	9.3	16.4	93.1	12.5	19.7
	2	2.8	0.5	1.5	6.7	19.7	8.2	9.5	20.2	9.7
	3	0.4	1.0	3.8	1.9	1.2	14.0	2.4	2.2	17.8

*ND No Detectable **TR: traces

APPENDIX C

TABLE C2. Residues of aldrin and dieldrin in farmer's samples of potatoes expressed in micrograms per kilogram (ug/kg)

Zones	Sample No	Doses a.i. k/ha	Lab sub-sample	Aldrin	Dieldrin	Aldrin + Dield.
Boyaca	1	0.50	1	2.80	29.20	32.00
			2	2.90	31.10	34.00
			3	2.80	30.50	33.30
	2	0.00	1	0.00	0.00	0.00
			2	0.00	0.00	0.00
			3	0.00	0.00	0.00
	3	0.00	1	0.00	0.00	0.00
			2	0.00	0.00	0.00
			3	0.00	0.00	0.00
Cundinamarca	1	0.00	1	0.00	0.00	0.00
			2	0.00	0.00	0.00
			3	0.00	0.00	0.00
	2	0.00	1	0.00	5.80	5.80
			2	0.00	TR	TR
			3	0.00	5.30	5.30
	3	0.00	1	0.00	4.30	4.30
			2	0.00	6.60	6.60
			3	0.00	5.60	5.60
Caldas	1	1.25	1	42.70	27.90	70.60
			2	41.60	30.40	72.00
			3	33.10	31.10	64.20
	2	0.93	1	7.00	11.40	18.40
			2	9.40	16.20	25.60

TABLE C2 (cont.)

Zones	Sample No	Doses a.i k/ha	Lab sub-sample	Aldrin	Dieldrin	Aldrin + dieldrin
Caldas	2	0.93	3	9.10	15.90	25.00
	3	0.62	1	10.20	8.20	18.40
			2	11.50	8.30	19.80
			3	14.00	8.40	22.40
Antioquia	1	1.87	1	1.00	2.00	3.00
			2	1.00	2.00	3.00
			3	1.00	2.00	3.00
	2	0.00	1	0.00	0.00	0.00
			2	0.00	0.00	0.00
			3	0.00	0.00	0.00
	3	1.25	1	2.70	12.60	15.30
			2	2.30	8.90	11.20
			3	3.30	14.10	17.40