MANUAL TO TRAIN TRainers ON
SAFE AND CORRECT USE OF
PLANT PROTECTION PRODUCTS
AND INTEGRATED PEST
MANAGEMENT (IPM)
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PRESENTATION

One of the main objectives of CropLife Latin America is the development and enforcement of Education and Training programmes on the Correct Use and Management of plant protection products and Integrated Pest Management (IPM).

To reach this objective, since 1991 the first projects have been under way in the region and to date they have been extended throughout Latin America. Thanks to this contribution from the agrochemicals industry, it has been possible to educate farmers and their families on the correct use of plant protection products, which turns into a great advancement in farming technical practices in the region and producers and society have been profiting from it.

Knowing that our Education and Training programmes have been accepted from the beginning by government authorities, ONGs and producers, who require didactic material according to their needs, this important material has been prepared so the interested parties will have access to updated information, that will give them a tool to orient farmers towards crop protection, within production schemes that care for the health of the consumer and for the environment.

CropLife Latin America prepared this manual, based on experience acquired in a period of over ten years, during the process of training instructors, technicians, farmers, housewives, teachers and students from rural areas, with the purpose to orient farmers to practice a sustainable agriculture.

This manual contains seven chapters, starting with the introduction that explains the challenge of feeding eight thousand million people in the nearby future and the industry’s contribution to plant protection to reach this goal; Integrated Pest Management (IPM), the role of plant protection products within Integrated Pest Management (IPM), the consequences derived from their incorrect use; safety norms for their correct use and management and the technology and application equipment required. It also includes a chapter that offers didactic-educational resources to communicate this knowledge skillfully to the various objective groups.

We are confident that this manual will be a real and effective contribution to rural development and that it will be used by persons working in projects and programs dedicated to this type of activity.

Cordially yours,

Agr. Eng. Anarco García Archila
Director Programa de Uso y Manejo Correcto/MIP
CropLife Latin America
CHAPTER 1

INAUGURATION AND INTRODUCTION TO TRAIN THE TRAINER COURSE
SAFE USE OF PLANT PROTECTION PRODUCTS AND INTEGRATED PEST MANAGEMENT (IPM)
CHAPTER 1

INAUGURATION AND INTRODUCTION
TRAIN THE TRAINER COURSE
SAFE USE OF PLANT PROTECTION PRODUCTS AND INTEGRATED PEST MANAGEMENT (IPM)

SPECIFIC OBJECTIVES:

- Welcome all participants and let them take part in the course inauguration.
- Introduce students and instructors amongst themselves so they can interact all together.
- Let them know the objectives and methodology of the course.
- Explain to them the multiplying effect concept that is the object of this course.
- Evaluate their initial knowledge about the subject.
- Give them a motivation chat about the importance of the subject.

METHODOLOGY:

First: The course coordinator will say a few welcome words, which must show his appreciation for the assistance of the participants and cooperative institutions and will announce the name of the person that will inaugurate the course.

Second: The person designated to inaugurate the course will mention the importance of the event for the country, the region, the community and the participants.

Third: The course coordinator will ask the participants and instructors to identify themselves, writing their name on a card and pinning it up to their shirt, so they can recognise each other.

Fourth: The instructor in charge will explain the objectives and methodology used during the development of the course. Next, he will explain and determine the results expected from the multiplying effect, as a result of this course.

Fifth: The instructor will evaluate all participants to know the level of knowledge they have about the content of the course to be able to redefine it.

Sixth: The instructor will motivate the participants with a conference about “The challenge of feeding eight thousand million persons”. The instructor can base this conference on information obtained by him on the subject.
REQUIRED MATERIAL:

- Board (For chalk or board markers)
- Slide projector, overhead projector, multimedia projector and screen.
- Slide set, transparency film, diskettes or CDs (according to need).
- Manual
- Notebooks, rulers, pencils, ballpoint pens
- Blank cards for names
- Paper markers
- Forms for initial evaluation

REQUIRED TIME:

1.5 hours

STUDY INFORMATION:

For the suggested conference the instructor may assist himself with the following information, taken from the publication “Food for All”, made by International Fertilisers Association (IFA) and CropLife International

**FAO’s World Food Summit.** To make people conscious of the challenge that food shortage represents, suggesting solutions and implementing effective measures to produce high quality food were the topics selected at FAO’s summit, that took place at Rome in 1996.

The plant protection industry is ready to contribute with the implementation of the decisions taken at the Summit. Its members are conscious that food shortage can only be reduced by improving the social, economic and political system in the countries badly affected. These changes are a requirement to have a flourishing agricultural sector.

**World population and economic growth.** According with present estimates, world population will increase from 6-8,000 million by year 2020; this means an annual increase of 8.5 mio. people.

At the same time, more and more people will benefit from the economic growth. This will bring a greater buying power, specially in Asia, where only in China and India there is a population of close to 2,000 million people. With the economic boom, calorie consumption per person will rise, increasing the demand for high quality food, such as meat and dairy products.
More high-quality food. Cereals are the most important source of basic nutrients for humans and animals. Present consumption is close to 1,900 mio. tons per year. To satisfy future demand, production will have to be duplicated by year 2020. This means an annual increase of 2.4%. Current annual increase rate is 1.5%. Production of other types of food will also need to be significantly increased.
Growing demand for quality food requires a higher production of cereals.

Needs of cereals per kg. of meat

- Pig: 3 kg
- Chicken: 2 kg
- Cow: 7 kg

Necessary increase of cereals production for year 2020

- Necessary production: +2.4% per year
- Estimated production: +1.5% per year


1,900 2,000 2,200 2,300 2,500 2,700 3,000 3,400

Millions of tons
Technical challenge. Food production should increase in proportion to the growth of world’s population and its nutritional demands. Therefore, agricultural production should continue developing ecologically and economically according to its needs. Traditional methods known should be combined with modern techniques to provide proper solutions. This requires a vast investment in agricultural research, training and education, as well as the application of environmental farming techniques.

Crops need nutrients and protection. Most high quality land is now used for farming; therefore, food production can be duplicated within a same generation only by increasing productivity of the plots that are already being cultivated. Plant nutrition and plant protection are of crucial importance.

The same way as with humans and animals, a healthy growth of the plants depends on having an adequate water supply, enough nutrients and protection against pests and diseases.

“Words, even if they are wise, do not produce food, and cereals do not grow from reports, no matter how important these are”.

Jacques Diouf, Director General - FAO
Fertilization means nutrition. The different types of soil of the world contain a varied amount of nutrients. For example, lime soil contains high levels of nutrients, whilst sandy soils have a low content. With the crops, the nutrients are removed from the soil. To maintain or improve fertility, these nutrients should be replaced by mineral and organic fertilisers.

Organic fertilization by itself does not guarantee soil fertility at long term. Loss of nutrients when removing the crops and the use of biomass in animals feed, energy and building materials cannot be properly replaced if complementary mineral fertilisers in various forms are not applied. Now it is well accepted that organic sources of nutrients are not good enough to strengthen a productive and sustainable agriculture.

Organic fertilisers contain animal and plant residues, liquid fertiliser, and compost. Mineral fertilisers obtain lots of nitrogen from the atmosphere, as well as phosphorus and natural potassium, and secondary elements.

Nitrogen: A life structural component. Nitrogen has a considerable influence regarding amount and yield quality of the crop. This element is the component of the fundamental structure of all plant and animal protein. 78% of air is nitrogen, but only legumes, such as peas and beans can use that source directly. Most plants depend of compounded mineral nitrogen from the soil. This makes fertilisation with nitrogen essential, specially in light soils that retain less nutrients. For them to grow, plants need phosphates, potassium, sulfur and in small amount a series of elements such as iron, zinc and magnesium. Experts predict that by year 2020 the use of mineral fertilisers must be duplicated, if Africa and Asia want to produce enough food. At present, fertilisation with mineral nitrate guarantees a food supply for 2,000 million human beings.

“Fertilisers are an important factor to increase agricultural production. Developed countries are using high levels of fertilisers, whilst developing countries still have little access to this important factor to increase their production”.

Jacques Diouf, Director General de la FAO
**Mineral fertiliser, the essential supplement.** In agriculture, a good performance requires efficient use of fertilisers, one that will supply the exact needs of nutrients required by the plants and that will allow the optimum use of available nutrients. An application directed to a specific target is only possible with mineral fertilisers. Farmers can choose the right moment to apply them taking in consideration the type of soil, weather conditions and other environmental factors. On the other hand, the nutrients contained in organic fertilisers may vary considerably, in accordance with their composition and handling.

**Protecting the crop.** If man can produce more good quality food at reachable prices, crops should be well protected from diseases, pests and weeds. If crops are not protected, the yield of wheat, rice, corn, cotton, soybean, fruits and vegetables could practically be reduced to half. In other words, to obtain the same volume not protecting the crops, the area grown would have to be doubled.

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**Why insecticides and fungicides?** Protection is needed when pests and diseases overtake mechanisms of crops’ self-protection, endangering their quality and yield.  
**Why herbicides?** Weeds steal light, air, water, space and nutrients from the crops, which they need for their development and the growth of their roots. Farmers must prevent this.

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**Guaranteeing rice crop.** Rice is the basic food for half of world’s population. 90% of world’s production is consumed in Asia. Rice crops should be well protected from numerous pests and diseases. If farmers stopped protecting their crops, 83% of their potential yield would be lost.

**Guaranteeing Wheat crop.** Wheat is the basic food for almost 1/3 of world’s population. Improvement in agriculture techniques, use of more productive varieties, programmed fertilisation and the most effective protection methods have helped in the last decades to standardize yield increases. In spite of this, about 36% of global wheat yield is lost every year. If crops were not protected, the loss would surpass 50% of the total crop.
Food must be protected while stored. There might be great losses after harvesting. Rats and mice are only two of the major dangers. Various insects, such as weevil, consume vast amounts of cereals and other types of food or make them useless. Therefore, a safe storage is another important contribution to ensure food supply. After picking the crop, plant protection products have the important function to safeguard the provisions kept in silos and stores.

“Can we move on to revert the shortage per capita in food production that now clouds the future of civilization?”
Lester R. Brown, Worldwatch Institute.

Fertilisation and plant protection benefit the environment. Fertilisers and plant protection products let farmers produce more food per hectare.

A higher yield is required per hectare.

The use of fertilisers and plant protection products saves the most limited resource from our planet: the land. These products help to preserve animals and plants natural habitat and contribute to maintain biodiversity. Fertilization and plant protection helped during the Twenty Century to increase fivefold wheat yield in Central Europe.
Whilst world's population increases, more people need to obtain food from same amount of land

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>3,200 Mio.</td>
</tr>
<tr>
<td>1988</td>
<td>5,100 Mio.</td>
</tr>
<tr>
<td>2020</td>
<td>8,500 Mio.</td>
</tr>
</tbody>
</table>

Source: Bayer

Agriculture and the environment

Low productivity uses more land: 1 ton of cereals is produced per ha.

High productivity permits to maintain the natural habitat Over three tons of cereals are produced per ha.

Source: Bayer
Wooded areas are increasing in Central Europe. It is estimated that 30% of this expansion is due to crop protection.

If India produced its present wheat volume with the technology used 25 years ago, they would need 40 million additional hectares.

Centro Internacional de Mejora del Maíz y del Trigo, (CIMMYT)
(International for improvement of Corn and Wheat)

**Herbicides protect from erosion.** Loss of soil due to erosion is one of world’s major problems. As soon as the humus layer is removed, wind and water may continuously erode this layer; for example, between one crop and the other. With the method known as minimum tillage, the seed is sown inside the stubble, without previous plough. This technique holds firmly the upper layer of the soil with its organic content. The erosion caused by wind and water, as well as the loss of soil humidity, can be significantly reduced.

Among other objectives, tillage between previous yield and next sowing is designed to attack the weeds. With a minimum tillage system, this role is played by herbicides. Only these products provide a favorable technique for the environment. In vulnerable areas of USA, minimum tillage has reduced erosion up to 95%. This technique has also been used with great success in Brazil and Argentina in large and small farms with a tendency to erode. With minimum tillage it is estimated a 3-4% increase of organic content every decade. This contributes to a continuous improvement of soil fertility.

![Comparison of various tillage systems](image)

“*It is not intensive farming which causes degradation of the environment in developing countries, it is the lack of it*”.
Per Pinstrup-Anderson, Director de International Food Policy Research Institute, Washington D.C.
Planned fertilisation improves soil quality and fertility. Sensible fertilisation and high yield improve soil fertility. Fertilisers increase not only the visible volume of plant growth but also their roots. These remain on the ground after picking the crop and later become humus, which improves water retention, stores nutrients and forms a stable soil structure. This reduces the erosion. Soil fertility must be urgently restored with a proper fertilisation programme for each particular case.

Fertilisation and plant protection for healthy food. Market value and healthy food are related with the latter’s internal and external quality. The compounded fertilisation forms are the base for a balanced nutrition and a high quality food. Attacks by fungus, bacteria and insects bring more than just cosmetic damage. These may generate damaging substances, which can even be cancerous. An example are the micotoxines. Some of these substances are highly toxic, even if they are consumed only once. Modern science has identified a great deal of diseases that may also affect humans and animals. Plant protection helps to attack them and, therefore, contributes to protect human health.

Fertilisation and plant protection are synonym of food availability. As any other economic sector, farming must take into consideration not only ecological aspects but also immediate economic costs.

Fertilisers and plant protection reduces the cost of protecting crops.

Producers deserve to obtain adequate benefits without the consumers having to pay higher prices for the products. Integrated agriculture involves the correct use of fertilisers, organic materials, plant protection products, and improved seeds, after evaluating ecological and economic aspects. The integration of these factors combines high productivity with high food quality at accessible prices.

The fertiliser and plant protection industry faces the challenge. The Earth Summit celebrated in Rio de Janeiro in 1992 included “Sustainable Agriculture Development”. In agriculture, ecological compatibility cannot be separated from sustainability. Integrated Crop Management (ICM) is sustainable and exercises an optimum agriculture.
Integrated Crop Management means Sustainable Agriculture.

It is the system of the future, that considers economy and ecology as components of equal value and combines proved traditional methods with modern techniques. Integrated Crop Management (ICM) is a dynamic and holistic system that demands knowledge from specialists and flexibility as well as sensibility.

**Integrated plant nutrition.** It is part of Integrated Crop Management (ICM). This form of fertilisation furnishes the necessary nutrients for local conditions at the right time and in the right amount.

**Integrated Pest Management (IPM).** It is part of Integrated Crop Management. Management techniques are used, as well as biological, biotechnical and chemical measures to keep diseases, pests and weeds under the economic threshold.

**The slogan is: The least possible but as much as necessary”**.

ICM has also the advantage of having a considerable variability. To establish it, it is required to count with political willingness from high authorities and to provide producers with intensive education and training.

**Plant protection and responsibility: to minimize risks.** Plant protection products not only should work well but they should also be safe for users, consumers and environment. The plant protection industry, therefore, only develops, produces and sells products that have been properly tested and approved by the corresponding authorities. Products must be manufactured and used without wasting resources or causing damage. The surplus should be eliminated. The industry maintains a constant supervision of these products, performing risk analyses through each developing stage. Research provides industry a high priority knowledge to possible damaging effects against humans, animals, plants and environment. A product is not put in the market until the industry is absolutely sure that it is not harmful to health or ecology and until they have investigated its degradation mechanism on soil, air, water, plants and animals. If the product is handled correctly, no undesirable effects are expected. Containers are designed to minimize contact of user with the product. The main purpose when developing plant protection products is safety for the user, consumer and ecosystem, as well as lower application volumes, higher economic efficiency and low cost for farmers.
Projects for the correct use of plant protection products In 1991, CropLife International (formerly Global Plant Protection Federation – GCPF) started three pilot projects about Correct Use of Plant Protection Products, in Guatemala, Kenya and Thailand. These projects were aimed to educate people from developing countries in the correct use of plant protection products. Ever since the beginning Crop Life International worked jointly with national agriculture and health authorities as well as with local communities to train farmers and hand labour, as well as those who are in the business of selling plant protection products. Consultants, doctors, hospital and paramedical staff, teachers, students, firemen, etc. participate in training programs. They learn how to recognise and avoid dangers they may encounter with the use of plant protection products. As a result of the success obtained with these pilot projects, they have been extended to other countries with the cooperation of government authorities, international ONGs and private sector.

Fertilisers and rural development. The importance of a cooperative approach between the industrial sector and relevant organizations to achieve agricultural development is proved by the Fertilisers Industry Agricultural Committee (FIAC). This independent regulation team, formed by a panel of experts, was established in 1960 by FAO to provide technical help that would orient international programs on plant nutrition.

Besides contributing with its experience, the fertiliser industry, through FIAC, gives contributions in cash and in species for countries where international programmes exist. Over 50 countries have been benefited by FAO’s programmes on Plant Nutrients Handling and almost one fourth of a million trials have been performed. This modern system of Integrated Crop Nutrition is now being incorporated in many of these projects.

Private agricultural research. The plant protection industry is one of the most innovative sectors of the economy. Companies invest over 10% of their profits in private research and development. The whole industry offers a wide range of products and concepts to guarantee and raise profits in various crops. The industry contributes with a vast knowledge to introduce integrated crop management techniques. The companies will be able to solve more problems with the cooperation of genetic engineering and in this way, the environmental and natural resources will be better protected. Industrial technical services will help producers all over the world to use plant protection products correctly and to introduce innovative solutions to farming problems.

Investments for the future. The Plant protection Industry dedicates about ten years to develop each product before putting it in the market. This is a double challenge. Today’s investments will give a profit much later. Companies must estimate ten years ahead what will be the final demand for each product.

The development of a plant protection product takes ten years and its cost is between 200 and 250 million dollars.
The fertilisers industry is putting all its efforts to find ways to programme a more exact nutrient application technique to minimise losses. Research focus on fertilisers (for example: The development of products less prone to lixiviation) and to develop and improve application techniques, in cooperation with manufacturers of farming machinery, to manufacture modern “precision equipment”, to apply crop supplies in a more specific way, using globalisation systems

Fertiliser and plant protection companies invest not only for profit. These industries also aim at other objectives, they see an opportunity to improve world’s food situation. They would like that in this common responsibility not only be involved the agricultural sectors but also politicians and the media to support their efforts.
CHAPTER 2

INTEGRATED PEST MANAGEMENT
CHAPTER 2
INTEGRATED PEST MANAGEMENT (IPM)

SPECIFIC OBJECTIVES:

That the participant:

- Learn the Integrated Pest Management (IPM) concept
- Understand the place that IPM has in sustainable development
- Know how the plant protection industry supports IPM
- Know the basic components of an IPM programme
- Understand the ecological and economical basis of IPM
- Acquires the capacity to implement an IPM programme

METHODOLOGY:

First, the Instructor will give a chat about IPM. To do this, he can use the movie “Basical principles of Integrated Pest Management” or talk about the basic principles detailed in the documents included in this manual.

Second, he will propose a methodology to implement an IPM programme and will give an example. He can use as an aid the presentation “How to elaborate an IPM programme”.

Third, he will develop a workshop so the participants will elaborate an IPM programme on the suggested crops. These programmes elaborated by the participants will be presented and discuss at a general meeting.

REQUIRED MATERIAL:

- Board (For chalk or board markers)
- Slide projector, overhead projector, multimedia projector and screen.
- Slide set, transparency film, diskettes or CDs (according to need).
- Notebooks, rulers, pencils, ballpoint pens
- Paper markers
- Basic study documents
- Forms for initial evaluation

REQUIRED TIME:

Four (4) hours
STUDY DOCUMENT:

For Chapter 2, Integrated Pest Management (IPM) it is necessary to study the following document:

INTEGRATED PEST MANAGEMENT

INTRODUCTION

The demands of a growing world population for food and fibre require world agriculture to produce higher yields from cultivated land. Feeding future populations with today’s crop yields is not viable; it would require a drastic expansion of planted acreage. In many parts of the world additional land is unavailable. In others, an expansion of cropped area would be environmentally and socially unacceptable. To increase yields from existing land requires good plant protection against losses before (35%) and after (20%) harvesting. (Bottrel, 1979).

The challenge will be to do this without harming the environment and the resource base for future generations of farmers and consumers. IPM is a principle on which sustainable plant protection can be based. The improvement of pest control technologies in developing countries reduces economic losses in 50%. (Smith 1978).
IPM policies and objectives are being adopted increasingly in developed and developing countries. IPM implementation is most advanced in Western Europe and North America, and is expanding in developing countries in Southeast Asia, Latin America, the Indian subcontinent and Africa. The goal is to achieve long-term sustainable systems of plant protection and production.

What is IPM?

There are many definitions of IPM, issued by governments, donor organisations, aid agencies, NGOs, and universities. Some assume that IPM will eliminate the use of plant protection products. This is unlikely. Extreme views equating IPM with “pest free” farming will become increasingly marginalized and more balanced views will prevail.

The plant protection industry supports IPM as defined by the FAO International Code of Conduct on the distribution and Use of Pesticides. (Article 2):

“Integrated Pest Management (IPM) means a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economically unacceptable damage or loss”.

For farmers and pest control operators, IPM is the best combination of cultural, biological and chemical measures that provides the most cost effective, environmentally sound and socially acceptable method of managing diseases, insects, weeds and other pests under the circumstances in which they work.

Therefore, an elementary principle of effective IPM is to develop strategies taking into account all relevant control tactics, and methods available locally. The successful user of IPM will evaluate the potential cost effectiveness of each alternative as well as the whole control strategy.

This recognises that the accountability for implementation of IPM ultimately rests with the farmer and others trying to control pests. They will only adopt and exploit IPM if it is seen to be practical and add value to their activities.

IPM allows farmers and other persons involved to control diseases, insects, weeds and other pests in a most effective, environmentally sound and socially acceptable way.
IPM’s place in sustainable development

IPM is the plant protection system that best meets the requirements of sustainable development and sustainable agriculture. IPM is a component of Integrated Crop Management (ICM). ICM has been developed as a farming system to meet the requirements of long-term sustainability. It is a farming strategy which involves IPM, managing crops profitably, with respect to the environment, in ways which suit local soil, climatic and economic conditions. It safeguards the farm’s natural resources in the long term. It includes practices that avoid waste, encourage energy efficiency and minimise pollution. ICM is not a rigidly defined form of crop production but is a dynamic system which adapts and makes sensible use of the latest research, technology, advice and experience.

Integrated Pest Management (IPM) in the context of Integrated Crop Management (ICM) and Sustainable Development
Who is supporting IPM?

- Widespread implementation of IPM is supported by consumer and environmental groups, food chains, major donors, aid agencies and non-governmental organisations in agricultural development, the FAO, as well as national governments and the plant science industry itself.

- Adoption of IPM is an important part of sustainable agriculture. This is endorsed by the FAO World Food Summit (Objective 3.1) and the Río Environmental Conference (Agenda 21). It forms part of the FAO International Code of Conduct on the Distribution and Use of Pesticides.

- Adoption of IPM is growing fast in developed and developing countries, motivated by the desire to achieve long-term sustainable systems of crop protection, at national and international level.

- IPM is becoming incorporated into regulatory policies and strategies of governments, donor and development agencies. Legislation is increasingly being used to support integration of IPM into farming practice in developed and developing countries.

How is IPM likely to help farmers and other customers?

- Improving consumer confidence in the quality of food and fibre products.

- Improving crop profitability where plant protection products and pest control measures now available are poorly used.

- Guaranteeing stable production and yields.

- Reducing severity of pest infestations.

- Reducing potential pest resistance problems.

- Securing agricultural environment for future generations.

How does the plant science industry support IPM?

Worldwide, a great part of research, development, technology transfer, education and training undertaken by the plant science industry, already supports implementation of IPM. However, more can be done to research and develop IPM technologies.

In Latin America, CropLife Latin America supports its adoption and promotes putting it into practice, as a conciliatory concept of crop protection, with undisputed results for the development of sustainable agriculture, through Integrated Crop Management for the benefit of farmers and consumers.
PEST CONTROL

STRATEGIES

1. COEXISTENCE:

Leave it to nature when damage is sporadic. Example: Let Spodoptera frugiperda eat the pasture.

2. PREVENTION OR PROFILAXIS:

Do something to avoid or prevent pest infestation. Example: Sow a resistant variety (phytogenetic control) to prevent Empoasca sp.

3. ERADICATION:

Implicates weed extermination. Example: Liberate sterile males to eradicate Ceratitis capitata in fruit trees.

4. ELIMINATION:

When pest reaches intolerable levels, it can be eliminated or reduced temporarily. Example: Picking eggs and larvae (Mechanical control) to avoid cotton loss.

5. HANDLING:

Eliminates damage caused by pest population. Does not eradicate or eliminate it. Diversify or rotate cotton to another crop (Cultural control) to handle Heliothis zea.

6. INTEGRATED PEST MANAGEMENT:

It causes a general reduction on the average pest population density and uses additional elimination procedures when population exceeds a critical level.

7. INTEGRATED CROP MANAGEMENT

Measures to implement:

1. Crop rotation
2. Plant protection through IPM
3. Vegetal nutrition
4. Efficiency in use of electricity
5. Handling of waste and contamination
6. Handling of soils
7. Handling of wild life and landscape
8. Evaluation of measures
BASIC COMPONENTS OF AN IPM PROGRAMME

IPM requires three areas of competence: prevention, observation and intervention:

**PREVENTION**
Indirect measures:
- Location
- Crop rotation
- Cropping pattern
- Phyto-genetic
- Crop husbandry and hygiene
- Fertilisation
- Irrigation
- Habitat management
- Trap crops
- Inter-cropping
- Harvesting and storage

**OBSERVATION**
Decision tools:
- Crop monitoring
- Support decision taking systems
- Area-wide management

**INTERVENTION**
Direct measures:
- Mechanical and physical control
- Biological control
- Microbiological control
- Ecological control
- Selective chemical control
1. PREVENTION – Indirect measures

OBJETIVE: Reduce initial severity of pest outbreak

Many aspects of farm and crop management serve to limit or prevent initial outbreaks of pests.

LOCATION:

Growing crops in appropriate locations, where they adjust to climate, soil and topography, provides the crop with optimal growing conditions from the beginning of the cycle.

CROP ROTATION:

Growing different crops in rotation helps to reduce the concentration of certain pests, especially those in the soil, such as nematodes, root feeding insects and fungal pathogens. Rotations also reduce weed problems and increase the range of control methods that can be used.

CROPPING PATTERN:

Whenever possible, it should be avoided to plant similar host crops alongside each other, since it can substantially increase weed, diseases and pests pressure.

CROP VARIETY SELECTION:

Selecting crop varieties has always been a cornerstone of plant protection, especially when it comes to choosing crops resistant to pests and diseases. These varieties may reduce the need for frequent plant protection measures and minimise the dosage used of various products.

The use of resistant varieties stimulates survival of beneficial species. Progress in genetic engineering increases the opportunity to develop new pest and disease resistant plants and herbicide tolerant crops.

Transgenic varieties offer the opportunity to add biological agents to the plants, as in the cases where proteins with insecticide action can be incorporated genetically. When this is done, the pest dies from eating the plant and the beneficial organisms are not affected. Transgenic plants offer new and important options to farmers but a careful management is necessary to delay or prevent resistance development.
CROP HUSBANDRY AND HYGIENE

Mechanical, physical and cultural plant protection methods are important in promoting good crop development and in preventing or minimising weed, disease and pest infestation. For example, traditional mould board ploughing turns the soil and buries crop residue and weeds before the seed bed is prepared for the next crop. However the process can increase erosion and, therefore, it should be used only when necessary.

It is desirable to combine it with other conservation techniques, such as the use of contour ploughing and ridging. In many countries, there has been a trend towards a reduced ploughing and ridging. In many countries, there has been a trend towards reduced ploughing, using herbicide technology. This has led to the practice of direct drilling in Europe and no till in the USA. As result, soil erosion problems have been greatly reduced. When an IPM programme is designed, it must be taken in consideration that soil alteration as well as location of vegetable residues and weed ecology influence on the incidence of diseases and pests.

Good crop hygiene is also important to reduce the build-up and carry-over of pest populations from one crop to another. Methods are often labour intensive, but may provide an essential way of reducing the survival of some pests into the next season.

FERTILISATION

Good fertilisation practices must be implemented to promote the crop’s growth, but excessive use of nitrogen must be avoided, since too much nutrition and a strong growth stimulate the presence of many diseases, pests and weeds.

IRRIGATION

A water supply for the crop can stimulate or reduce pest incidence. Flooding of certain crops, particularly lowland rice is important to control weeds. However, flood irrigation can also adversely affect the survival of some soil-inhabiting beneficial organisms. In the case of vegetables, this effect can be lessened by growing the crop on ridges or raised beds, and it should be taken in consideration when IPM programmes are being designed.

NATURAL HABITAT MANAGEMENT

Protection of natural habitats within the farm environment is accepted as a means of maintaining many natural enemies of pests. A careful management of land margins as well as growing trees or hedges, are particularly important because they not only provide habitat, cover and refuge for beneficial insects and other animals (e.g. in rice paddies, field levees but also provide important refuges for predatory spiders, which help control several important rice pests; and for snakes which help to control rats) but also contribute to the conservation of plant and wild life.
TRAP CROPS

Some times a pest can be tempted by the farmer to leave a sensitively vulnerable crop to enter into another that would suffer less damage if attacked (e.g. In some countries maize is sown across cotton fields, in rows alternated every 10 to 15 mts., with the purpose to attract bollworms during critical periods of crop development. They are then controlled by limited spraying).

INTER-CROPPING

Traditionally, some farmers may sow different crops in alternate rows or under sow a crop or sow one crop (e.g. beans) under the other (e.g. maize) to help improve soil fertility and reduce weeds. Such systems can be labour intensive and difficult to mechanise, but can help reduce pest pressures in individual crops.

HARVESTING AND STORAGE

Carry-over of weed seeds and pathogens can be reduced by appropriate harvesting, seed cleaning and storage methods.

OBSERVATION – Decision taking tools

AIM: Determine What action to take and When to take

CROP MONITORING

Management of any crop needs routine inspections to assess how well plants are growing and what actions need to be taken on tillage, fertiliser use, weed, pest and disease control, as well as when to harvest. Monitoring for pests is an important part of the need to walk through a crop. Various tools, such as pheromone traps, diagnostics and forecasting systems are available to assist pest monitoring, minimise the time required, and achieve acceptable accuracy in determining changes in pest infestation.

DECISION TAKING SUPPORT SYSTEMS

Farmers need assistance in interpreting pest monitoring data. Simple monitoring systems can be designed for farmers, for example, pegboards or charts, special booklets, radio and television programmes or more advanced aids, such as prediction models and computer-based systems. Development and provision of up-to-date information is a key factor to enable farmers to implement IPM programmes.
AREA-WIDE MANAGEMENT

IPM often requires collaborative decisions within a national or more localised area to provide effective pest control. Some of these decisions need to be taken centrally by governments in relation to:

- Quarantine regulations and legislation
- Provision and training of advisory services
- Establishment of resistance management strategies against highly mobile pests and diseases on major crop systems.

Other decisions can be made by farmer associations or producers groups to meet localised needs. Geographical Information Systems (GIS) and remote sensing techniques can also assist in implementation of area-wide management.

Crop monitoring or observation is a key step in deciding when to intervene. Many indirect prevention measures have a cumulative effect, for example, host plant resistance + crop rotation + conservation of natural enemies, all help to reduce pest pressure, but are unlikely to be sufficient on their own to eliminate the need for some form of intervention.

3. INTERVENTION – Direct measures

AIM: To reduce the effects of economically damaging pest populations to acceptable levels.

Mechanical, biological and chemical control measures may be applied individually or in combination, taking into consideration costs, benefits, timing, available labour force, machines/tools and control agents, as well as ecological and environmental effects. Some of main IPM intervention measures available for farmers and others wishing to reduce the effects of pests include:

Mechanical and Physical Control

A number of mechanical and physical techniques continue to be used in agriculture (e.g. weed control by manual methods or mechanical tillage; insect control by hand picking of egg masses or larvae; disease control by removing infected plant debris). Before including such methods in IPM recommendations, their impact on yields (e.g. through root disturbance) and their requirements for family labour inputs need to be critically assessed. Recommendations must be practical. Also, the possibility or integrating appropriate mechanical techniques, with judicious use of plant protection products should be explored (e.g. instead of replacing manual weeding entirely by herbicides, it may be better to use band treatments to control weeds close to the crop plants, but continue to hoe the central part of the inter-row space).
Pheromones

Development and availability of pheromones offers interesting new possibilities for the farmer.

- Besides selective trapping techniques to monitor the movement of pests or changes in populations during the season, pheromones are also used in “lure and kill” strategies to attract the pest to localised insecticide deposits and reduce the need for overall crop spraying.

- The use of pheromones to interfere with mating activities to delay or reduce the need for control treatments.

Biological Control

Research on nature’s own methods of pest control is yielding new useful products and methods which can be integrated into IPM programmes. However, most biological control techniques (e.g. using beneficial insects, mites, nematodes) work best when crops are grown in controlled environments (e.g. glasshouses and plastic tunnels) to ensure consistent result.

There are a few cases where control techniques with living organisms are successful in open field conditions (e.g. predatory mites against spider mites). However, biological products are generally too often unreliable or not efficient enough in the field to be commercially used on their own. Nevertheless, there is increasing interest in using other biological products (e.g. viruses, fungi and bacteria). These require similar technical expertise as chemical agents in relation to formulation, field application and resistance management.

Classical biological control (e.g. the introduction of a predator or parasite for the control of a particular pest species) and saturation control (e.g. repeated mass release of a control agent) programmes impose high requirements on the selectivity of chemical control agents to be combined within them. This narrows down the number of candidate chemical control agents for IPM based on classical biological and saturation control strategies.
**Bacillus thuringiensis**, a bacteria produced massively to control pests (e.g. mosquitoes and caterpillar pests in vegetables, vineyards and orchards) has been one of the most successful biological control measures. The insect spectrum of activity is narrow compared with synthetic chemicals and this is useful in IPM strategies.

**Chemical Control**

A very wide range of chemical products is now available. These represent the results of some fifty years of research, development and field experience around the world by the crop science industry. The industry continues to invest and support this achievement. With present knowledge, the use of chemical control agents represents in many situations the most important and widespread means of achieving effective and reliable reduction of pest (disease, insect, weed and rodent) infestations. As such, it is essential to reduce unnecessary user exposure to plant protection products, improve standards of work practice and hygiene, limit residues in the environment and harvested crops, and avoid potential problems of pest resurgence and pesticide resistance. Judicious application of chemical products to minimise the risk of adverse effects is integral with the principles of IPM.

To make full use of natural beneficial agents, great care is needed to maintain untreated refuges (e.g. hedgerows, field margins, or isolated habitats) where natural enemies live. Improved application techniques, that allow lower use-rates of chemical controls offer some way of reducing exposure to chemicals of beneficial pests. Avoiding spray drift into refuges is essential to reduce product contamination. The main requirement is to ensure that treatment timing (during day and season) as well as specificity of product used, reduce adverse effects on beneficial pests as much as possible.

Local recommendations for IPM will vary, depending on the farming system, type of crops and climatic conditions. Regardless of whether plant protection products are of synthetic or natural origin, they will continue being indispensable components of IPM in agriculture systems on a world-wide scale. Their use in Integrated Crop Management (ICM) systems must be based IPM’s principles.
FACTORS TO BE CONSIDERED WHEN DEVELOPING AN IPM STRATEGY

When should plant protection products be used?

Farmers are the primary decision makers in IPM programmes. They must decide individually or collectively how to manage the range of insect-pests, weeds, diseases and other pests that may cause damage big enough to produce economic losses if no action is taken.

The extent of such losses can vary significantly between farming seasons, depending on climatic conditions and other factors. In the past, farmers were often encouraged to apply plant protection products on a routine calendar schedule (e.g. weekly sprays). Since the severity of pest infestations varies, it is generally far better to monitor pest populations on the damage they have caused before deciding to use a plant protection product when a certain threshold has been reached. This threshold is usually called the “economic threshold”. It is defined as the pest population level that causes losses greater than the cost of controlling the pest.

One difficulty with the use of economic thresholds as a decision tool is that the income from the sale of crops can change rapidly, especially some horticultural crops which depend on supply and demand conditions in local markets. Prices can fluctuate abruptly and farmers may require a greater “action threshold”.

This not only depends on the pest pressure but also on the stage of crop development when it occurs. The latter is important because many crops can compensate for some damage, at least during part of their growing cycle.
This is a hypothetical example of change of “action threshold” during a growing season

In some circumstances, early prophylactic chemical treatment may be used to reduce the number of later season sprays. A good example of this is the use of a seed treatment, which may be essential to protect young seedlings during a critical period of crop establishment. Another example is a crop where there is zero tolerance of the pest or even signs of pest damage.

HOW CAN A CROP BE MONITORED?

Detecting pests in a crop by walking through the fields takes time but it is an essential part of IPM. Many farmers, particularly smallholders, check their fields repeatedly, but they need to know what signs to look for. This requires education and training. In some cases, only a brief supervision is required, but farmers must know what pests need to be examined, what to look for, how often and at what crop stage.

The supervision may be initiated during a growth stage of the crop, for example when blooming starts or when the presence of pest is detected, by using pheromone traps or diagnosis tools).
WHAT PRODUCTS CAN BE USED IN AN IPM PROGRAMME?

In developing an appropriate strategy of chemical control in IPM programmes, it is essential to review the known product characteristics and costs of products that are locally available; then select the products that provide the most cost-effective treatment, with minimal undesirable side effects. Good advice on the most appropriate plant protection product to use in an IPM programme is needed. Some chemicals have a broad spectrum action, while others are only active against a few pest species. Selective compounds are less likely to affect natural enemies and other non-target organisms, but are often more expensive and not so widely available. When they are available, it is important to determine whether fewer applications of a more selective but more expensive compound are actually more cost effective than a cheaper broad-spectrum compound which requires more applications.

Most commercially available products have a broad spectrum action. When reviewing the choice of such compounds in IPM programmes the choice of such compounds in IPM programmes, it is important to distinguish between intrinsic toxicity and bio-availability. This intrinsic toxicity of some broad spectrum compounds against natural enemies can be misleading. Under some field conditions (behavioural selectivity” can occur, which limits their “bio-availability” against non-target organisms. For example:

- When plant protection products are highly systemic within the plant, localised treatments may keep contact between the active ingredient and non-plant eating organisms to a minimum.

- Compounds that combine translaminar penetration with fast degradation on the leaf surface can also be “selective”.

- Products with short persistence or bio-availability can also be “selective”, even though there could be an initial impact on beneficial pests.

- If application dosage and the right moment of application are carefully evaluated, as it is done with seed treatment, exposition of beneficial organisms to the product can be reduced.

All plant protection products can be considered for use in IPM programmes, but to select them rationally, farmers and their advisors should have a good knowledge of the products available on the market.
In all IPM systems the possible side effects of all products used should be taken into account. Even though insecticides, are ranked as the most toxic group for arthropod natural enemies, some fungicides and herbicides are also rated as harmful. It is also important to recognise that populations of beneficial species can recover quite quickly, (regardless of the use of broad-spectrum products, particularly if they are easily degradable), by migration from refuges at field borders to treated areas and later re-colonising them. Whenever feasible, such considerations should be taken into account when recommending which products to use.

It is also possible to physically limit the impact of broad-spectrum products (e.g. through selective treatment with a non-persistent pesticide in orchards crops). Part of the crop surface is left untreated to allow natural enemies to survive and re-colonise the treated area. Another example is band treatment of fruit tree stems to prevent certain pests from climbing into the upper canopy or to restrict movement of predators, so that beneficial insects can survive in fruit tree canopies.

**Recommendations:**

- Take care of beneficial insects
- Do not spray blooming crops when bees are pollinating.
- Do not spray field margins with insecticides and avoid drift towards hedgerows.
- Whenever possible, use selective products.

**What use rates should be recommended?**

Product label recommendations are designed to provide reliable control under average field conditions and cover the legal responsibility of the manufacturer. Ideally, the minimum effective use rate of a product should be employed against a particular pest to provide adequate control. Use rate moderation is likely to be most feasible when the host plant shows a partial pest resistance, increasing the susceptibility of the insect to chemical control agents.

Evaluate the range of product dosage suitable for IPM in relation to local pest conditions and farming environment.
IPM IMPLEMENTATION

Implementation of IPM at large scale by farmers and other users of plant protection requires collaboration and support from the plant protection industry and governmental and non-governmental organisations. The industry has a major role to play. This not only includes multinational research companies but also national associations, distributors, dealers and retailers. The range of knowledge from the plant protection industry (e.g. technical, research, development, marketing, education and training), its experience, resources, products and infrastructure are all relevant to the goal of transforming IPM into a reality in the hands of farmers and others trying to manage pests substantially.

Outline of an IPM network and the plant protection industry

Products and service required for an IPM project

A wide range of products and service will be required by farmers to adopt IPM. Meaningful IPM must be based on farmers’ measures needs, concerns and circumstances. Some of the most important opportunities include:
Research and development

Product design

- Search and development of natural and biological chemical products which will widen the technology range available for IPM programmes.
- Investigate whether existing products are useful for IPM as well as their appropriate application.
- Development of decision tools, such as diagnostic and broadcasting systems.

Field applications

Develop and test crop season programmes, oriented to farmers, which may include:

- Crop calendar and critical stages for pest control.
- Pest complexes (diseases, insects, weeds).
- Identification of appropriate prevention, observation and intervention measures.
- Application techniques
- Climatic pause

Economic or action thresholds

- Develop and test appropriate economic or action thresholds. It is important to monitor infestation levels in a crop and only treat those which cause economic damage. The economic or action threshold may change, depending on the stage of crop development. There is a wide range of biological and economic factors that may influence threshold levels. It is important that thresholds be defined in a simple and understandable way so that farmers can easily adopt them.

Sampling methods

- Farmers need simple methods and programmes to determine quickly whether a pest population is likely to cause economic damage. Guidance and support is needed to establish the effectiveness of various sampling procedures and related decision criteria.

There are many ways in which to use local knowledge to help develop practical methods acceptable to farmers. In some regions, it may be possible to develop local computerised databases to assist in making decision on an area-wide basis.
Effects on beneficial insects

- The impact of plant protection products on important beneficial insects and other species needs to be monitored as a basis for developing appropriate IPM strategies.

- To conserve pests’ natural enemies is recognised as an important part of IPM programmes. Natural regulation of pest populations and their dynamics should be considered. Therefore, in addition to assessing the effect of a plant protection product on the pest, the impact on important natural enemies should also be taken into account. Reduction in the amount of product used may reduce exposure of natural enemies and lessen the risk of pest resurgence. Maintain minimum pest population for natural enemies to feed themselves may be essential for their survival. Such an approach requires a fundamental understanding of the impact produced by different control strategies on the population dynamics of the pest and natural enemy system.

- Research should also evaluate the importance of weeds and other local plants that may encourage survival of beneficial species at field edges.

Novel products and techniques

The constant search for novel modes of action of chemical products continues will widen the range of IPM strategies and practices available to farmers and others to manage pests economically and sustainably.

Novel modes of action of chemical products have triggered rapid changes in plant protection practices, such as:

- Lower amounts of plant protection products in the environment (from 50 to 20, to 10 grs. Of active ingredient per ha.).

- To increase environmental compatibility, imitations of natural principles have been created (there are imitations of insect hormones, of plant defence agents, etc.).

- Certain novel techniques are applied combined with plant protection products (e.g. pheromones “lure and kill” to provide safer, more effective and reliable means of control).

- New and older compounds need to be protected from the risk to develop resistance. An example is the diamondback moth (Plutella maculipennis) in Southeast Asia, that developed resistance problems just after the insecticide used for its control was introduced on the market. This example illustrates how the use of new products without following the strategies recommended by the industry to manage resistance (like the ones developed by the GCPF Insecticide Resistance Action Commission) can shorten the useful life of a product.
**Selective plant protection products:**  
They are expensive and valuable and must be used in a rational way.  
Selectivity will continue being an intermediate commitment between what is scientifically possible and economically acceptable.

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**IPM programmes for season-long crops**

Research to determine the most suitable plant protection products, appropriate local dosage and timing recommendations during the crop season, needs close collaboration from scientists developing IPM in a particular farming area. Instead of recommending various separate products against different pest species, IPM may require a programme designed for a crop in a given area. The aim is to have season-long recommendations, including products that complement other IPM tactics and provide a means of resistance management.

**How to manage insect resistance**

- Resistance usually develops when an insect species is exposed, generation after generation, to the same active ingredient. This process may develop very quickly, in as little as one season, or may never happen. The important factors that determine the speed or lack of resistance development are pest biology, crop species, the number of available insecticides and other control agents for the crop and the grower’s use of them.

- A grower should use all tools available to avoid development of resistance. These tools include chemical and biological insecticides but also any farming practices that would reduce insect population, such as crop rotation or reducing crop stubble at the end of the season. The industry can provide the information, but the grower must make the final decision.

In many countries, improved application is still needed. Low cost application equipment often gives poor distribution of products. Many pests can survive under the “umbrella” of leaves which collect the spray because farmers hold the nozzle above the crop. In high volume applications, the spray often completely wets the top leaves and then drips over the outer canopy to the soil. This wasted spray can have serious adverse effects on soil inhabiting natural enemies, especially spiders and ants. When farmers see pests surviving, they will often spray some crops as frequently as twice a week, instead of investing in better equipment, or changing their spraying practices. Even simple changes (e.g. by directing the nozzle to spray more where the pest is located, on the undersides of leaves) can give better control of a pest. Provision of better control of pressure at the nozzle will also improve spray coverage of a crop and reduce losses due to spray drift, especially when low pressures are needed for herbicide treatments.
Many farmers spray late or under-dose because of difficulties in obtaining sufficient water to spray. However, there are reduced volume techniques suitable for semi-arid areas that permit to treat as soon as the pest population reaches the economic damage threshold. In some cases, it is better to use granules so that the product may be applied directly, for example close to the roots of the plants or in the “tunnel” of maize plants. It is rather convenient to stimulate improvement in application efficiency than resigning to have farmers purchase the most economic equipment available.

**Formulation developments**

Support is also needed to examine whether formulations can be developed to suit local conditions. The temperatures in many countries are very high and humidity very low; this will increase evaporation from the mixture. A less volatile formulation or use of an appropriate adjuvant could improve the delivery of pesticide and its retention if rain occurs soon after application. In some countries, there are restrictions for the use of mixtures even though a combination of products, including the use of adjuvants, may intensify the control of a pest.

**Pre-testing IPM methods and programmes**

Before developing an adequate control programme, it is important to understand the perception the farmer has about pest problems and present control practices. It is necessary to make a socio-economic research to evaluate acceptance and applicability of IPM’s recommendations. Agriculture is a dynamic process and, therefore, IPM’s recommendations must adjust to the market’s changes. So that IPM programmes can be successful, farmers’ opinions must be taken in consideration, through proper interaction or feedback. It is also important to evaluate the socio-economic effects of the IPM’s programmes and the components used on them (e.g. the use of herbicides in some cases is considered that contributes to migration problems. Nevertheless, hand weeding demands too much time, it is a hard work and not always can be done at the right time. Besides, yields from certain crops suffer because of late weeding or root damage to the plants).
**Education and Training**

Education and training is a vital part of IPM implementation. There are many links in the chain, beginning with the scientists that develop IPM and following the farmers and pest controllers who practice it. Appropriate education and training are required at each chain link.

Some key components include:

- Training of technical and teaching staff, who may be the key people who will take the IPM message to advisory and sales staff. Also, broadening the training to those concerned with marketing of plant protection products, so that they are well informed about IPM. It is important to ensure that the promotion of products complements the implementation of IPM programmes.

- Training of government and private extension staff, distributors and retailers is an important link with a direct influence on individual farmers. They need to be able to provide practical advice to farmers about appropriate local IPM programmes and practices.

- Development of education and training programmes for farmers. Practical ways of reaching smallholder farmers as well as large-scale plantations, and professional pest control operators must be defined (e.g. farmer field schools, mass media (TV, radio, newsletters, direct mail, videos, colour charts to help pest recognition, simple pegboards to count pests and make the use of economic and action thresholds easier, traps for pest population sampling).

- In the long term, it would help to reserve IPM implementation for next generation of farmers if they could get training in IPM technology at school. Much of the training information prepared for farmers could be adapted for schools.
Education and training are necessary to convince farmers and other interested parties trying to manage pests properly that IPM is relevant to their local circumstances and that it will bring them benefits. A range of knowledge and practical skills are required by farmers to adopt and implement IPM. These include:

- Recognition of pests and beneficial insects as well as their uses.
- How to keep initial infestation pressure low, using every farm management opportunity (e.g. optimized cropping system and sowing dates)
- How to select the most suitable varieties
- How to assess the importance of pest populations and their damage to the crop, as a low pest population may not cause economic damage.
- How to monitor resistance.
- Knowledge about products: pests being controlled and the effect on beneficial insects.
- How to select which plant protection products they should use; making emphasis on its efficacy to the target pest, user and environmental safety, specificity for the target pest and anti-resistance management strategy.
- How to decide when to apply a plant protection product
- Where plant protection products are needed and if treatments can be localized.
- What equipment is needed to apply the products.
- How to calibrate the equipment.
- What safety precautions must be taken.

Frequently, IPM must be implemented on an area-wide zone rather than a local zone. Much of the success of a programme will depend on educating all those involved in an area to accept the same overall policy. This applies particularly to the non-chemical aspects, such as synchronised sowing and uprooting dates when recommended as part of an IPM programme.

To succeed with the use of pheromones, especially in mating disruption programmes, extensive areas must be covered. Some aspects of a pesticide policy require an area-wide adoption (e.g. resistance strategies need to be used over a large area, although there is freedom for companies to compete with services and products with the same mode of action or common resistance mechanism within a region).

**Product Supply**

- Maintain supplies of plant protection products in accordance with local laws and the FAO International Code of Conduct on the Distribution and Use of Pesticides.
- Whenever possible, develop and supply product and effect portfolios to integrate with local IPM programmes.

Develop and supply IPM expert systems (e.g. pegboards, pest and beneficial insects identification guides, field diagnostics) to assist with IPM decision making.
SUMMARY:
The challenge of implementing Integrated Pest Management (IPM)

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    - Participants: Enterprises, government, dealers and retailers staff
    - Universities and schools
    - Users: farms, food processing companies, growers and smallholders.
    - Subjects include: Pest and beneficial pests recognition, appropriate IPM strategies, product knowledge, product safety
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ECOLOGICAL ASPECTS THAT CONTRIBUTE TO PEST PROLIFERATION

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Adapted by:  Carlos Palacios

I.  INTRODUCTION

Pest control is one of the activities on which farmers put much effort to achieve their objectives. During the last decades, it has been accepted that there are limitations in pest control that is based only in chemical products and other methods studied, based on the knowledge and characteristics of various components of agro-ecosystems in general and of species whose growth needs to be controlled.

The knowledge of the characteristics and interrelations of the different components of a farming system permits to handle properly not only the species that eventually become a pest, but also other elements that are part of the system, such as diseases, weeds, soils, climate, etc.

An ecological objective is then introduced, in which the movement of time and space of the different elements of the farming system turns into a complicated game, as if it was a chess game, where the board is the system area and the pieces the different components, e.g. climate, soil, diseases, insects, grown species, weeds, etc.

The game system are all the management practices that tend to use the elements of the system and from that comes the final product; in other words, the farmer’s achievements.

The objective of this document is to make a relation between the fundaments of the systems theory and the ecological factors that determine the extent of the populations, until they become a pest population.

II.  BASIC CONCEPTS ABOUT AGRICULTURAL ECOSYSTEMS

It is understood that a system consists of all the interrelated elements, components, parts or subsystems that function together. The connection between the compounded elements of every system, called events or subsystems is much more solid and stable than the relation of each of the elements with parts or subsystems from other systems.

Ecosystem or ecological system is the system or unit of a biological organisation formed by all the organisms of a certain area in interaction with the physical environment. It is characterised by the intimate relation between all its components, which are usually the following:
a) **abiote substances** - (basic inorganic and organic compounds and the climatic regimen);

b) **producers** - (autotrophic organisms, mostly green plants);

c) **consumers** - (heterotrophic organisms that eat other organisms or organic matter formed by particles); and

d) **desintegrators** - (heterotrophic organisms that disintegrated decomposed products).

Ecosystem is then a unit formed by an alive part (communities) and one part that is not alive (physical environment).

The main role of an ecosystem in an ecological thought is to underline the adjustment of the components to form functional units. This means that the type and amount of abiotic substances in a given area have an intimate relation with the type and amount of producers (plants); these, with the consumers (animals) and the interaction of the previously mentioned with the disintegrators.

Agricultural system is the concept that involves the units constituted by the inter-relation of the ecological, social and economic components. Obviously, it is a unit formed by some parts that are alive and others that are not.

The biological matter within the ecological level studied in this event, can be grouped, according to Rabinovich (1980), in three organisational levels: Individual, population and community. Population is a group of organisms of the same species, variety or race that live inside a given area. Community is the population that exists and interacts in a given area.

According to Rabinovich, the three basic groups are different one from another for their qualities. The levels and attributes, according to the author, are the following:

<table>
<thead>
<tr>
<th>ORGANISATIONAL LEVEL</th>
<th>ATTRIBUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIVIDUAL</td>
<td>Ecophysiological variables: Energetic efficiency, rhythm, physiological answers, ethiological characteristics, etc.</td>
</tr>
<tr>
<td>POPULATION</td>
<td>Population growth, population parameters, social phenomenon, inter-specific competition, numeric and functional answers, etc.</td>
</tr>
<tr>
<td>COMMUNITY</td>
<td>Succession, diversity, inter-specific relations, etc.</td>
</tr>
</tbody>
</table>

Taking in consideration the ecological aspects that affect pest infestation, the importance of the population study and the attributes of the inter-relation that all populations have with each other (biotic community) and of these with the abiotic part (ecosystem) must be observed.
III. FACTORS THAT DETERMINE THE MAGNITUDE OF A POPULATION

1. POPULATION

Population is a group of individuals of the same specie that occupy an specific area and procreate among themselves. A population becomes a pest when its presence is not desirable from human’s point of view.

It must be understood that population is a biological form, with above attributes, in a determined period, since its characteristics are modified as time passes through a process called evolution, to make space for new populations. Key concepts about evolution, literally quoting A. Sutton and Harmon (1977) are the following:

- "Evolution is the process through which populations of species modify their characteristics as time passes. The main cause of evolution is natural selection.
- Natural selection results in differential reproduction of characters that give individuals better conditions to adapt themselves to the environment.
- Individuals do not evolve, populations do. Evolution refers only to a genetic change of all the population, from generation to generation. The main evolution changes arrive during a period of time because variations from one generation to the next are usually small.
- To survive, populations must constantly evolve, the same way the environment does.

2. POPULATION GROWTH

Populations restrict themselves to places accessible to food and essential biological and physical elements. They become a pest when they grow to such a point where they cause damage to the products being grown by the farmer.

The growth of a population is the result of a determined process caused by the interaction of two factors:

The biotic potential and the environmental resistance. The biotic potential is the inherent power that a population has to increase in number under ideal environmental conditions. Under optimum conditions some populations have much more descendants than other. Environmental resistance is formed by the group of biotic and abiotic factors that prevent organisms from reaching their biotic potential or to continue with it; in other words, it consists in all the factors with which the environment prevents a population from multiplying at an unlimited speed. The result of the interaction between the biotic potential and the environmental resistance is the population growth, which is defined as the increase or decrease in the total number of a population.

Nature does not allow that populations grow limitless, they rather increase when environmental conditions are favourable and decrease when these determine it. If a population grew, assuming that its descendents survived and increased in
number, and their children reproduced successively, we would then have a large population in the short term.

The population growing process is considered by Sutton (1977) as a cybernetic system, with a negative feedback that tends to keep the population at a certain type of equilibrium. (See figure No. 1). The process of negative feedback, represented in the chart with the form of an eight, is based “on the fact that, when the population density increases, the environmental resistance also increases, which, at the same time, originates a population decrease” (Sutton 1977).

Environmental resistance can be divided in two types: a) Extrinsic environmental resistance, conformed certain factors that affect the population from the outside and b) Intrinsic Environmental resistance, conformed by certain factors that affect the population from the inside.

Figure 1. Eight shaped diagram. (Sutton y Harmon, 1977).
3. EXTRINSIC ENVIRONMENTAL RESISTANCE

The exterior factors that decrease the fertility and survival of individuals from an animal population can be grouped in abiotics and biotics. Among the abiotics we can mention the weather (basically temperature and humidity) and among the biotics, depredation, food supplies, habitat, and diseases, which are fundamentally an expression of the biologic diversity.

3.1 Tolerance Theory

The tolerance theory explains the form in which abiotic factors determine the size of the population and is based on the general concept of the tolerance law. This concept consists in that for each one of the abiotic factors, an organism has tolerance limits in which it can survive; therefore, any abiotic factor outside the upper or lower extreme limit, tends to limit the opportunity for survival for the organism. See figure No. 2.

![Figure 2. Distribution of the tolerance rank of a population. (Sutton y Hamon, 1977).](image-url)
3.2 Biological Diversity
In Ecology it is widely known that the species diversity encourages the stability of ecosystems and, therefore, participates as environmental resistance of the ecosystems in the populations’ growth.

As a result of the biological diversity, the predators, habitats, food supplies and diseases increase their diversity.

When a higher diversity exists, there are more food alternatives for each animal specie in the system. Diversity produces more interconnections, which join closely all the system elements and this presents a major environmental resistance to the development of only one specie or population.

The biological diversity in a system provides abundant interactions among the species, which function as an extrinsic restrictive factor for each of them. All the relations produced by organisms of various species are called interspecific relations.

4. INTRINSIC ENVIRONMENTAL RESISTANCE

The intrinsic environmental resistance is formed by factors that affect the population’s growth, generated inside the population itself, such as territory and social tension. This resistance appears when the members of the population compete among themselves. Generally, it is estimated that the environmental resistance, or the intrinsic plus the extrinsic perform a major role in regulating the population’s growth, even more than any other form of extrinsic environmental resistance by itself.

The intrinsic environmental resistance is fundamentally generated as a consequence of interspecific competition; as a consequence of that competition, emerge the territoruality and social tension. Territoriality: is a form of interspecific competition, through which the organism defends the area needed from other members of its own specie; this mechanism performs an intrinsic environmental resistance over the population, limiting the food and the number of mates in a determined area to a limited number of members capable to defend it from others.

Besides the territorality, it has been determined that an animal has an individual distance, in which the presence of other animal of the same specie generates various adverse reactions, such as social combats or simply terror to physical damage. This can affect the capacity of the organisms to reproduce and survive.
5. POPULATION GROWTH

As indicated before, the population growth is a consequence of the interaction of the biotic potential and the environmental resistance as a whole, just in interaction. Probably, it is not possible to find a determining universal cause of population regulation. No factor ever prevails in regards to time and space. One moment one factor can be determining and the next moment another; under some circumstances an increase in mortality could be produced as a result of food shortage, diseases, increase of one or several predators, climatic changes or the social behaviour of the same population.

Populations are regulated, as mentioned before, by the dynamic integration of all environmental factors, extrinsic as well as intrinsic. Figures Nos. 3 and 4 show the influence of all environmental factors in an insect. Figure No. 3 shows all the environmental components, affecting the different activities of the insect. Its response to increase in number is a result of the interaction of all of them.

Figure No. 4 shows the cybernetic system of population regulation proposed by Sutton, which shows that population is regulated by several extrinsic and intrinsic factors that jointly constitute the environmental resistance, taking as a base the starting point.

Organisms better adapted to face other mortality factors

**Figure No. 4.** Cybernetic system that regulates population. (Sutton, 1953).
Figura 3. Environmental factors that affect various activities of insects.
ECONOMIC ASPECTS OF INTEGRATED PEST MANAGEMENT
Adapted by: Carlos Palacios.

Proper knowledge of economical concepts involved in pest control is a fundamental requirement to succeed with any farming project. The complexity levels of these concepts and the measures to be taken increase in direct relation with the different types of pests that are found at any moment. In cases where only one pest is present, determining the benefits and economical costs derived from its elimination may be relatively simple. If instead a bunch of pests is found, to determine the benefits received from applying control methods is a task that in most cases results quite difficult.

The results to be obtained with the various forms of pest control need to be analysed in several ways. In some cases it is enough to establish the cost of plant protection and the increase in earnings; in other cases, it is necessary to analyse the budgets, determine the benefits and the risk involved with certain control measures.

01. Basic economical concepts related to pest management

Pest concept - Any organism constitutes itself into a pest when it has reached a population level large enough to cause economic losses. An insect that is damaging economically a crop is a pest. The main goal to estimate the economic damage levels is to define the “economic loss” for a given crop and estimate the population level of the pest that produced that loss.

♦ Damage to the plant. Harmed caused to the plant that can result in economic loss (Loss of crop)

♦ Economic loss (Loss of crop). Reduction in harvest quality or quantity due to economic damage caused by the pest.

♦ Pest status. Categories in which a pest can be included, depending on the intensity of the losses caused to the harvest and the size of the investment to avoid them. These pest categories are usually grouped in: potential, occasional and key pests.

A. Potential pests: Those insects that under normal conditions do not cause significant losses but, on the other hand, their population could exceed economic damage levels due to disturbances caused by the products used to protect the crops against key and occasional pests. Some of these products may cause a massive death to biological control agents, upsetting this way the natural control that maintained the “potential pests” population under the levels on which there was no economic loss on the harvest.
B. Occasional pests: These are population levels that fluctuate in pest status, either in time or space. Under this situation populations are usually kept below economic damage levels through biological and cultural control, which is altered now and then.

C. Key pests: These are the pests with permanent population levels, which are persistent and severe. This type of pests require the use of suppression and eradication strategies.

D. Indirect pests: These are the ones that do not affect directly the parts of the plant that constitute the final product of the harvest; such as some defoliators.

E. Direct pests: These are the pests that affect directly the parts of the plant that constitute the final product of the harvest; for example, coffee rust.

Economic damage level (EDL): Density of an organism population that causes economic loss big enough to make its control economically profitable. At this level of economic damage the cost of control equals the expected economic benefit. Below this population level, the cost of control would exceed the value of the part of the crop that is being protected from damage, obtaining an economic loss. Above this level, the value of the part of the protected crop exceeds the cost of control, obtaining an economically positive result. This level of economic damage varies according with time and place, climate, agricultural practices and economic conditions that prevail. Figure No. 1.

Economic threshold or action threshold. It refers to a population density on which it is urgent to start taking control measures to avoid an increase in pest population that will allow it to reach an economic damage level. The economic threshold comes before the economic damage level in order to have enough time to take control measures so these can have the desired effect before the population reaches or exceeds the economic damage level.

This means that there is a delay between the estimate of the organism population level (monitoring or sampling) and the pest control. Then the economic threshold is at a lower organism population density than the economic damage level, to have enough time for the control method to act. Analyse figure No. 1.
The economic damage threshold is very hard to estimate because it depends on future population dynamics from pest organism. It is normally necessary to do research for several years to be able to predict future population growth. Other factors that make it difficult to determine this could depend, for example, from subjective factors incorporated by the farmer in a decision making process, as well as available economic resources; also risk level that he is willing to assume or the fact that the production is for self-consumption versus wanting to maximise his profits, etc. These factors are also hard to predict.

On the other hand, economic damage level is easily estimated and could serve us as a first step or “temporary threshold” to divide control actions in two groups: One implemented quite below the economic damage level, which is non-profitable and another starting from economic damage level upwards, which is profitable. This might point out the “optimum” density to initiate the control, and will permit to eliminate non-profitable applications, which are, logically, unnecessary, “rationalising” chemical control this way.

02. Loss estimates

To estimate losses had in crops, caused by insect pests, is the first step towards rationalisation to attack them. Once the losses caused by these insects have been quantified in several crops, the research work can be given a priority, according to the economic importance from the pests. Besides, present problems caused by insects not previously identified as pests and insects that require many chemical applications can be identified, even if they do not cause any economic damage. Finally, the information obtained will permit to estimate the economic damage level caused by them, which is the basic instrument for integrated pest management.
03. Components and estimated economic damage level (EIL)

When EIL definition is analysed, “the pest population density in which control cost equals economic profit obtained from the control” it is concluded that EIL is integrated by two types of information: biological information obtained from farming experimentation and economic information obtained from the production and commercialisation process.

On the biological sphere it must be estimated:

A. Relation between pest population density and crop yield, and
B. Reduction in pest population density caused by control method (for example, one application of a phytosanitary product).

Necessary economic information:

A. Selling price from the crop, and
B. Cost of control method used (supplies, machinery, labour, etc.)

The EIL is given in its most simple way as a pest population density, where:

\[ \text{COST} = \text{BENEFIT} \]

That is,

\[ C = \text{mDSP} \]

Where,

\[ C = \text{Control cost} \]
\[ m = \text{Yield reduction per pest unit} \]
\[ D = \text{Pest population density} \]
\[ S = \text{Degree of pest elimination obtained by control} \]
\[ P = \text{Yield selling price} \]

When analysis is made it must be clear that the term mDS represents “saved yield” by control and when is multiplied by P, it gives us the monetary value of said “saved yield”. To obtain the pest density equivalent to EIL, the equation is resolved for D, that is:

\[ \text{EIL} = D = \frac{C}{mSP} \]

This is the most simple form for the relation; however, various authors present several equation forms which are superficially different.
WORKSHOP 01
ELABORATION OF AN INTEGRATED PEST MANAGEMENT PROGRAMME AND DECISION TAKING

In this workshop the participants must accept that only harmful organisms that cause economical damage are considered as pests. To discover at what moment they reach this stage, it is necessary to keep an eye on each phenological stage through sampling. Participants should learn that sampling is a working tool that will help to take handling decisions when a pest attack occurs. They should also recognise that there are different forms to control pests and that it is important to consider possible management alternatives before choosing a chemical alternative. They should understand that a chemical type alternative is just another component within integrated pest management which should be used in a rational way.

Titles of main subjects:

A. Crop Phenology
B. Pest sampling for diagnostic and decision taking
C. Alternatives for pest handling
D. Integrated pest management

OBJECTIVES

At the end of the activity the participants will be able to:

- Identify the various phenological stages of the crop
- Identify the critical stages of the crop phenology and its key pests
- Perform a pest sampling
- Know and mention various alternatives of pest management
- Know and practice integrated pest management

REQUIRED TIME

Two (2) hours
STEP No. 1 – PRESENTATION:

CROP PHENOLOGY

During their development process all plants go through different growing stages. If a bean plant is taken as example, we notice that this begins germinating, continues emerging, primary leaves, first definite leaf, third definite leaf, pre-flowering, flowering, pod forming, pod filling and ripeness. Each of these stages can be influenced (accelerated or slowed) by climatic conditions and the site where is developing. All this is known as phenology. It is important to know the various phenological stages of a plant and identify during each stage the phytosanitary problems (pests) that are damaging the plant. Likewise, it is useful to know how all these pests are regulated by biotic and abiotic factors from the environment in which they develop. When all interrelations from a crop are known well, it is possible to be able to restructure a proper integrated pest management plan.

Message for the instructor: Give to each participant drawings that illustrate the phenological stages of the most important crops in the region. Ask them to write down on the drawings, the most important phytosanitary problems (pests) for each phenological stage. Ask the participants how do climatic changes influence in the presence of certain pests. Ask them about several crop varieties. Make the students participate with their experiences.

PHENOLOGY OF THE BEAN CROP
STEP No. 2 – PRESENTATION:

PEST SAMPLING FOR DIAGNOSTIC AND DECISION TAKING

Organisms sampling is an activity that must be realised in each crop phenological stage, since it will allow to supervise the population dynamics of beneficial and damaging organisms and it will be the basis to take rational decisions. All crops have organisms that will never become a pest, because the populations that develop do not cause important economic damage. For that reason, before recommending chemical control for an existing pest, it is necessary to recognise its “economic threshold”, that is, the organisms population that will cause a damage superior to the cost of its chemical control. This is done through a sampling practice.

Message for the instructor: Use illustrations with the phenological stages of crops from the region. Establish on them the various pests that attack those crops. Define the critical stages and key pests. Prepare charts that include phenological stages, pest organisms by phenological stage, sampling frequency, sampling size, economic damage threshold. Remember that economic thresholds vary from one country to the next and even in the same country there are various climatic changes, pests, crops, value of products and crops and, therefore, local levels should be applied. Make a field sampling practice. Get the help of various models or types of traps. Use the material included in this manual.

STEP No. 3 – PRESENTATION:

ALTERNATIVES TO HANDLE PEST POPULATION

Once the economic importance of an organism pest population has been determined, it is necessary to formulate a series of questions before making an intelligent decision: Which is the best way to solve a pest problem in a safe and economic manner? What handling alternatives or tactics exist to solve a pest problem? Is it necessary to use a chemical alternative? Can the pest problem be solved using other means that may present a lower risk? Etc.

It is very important to recognise that there is a variety of alternatives and tactics for pest control, which can be used by the participants, alone or combined. These alternatives are grouped in those tactics used to prevent the pests (indirect measures) and the tactics used to attack the pests or that intervene to reduce to acceptable levels pest populations present in the crops, which are economically damaging (direct measures). In a general way, among the indirect measures that can be mentioned are the following: Site of the crop, crop rotation, healthy and good quality seed, which has been properly treated; crop distribution; resistant varieties; crop handling, fertilization, RIEGO, habitat handling, trap crops, intercrops, harvest and storage. Among the direct measures we can mention: physical or mechanical control, ecological control, biological and chemical control.

Message for the Instructor: Use illustrations of the varied control alternatives. Ask the participants to offer examples of control methods they know about. Complete the “Alternatives” column in the chart that is being elaborated.
BEAN: INSECT PESTS THAT HARM THE CROP IN ITS PHENOLOGICAL STAGES

1. Black cut worm (Agrotis spp)
2. Borer (Elasmopalpus lignosellus)
3. Snail (Sarasinula plebeia)
4. Banded beetles (Diabrotica spp)
5. Army worm (Spodoptera spp., Estigmene acrea)
6. Green leafhopper (Empoasca loraemon)
7. White fly (Bemisia tabaci)
8. Bean pod weevil (Trichapion godmani)
9. Bean weevil (Helicoverpa zea)
### MAIN BEAN PESTS: SAMPLING AND CRITICAL LEVELS

<table>
<thead>
<tr>
<th>GERMINATION TO 2 TRIFOILIATED LEAVES</th>
<th>SAMPLING FREQUENCY</th>
<th>SAMPLE SIZE</th>
<th>CRITICAL LEVELS</th>
<th>BIOLOGICAL ALTERNATIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) White grub</td>
<td>(1) Before sowing 2), (3), (4), (5), (6), (7), (8), (9) y (10)</td>
<td>(1) 25 holes of 30x30x20 per ha.</td>
<td>(1) In 25 holes, 6 large larvae or 12 small.</td>
<td>- Metarrhizium</td>
</tr>
<tr>
<td>(2) Black Cutworm</td>
<td>(2) No adults leafhopper</td>
<td>(2) (3), (4), (5)</td>
<td>(2) 5% of cut plant.</td>
<td>- Bacillus popilliae</td>
</tr>
<tr>
<td>(3) Rootworm larvae</td>
<td>(3) Number of rootworm larvae</td>
<td>(3), (4), (5)</td>
<td>(3) and (4) 5% of damaged plants</td>
<td>- Bacillus thuringiensis</td>
</tr>
<tr>
<td>(4) Borer larvae</td>
<td>(4) Number of white fly</td>
<td>(4)</td>
<td></td>
<td>- Nematods</td>
</tr>
<tr>
<td>(5) No. adults leafhopper</td>
<td>(5) No. of pods with presence of bean pod weevil</td>
<td>(5)</td>
<td></td>
<td>- Bees</td>
</tr>
<tr>
<td>(6) No. rootworm larvae</td>
<td>(6) Number of white fly</td>
<td>(6)</td>
<td></td>
<td>CHEMICALS:</td>
</tr>
<tr>
<td>(7) No. of pods with presence of rootworm larvae</td>
<td>(7) Number of white fly</td>
<td>(7)</td>
<td></td>
<td>- An authorised chemical</td>
</tr>
<tr>
<td>(8) No. White fly</td>
<td>(8) Diseases:</td>
<td>(8)</td>
<td></td>
<td>CULTURAL:</td>
</tr>
<tr>
<td>(9) No. Snails</td>
<td>- Damping off</td>
<td>(9)</td>
<td></td>
<td>- Crop rotation</td>
</tr>
<tr>
<td>(10) Soil diseases:</td>
<td></td>
<td>(10)</td>
<td></td>
<td>- Stubble management</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>PLANT BREEDING</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Resistant varieties</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FROM 2 TRIFOILED LEAVES TO FIRST PODS</th>
<th>SAMPLING FREQUENCY</th>
<th>SAMPLE SIZE</th>
<th>CRITICAL LEVELS</th>
<th>BIOLOGICAL ALTERNATIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Pupae leafhopper</td>
<td>Twice a week for all</td>
<td>(1), (2), (3) y (6)</td>
<td>(1) 200 per 100 leaves.</td>
<td>- Metarrhizium</td>
</tr>
<tr>
<td>(2) Number of rootworm larvae</td>
<td></td>
<td>(2), (3), (4), (5)</td>
<td>(2) 100 per 100 leaves</td>
<td>- Bacillus popilliae</td>
</tr>
<tr>
<td>(3) Number of white fly</td>
<td></td>
<td>(3)</td>
<td>(3)</td>
<td>- Bacillus thuringiensis</td>
</tr>
<tr>
<td>(4) No. of pods with presence of bean pod weevil</td>
<td></td>
<td>(4)</td>
<td>(4)</td>
<td>- Nematods</td>
</tr>
<tr>
<td>(5) Number of snails</td>
<td></td>
<td>(5)</td>
<td>(5)</td>
<td>- Bees</td>
</tr>
<tr>
<td>(6) Number of army worms</td>
<td></td>
<td>(6)</td>
<td>(6)</td>
<td>CHEMICALS:</td>
</tr>
<tr>
<td>(7) Number of bean pod weevils</td>
<td></td>
<td>(7)</td>
<td>(7)</td>
<td>- An authorised chemical</td>
</tr>
<tr>
<td>(8) Diseases:</td>
<td>- Damping off</td>
<td>(8)</td>
<td>(8)</td>
<td>CULTURAL:</td>
</tr>
<tr>
<td>(9) Foliage diseases:</td>
<td></td>
<td>(9)</td>
<td>(9)</td>
<td>- Crop rotation</td>
</tr>
<tr>
<td>- Powdery mildew</td>
<td></td>
<td></td>
<td></td>
<td>- Stubble management</td>
</tr>
<tr>
<td>- Downy mildew</td>
<td></td>
<td></td>
<td></td>
<td>PLANT BREEDING</td>
</tr>
<tr>
<td>- Rust</td>
<td></td>
<td></td>
<td></td>
<td>- Resistant varieties</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POD FILLING UNTIL RIPENING</th>
<th>SAMPLING FREQUENCY</th>
<th>SAMPLE SIZE</th>
<th>CRITICAL LEVELS</th>
<th>BIOLOGICAL ALTERNATIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bean pod weevils</td>
<td>Three times a week</td>
<td>(1)</td>
<td>(1)</td>
<td>- Metarrhizium</td>
</tr>
<tr>
<td>(3) Number of pods with bean</td>
<td>(2) Monitor two trifoiled leaves</td>
<td>(2)</td>
<td>(2)</td>
<td>- Bacillus popilliae</td>
</tr>
<tr>
<td></td>
<td>(1) and (3) 20 pods per site</td>
<td>(3)</td>
<td>(3)</td>
<td>- Bacillus thuringiensis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3) 10 of 200 pods.</td>
<td>- Nematods</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Bees</td>
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<td></td>
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<td>CHEMICALS:</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Resistant varieties</td>
</tr>
</tbody>
</table>
CRUCIFERS: INSECT PESTS THAT HARM THE CROP IN ITS PHENOLOGICAL STAGES

1. White grub (Phyllophaga spp.)
2. Black cut worm (Agrotis spp.)
3. Diamond back (Plutella xylostella)
4. Bugs (Diabrotica spp.)
5. Army worm (Spodoptera spp. A. Monistes and L. arpia)
6. Aphids (Brevicoryne brassicae)
7. Cabbage looper (Trichoplusia ni)
CRUCIFERS
HARMFUL INSECTS

WHITE GRUB

CABBAGE CATERPILLAR LARVAE AND EGGS

BLACK CUR WORM

FLOUR WEEVIL

CABBAGE LOOPER

DIAMOND BLACK LARVA AND ADULT

ARMY WORM
### MAIN PESTS FROM CRUCIPHERS: SAMPLING AND CRITICAL LEVELS
**CABBAGE, BRÓCOLI, AND COLIFLOWER**

<table>
<thead>
<tr>
<th>SEEDLING STAGE</th>
<th>FREQUENCY OF SAMPLING</th>
<th>SAMPLE SIZE</th>
<th>CRITICAL LEVEL</th>
<th>ALTERNATIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Black cut worms</td>
<td>(1), (2), (3) and (4)</td>
<td>Three sites per seed nursery bed and 10 plants per site.</td>
<td>(1) and (2) Three cutworm or diamond black larvae per every 30 plants.</td>
<td>(1) and (2) BIOLOGIC:</td>
</tr>
<tr>
<td>(2) Diamond black</td>
<td>Twice a week.</td>
<td>(3) 9 banded beetle adults per every 30 plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Rootworm</td>
<td></td>
<td>(4) 15 winged Aphids or 12 colonies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Aphids</td>
<td></td>
<td>(5) Determine presence of sick plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Diseases:</td>
<td></td>
<td></td>
<td>- Bacillus thuringiensis</td>
<td></td>
</tr>
<tr>
<td>- Damping off</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ESTABLISHMENT TO HEAD PREFORMATION</th>
<th>FREQUENCY OF SAMPLING</th>
<th>SAMPLE SIZE</th>
<th>CRITICAL LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Sample before transplanting.</td>
<td>(1) 25 sites/ha., 30x30x20 holes.</td>
<td>(1) 6 large larvae or 12 small.</td>
<td></td>
</tr>
<tr>
<td>(2) to (7) Continue sampling twice a week.</td>
<td>(2) to (7) Three sites of 10 plants each.</td>
<td>(2) Two plants cut from 30 observed.</td>
<td></td>
</tr>
<tr>
<td>(3) to (7) Continue sampling twice a week.</td>
<td></td>
<td>(3) 9 adults from 30 plants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4) 15 winged aphids or 12 colonies from 30 plants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5) determine presence of sick plants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6) (7) 3 larvae from 30, in cabbage and 9 larvae from 30 plants observed in broccoli and coliflower.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8) Six larvae of cabbage looper from 30 plants observed, in cabbage, broccoli or coliflower.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9) Determine presence of sick plants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEAD PREFORMATION AND HEAD FILLING</th>
<th>FREQUENCY OF SAMPLING</th>
<th>SAMPLE SIZE</th>
<th>CRITICAL LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) to (6) Same frequency of sampling.</td>
<td>Same size as the sample.</td>
<td>(1) 15 winged aphids or 12 colonies.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) at (5) Three larvae from 30 plants, either from broccoli, coliflower or cabbage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6) Determine presence of sick plants.</td>
<td></td>
</tr>
</tbody>
</table>
USE OF HEALTHY SEED

HEALTHY AND STRONG PLANTS

TRAPS WITH WATER

STICKY TRAPS

TRAPS WITH PHEROMONES AND FOOD TO ATTRACT INSECTS
CONTROL ALTERNATIVES

USE OF PARASITOIDS

USE OF PARASITES

USE OF PREDATORS

HOE CLEANING

USE OF CHEMICAL CONTROL

MANAGEMENT OF STUBBLE
CHAPTER 3

PLANT PROTECTION PRODUCTS
FOR PLANT CONTROL
CHAPTER 3
PLANT PROTECTION PRODUCTS FOR PLANT CONTROL

SPECIFIC OBJECTIVES:

That the participant:

- Recognise the role of plant protection products in pest control
- Know the procedure followed for research and development of each product
- Learn to classify plant protection products, according to: biological action, chemical group, mode of action, spectrum of action, formulation, risk, legal aspects.

METHODOLOGY:

The instructor will give a talk to the participants and start it pointing out the important role of plant protection products to control insect pests, to be able to insure food production. He should emphasize the efforts made by the plant science industry in research and development of products that are compatible with Integrated Crop Management (ICM) and Integrated Pest Management (IPM). The talk should end up making a classification of the products, according to the criteria mentioned in the specific objectives.

To support what has been learned, he should prepare a workshop, in which, with the use of local product labels and brochures, the participants can find this classification criteria. The workshop must end with a display of posters that describe these details.

REQUIRED MATERIAL:

- Audivisual equipment and screen.
- Board, markers or chalk, according to the type of board
- Flip chart paper and markers
- Labels and pamphlets of plant protection products

REQUIRED TIME:

Four (4) hours

TEXT DOCUMENT:

To develop this chapter, the Instructor should read, study and analyse the text on next page:
RESEARCH, DEVELOPMENT AND CLASSIFICATION OF PLANT PROTECTION PRODUCTS

INTRODUCTION:

The technological development from the last 100 years on transportation, communication, agriculture and health has been made to provide man with a better way of life. One of the basic elements of a better life quality is an efficient food supply. Man’s great success in that sense is shown by the increased figures in world’s population and in the average life expectation during the last 50 years.

However, at the end of the XX Century, in spite of all the technology available, according to FAO’s figures, over 800 Mio. people do not have enough food to meet their needs. World’s grain supplies are lower every year, as well as available fertile farming land. Producers in general are now faced to a public opinion conscious of the need for a healthy food supply and the importance to protect the environment. The need to make better use of water, soil and air is recognised. Only through development and implementation of environmentally sustainable methods it will be possible to maintain the biodiversity in our ecosystems and protect our future and the future of next generations. Man’s challenge is to continue producing more food, under circumstances in which arable, fertile and productive land is being reduced more and more every year, due to the degradation phenomenon and because land is also being used for non-agricultural purposes. The increase in purchasing power and man’s average life expectation forces farmers to provide an additional food supply and to do this, it is required to invest in modern technology that will allow to increase productivity.

When farmers starter tilling the land and sew the first seed, farming technology started its evolution and their harvests began to increase throughout the years. Some facts, such as farming, mechanisation, the use of mineral fertilisers and the genetic improvement of useful vegetable varieties have marked the history of the agricultural sector. Among the practices that have contributed to the concrete needs of agriculture in various periods, the use of plant protection products has played a very important role.

In spite of all the technical development, according to FAO’s estimates, pests and diseases still destroy every year almost one third of the food produced. These losses occur mainly in countries with low technology, where low profitability and production levels are registered and where a higher demand for food is projected for the next 50 years.

The need to produce more fibre and food, applying sustainable practices has favoured the development of new management systems, that include the use of all available resources to control insect pests, diseases and weeds. In the context of modern agriculture the concepts of Integrated Crop Management (ICM) and Integrated Pest Management (IPM) have been developed. As indicated in the previous chapter, IPM includes three components: Prevent, Observe and Proceed.
Prevention is oriented to reduce the initial level of pests and diseases. It contemplates the use of resistant varieties, adapted to specific climatic conditions. Cultural, physical and mechanical systems for pest, disease and weed control, as well as the use of traps, application of biological products and release of beneficial insects.

Observance or monitoring are practiced to detect pest levels to determine the exact moment to apply the product for its control.

Intervention or application of a plant protection product is determined, based on economic injury level (EIL), defined as the point in which the control costs less than the damage caused by certain pest, disease or weed level.

Even if all aspects and alternatives for pest control are considered, it is not profitable to produce food without the use of plant protection products, which are part of ICM and IPM.

The development of the plant protection industry has a relatively short history, if this is measured in relation with man’s history as a farmer. Almost from the beginning, when man changed from nomad and hunter to sedentary and farmer, he observed the presence of certain organisms that caused injury to his crops and started to think of ways to protect his crops against these pests.

There are reports starting in the year 1200 BC, regarding the use of ashes to protect seeds against insects; however, due to the lack of efficient control elements, even in the middle of the XIX Century, the Irish people so defenceless how an epidemic caused by the fungus Phytophter infestans devastated a complete potato crop. This same event repeated itself in Germany in 1916. Both cases are remembered as the major famine that Europeans suffered in their history, causing the death of 1.5 Mio. persons.

In the 40’s, the real development of the plant protection industry started and in only 50 years this industry has had an extraordinary evolution. It went from the first synthesis of broad spectrum insecticides to the production of highly specialised products for the control of specific crop problems all over the world.

Now, it can be easily said, without fear to exaggerate, that plant protection products are not the most toxic substances used by man but, undoubtedly, they are the chemical substances more analysed, controlled and regulated in all the world, even more than pharmaceutical products.
RESEARCH AND DEVELOPMENT OF A PLANT PROTECTION PRODUCTS

The discovery of new plant protection products is not an easy process for research laboratories and industrial development. Their invention and development demands the work of a multidisciplinary staff of chemists, biologists, physiologists, toxicologists, eco-toxicologists and other disciplines.

The investment made by the plant protection industry to obtain new products can be divided in two phases: Research phase, on which new chemical substances, with specific biological effects are identified. This phase and its manufacturing process are protected by patent laws. The development phase is when these molecules are transformed in useful and safe products for use in agriculture. The property of this information is protected by the industrial secret regime.

Research. To obtain one plant protection product, each company synthesises and researches over 45,000 different molecules each year. The molecules are generated from basic synthesis, by oriented chance, by analogue chemistry and by oriented biochemistry. These molecules are tested in labs and glasshouses to determine if they have any biological activity (Chart 3.1).

Once the biological activity is determined, from these thousands of molecules (herbicides, insecticides, fungicides, acaricides, etc.) possibly 10 will pass to the development process and, luckily, one or two get to be registered and commercialised (Chapter 3.2).

When the molecule is patented, its development continues, and the necessary information is generated to register the product. For all the products this process involves chemical, biological, toxicological and environmental studies, which are performed simultaneously and they end up with the registration of the product after a period of 8 –10 years. (Chart 3.3).

Chemical development. The chemical development of a molecule takes between 3 and 5 years and it has an investment of US$ 70 to 80 Mio. This job is oriented to obtaining a better synthesis process, to reduce manufacturing costs and possible impurities; to produce formulations for an specific use and design packing material appropriate for the market and the farmers’ needs. The industrial process is designed and factories that will guarantee an efficient supply of high quality products are built.
The long road of the Phytosanitary Research

Substances researched per year

CHART 3.1
Biological development. When a molecule shows an interesting biological activity, small amounts of product are produced and formulated, and tests are performed at glasshouse and field level to establish the complete range of action for insect, disease and weed control.

Field tests are made locally in all those countries, crops and markets where it is detected either a commercial possibility for the product or a specific phytosanitary problem. Through biological development, dose levels are established so that each crop has an effective and safe control for each problem with the lowest dose possible. This information will serve as a basis for the recommendations on the label. According with the product, the number of crops where the product will be used, and the number of pests against which it will be applied, the biological development takes between five and six years and it has an approximate cost of US$ 80 – 90 Mio. (Chart 3.3).

Toxicological studies. A molecule that shows an interesting biological activity will undergo initial toxicity tests. Only if a favourable result is obtained, the biological development continues. The next studies analyse all aspects related to possible health risk, when there is constant or prolonged exposure to an active ingredient and to the formulated product. In short, skin and eye irritation tests are made, as well as for inhalation and ingestion of the product. Also, studies on possible long-term reproduction effects are made and to find out if there is induction of tumours and cancer. (Chart 3.3 and 3.4)

To make the toxicological studies and the reports requested to the manufacturing companies by the corresponding authorities takes between six and seven years and the investment is between US$ 25 and US$ 40 mio. (Chart 3.3)

Environmental studies. The wide range of studies that analyse the possible environmental impact of a molecule and its formulations covers all the ecosystems. In all cases, possible effects on fauna (vertebrates and invertebrates) and flora are examined. The average life of the active ingredient in the environment is determined; also the possible fixation of soil particles and degradation faith, either metabolic or chemical. Studies are made to prove if the continuous use of a product produces accumulation in water and soil, or undesirable effects on animal life, fish, soil microorganisms, bees, beneficial insects and other fauna. The characteristics of degradation substances, their persistence, possible chemical activity and secondary effects to the environment are analysed.

This process lasts between five and six years and it requires an investment of US$ 25 – 40 Mio. to cover all necessary aspects. (Chart 3.3)

Complete developing process. The complete developing process for a new product represents a big effort in time and resources. To obtain all the necessary information that will guarantee its performance and safety it takes between eight and ten years and it requires an investment that varies from US$ 200 and 250 Mio. A company can only expect to register a product before the authorities and to place it on the market after completing the developing process.
CHART 3.2
<table>
<thead>
<tr>
<th>Years</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEMICAL Active Ingredient</td>
<td></td>
<td>Synthesis</td>
<td></td>
<td>Process development</td>
<td></td>
<td>Production in pilot plant</td>
<td></td>
<td></td>
<td></td>
<td>Production</td>
<td></td>
</tr>
<tr>
<td>Formulation</td>
<td></td>
<td></td>
<td></td>
<td>Synthesis optimisation</td>
<td></td>
<td></td>
<td>Formulation/Packing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOLOGY Research Development</td>
<td></td>
<td>Laboratory/Glasshouse</td>
<td></td>
<td>Field tests</td>
<td></td>
<td>Field tests for development and registration</td>
<td></td>
<td></td>
<td></td>
<td>Application optimisation</td>
<td></td>
</tr>
<tr>
<td>TOXICOLOGY Mammals Environment</td>
<td></td>
<td>Acute toxicity, sub-chronic, chronic/mutagenic/cancer/teratogen/reproduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Official evaluation of registration documents</td>
<td></td>
</tr>
<tr>
<td>ENVIRONMENT Metabolism Residues</td>
<td></td>
<td>Plants/animals/soil/water and air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

US $ 200 a 250 mio

US $ 70 a 80 mio

US $ 80 a 90 mio

US $ 50 a 80 mio
Increase of Toxicological Requirements for Registration

<table>
<thead>
<tr>
<th>Tests from 30 to 90 days</th>
<th>General Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute toxicity</td>
<td>Mutagenic effects</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cumulative toxic effects</td>
</tr>
<tr>
<td></td>
<td>28 days</td>
</tr>
<tr>
<td></td>
<td>Ecotoxicologic studies</td>
</tr>
<tr>
<td></td>
<td>Chromosomal Carcinogenicity rats</td>
</tr>
<tr>
<td></td>
<td>Reproduction 2 generations rats</td>
</tr>
<tr>
<td></td>
<td>Reproduction 3 generations of rats</td>
</tr>
<tr>
<td></td>
<td>1 year, dogs</td>
</tr>
<tr>
<td></td>
<td>2 years, rats</td>
</tr>
<tr>
<td></td>
<td>90 days, dogs</td>
</tr>
<tr>
<td></td>
<td>90 days, rats</td>
</tr>
<tr>
<td></td>
<td>Acute toxicity</td>
</tr>
<tr>
<td></td>
<td>Acute toxicity</td>
</tr>
</tbody>
</table>

1950  1970  1990
Registration. The norms to register a product are different for each country; however, there is a general concern all over the world to move forward in the harmonisation of the registration procedures.

At present, to obtain the registration of a product or the sales license takes between two and four years, depending on the type of product and the crops on which it will be applied.

After registration. Once a product has been registered, the process does not stop. Research continues and in many occasions, with the advancement of scientific knowledge, it is necessary to make additional studies.

For this reason, relevant authorities are constantly requesting the owner of a product registered, additional information that certifies the product’s safety, according to the most recent research. If there is no information available, the company interested in maintaining the product on the market must make the studies and present the report.

Frequently, products that have been on the market for many years require additional investment to prove that they comply with the safety parameters. These efforts represent a high percentage of a company’s budget for additional research and development.

CLASSIFICACION OF PLANT PROTECTION PRODUCTS

Pesticide concept. There are various alternatives to manage or control pests. The use of plant protection products (pesticides) is one of them. A pesticide can be defined as any chemical or biological substance; biological agent or mixture of substances destined to attack, destroy, control, prevent, lessen or repel the action of pest organisms that affect the health and well-being of man, domestic animals and useful plants.

The term includes substances destined to be used as plant growth regulators, plant defoliators, to dry it out, agents to reduce fruit density or to prevent fruit premature fall, and substances applied to crops before or after harvest to protect the product against deterioration during the transportation and storage process.
Desirable qualities in a plant protection product. The desirable qualities that a plant protection product must have are illustrated in chart 3.5.

**Optimum substances: Illusion or reality?**

**CHART 3.5 – Desirable qualities in a plant protection product.**

**CLASSIFICATION OF PLANT PROTECTION PRODUCTS**

Plant protection products can be classified according to various criteria. For example, according to: their organism objective of control or biological action; chemical group or structure to which it belongs; mode of action; action spectrum or specificity; type of formulation; danger and/or toxicology; legal aspects; application period, etc.
CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO THEIR CHEMICAL GROUP.

According to their biological action, plant protection products are classified as detailed in chart 3.1.

CHART 3.1

<table>
<thead>
<tr>
<th>PLANT PROTECTION PRODUCTS</th>
<th>ORGANISMS SUBJECT TO CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acaricide</td>
<td>Mites</td>
</tr>
<tr>
<td>Aficide</td>
<td>Aphids</td>
</tr>
<tr>
<td>Avicide</td>
<td>Fowl</td>
</tr>
<tr>
<td>Alguicide</td>
<td>Seaweed</td>
</tr>
<tr>
<td>Bactericide</td>
<td>Bacterias</td>
</tr>
<tr>
<td>Formicide</td>
<td>Ants</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Fungus</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Weeds</td>
</tr>
<tr>
<td>Garrapaticide</td>
<td>Ticks</td>
</tr>
<tr>
<td>Insecticide</td>
<td>Insecticides</td>
</tr>
<tr>
<td>Molusquicide</td>
<td>Molluscs</td>
</tr>
<tr>
<td>Nematicide</td>
<td>Nematodes</td>
</tr>
<tr>
<td>Rodenticide</td>
<td>Rodents</td>
</tr>
</tbody>
</table>

CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO THEIR CHEMICAL GROUP.

Based on their chemical structure, plant protection products are grouped in families or large groups, which, at the same time, can be subdivided. It is very important to know these groups from the agricultural and occupational safety point of view, since this will permit to manage them correctly (some groups are incompatible, other present crossed resistance or group resistance. There are specific medical treatment or first aid treatments in case of intoxication for each group).

The insecticide chemical groups are: organochlorates (practically discontinued) organophosphates, carbamates, pyrethroids, chloronicotiniles, benzoilureas, dibenzofuranes, acridiones, tiosulfones, tiodiazines, oximas carbamicas, tioureas, ethalates, fenoxibenciles, benzamides, pyrediazinones, phenyl ether, pirroles, organofluorines, hydracines, tritanes, formamidines, etc.

The acaricde chemical groups are: organophosphates, carbamates, norpyrethroids, formamidines, organomethalics, imides, pyrethroids, benciles, tiodiazines, tetrazines, quinoxalines, dinitrofenoles, pirazoles, tiazolidines, etc.
The most common fungicide chemical groups are: Copper salts, sulphur, dithiocarbamates, ethylenbisditiocarbamates, nitrofeniles, triazoles, benzimidazoles, pirimidines, acilanilines, sulfamides, morfolines, fitalimides, phosphoric acids, conazoles, phosphates, difeniles, anilides, ureas, tiadizines, pyridazines, quinones, pyridilisulfuros, benzamine, amtraquinones, oxazoles, gaunidines, tiadizoles, pirroles, piperdines, imidazoles, dithiolanos, pyranosides, isoftalaltos, oxazolidines, quinocines, pyridines, methoxiacrilates, etc.

The most common herbicide chemical groups are: phenoxy acids, phosphonic acids, bypriridiles, triazines, oxidiazoles, triazoles, ureas, dintrazoanilines, benzoicos, acetanilides, difenil ether, oximes, organophosphates, benzofuraniles, benzotiodiazoles, pirazoles, benzitiazoles, phosphoniles, uraciles, carbamates, sulphonilureas, pyradizanones, pyridones, furanonas, imidazoles, falamates, quinoxalines, etc.

Description of main insecticide chemical groups.

Inorganic insecticides. These are compounds whose active ingredient is a metal or inorganic element. Its structure is simple and does not contain carbon. When the organo-synthetic insecticides appeared, their used decreased and at present these compounds have been taken out of the market because they are toxic to humans, for example calcium arseniate, sulphur, etc.

Organochlorated insecticides. These are organo-synthetic products whose molecule contains chlorine. Most of them are insecticides. They were developed and widely distributed after 1940 but at present most of them are banned from the market and in the Latin American countries their use is restricted due to their characteristics of persistence and tendency to accumulate in the food chain.

Organochlorated insecticides are neurotoxic and act on the peripheral nerve system, affecting the sodium and potassium balance of the neurones. They also present an acute low toxicity.

In this group are found: Dicofol, DDT, metoxichlor, hexachlor, lindane, pentachlorfenyl, endrin, aldrin, dieldrin, clordane, toxafene, heptachlor. Some of these products are still sold without restrictions and other are sold with some restrictions in some countries, for example the insecticides Dechlorane, Mirex and Endosulfan.

Organophosphate insecticides. They are organic derivatives from phosphoric acid that were placed on the market during the 50’s and 60’s. Most of them are insecticides; some are insecticides-acaricides and others also have nematicide effect.
Their main characteristics are: Fast degradation when in contact with the environment; in most cases relatively high toxicity for vertebrate organisms; highly volatile in comparison with other groups. Very soluble in grease and organic solvents; fast action on insecticides, that is why they can favour resistance development.

Some of the most known are: Azinphos Methyl, Acephate, Azametiphos, Chlorpiriphos, Demethon, Diazinon, Diclorvos, Dimetoato, Disulphoton, Ediphenphos, Ethoprop, Phenamifos, Fensulphotion, Fenthion, Phorate, Phoxim, Isophenfos, Malathion, Metomidphos, Mevinphos, Parathion, Methyl, Monocrotophos, Naled, Oxidimeton Methyl, Pirimiphos Methyl, Prophenofos, Terbufos, Thiometon and Trichlorfon.

Carbamate Insecticides: These are products derived from carbamic acid. They are mainly insecticides. Some carbamates have fungicide action and others nematicide action. Very few of them act as herbicides. Their action and characteristics are similar to the ones from the organophosphates. The insecticides carbamates are highly toxic for bees.

The most used active ingredients are: Carbaril, Metomil, Propoxur, Carbofurano, Carbosulfano, Oxamile, Isoprocarb, Metalcarb, Alamicarb, Bendiocarb, Benfuracarb and Aldicarb. Carbofurane, Carbosulfane, Oxamile and Aldicarb are also nematicides.

Formamidine Insecticides. This chemical group was developed in the latter part of the 70’s. Their mode of action is by ingestion or steam action.

The most known active ingredient is chlordimeform, which has an acaricide effect. Amitraz is another active ingredient of this group that has insecticide and acaricide biological action.

Insecticides Pyrethroids. These are insecticides structurally related to the ones extracted from the flowers of the Chrysanthemum cinerariaefolium (pyretrines y cynerines). The synthetic pyrethroids are lipophilic compounds, water insoluble, with high stability to light and temperature, with little soil mobility and easily degradable by the action of micro-organisms and practically non-toxic for hot blood animals. They act by contact and to a lesser degree by stomach action. They have neither systemic nor translaminar action.
Among the most known pyrethroids we can find the following active ingredients: aletrine, bifetrine, bioresmetrine, cifuflurine, cipermetrine, decametrine, deltametrine, esfenvalerate, fluvalinato-tau, fenvalerate, resmetrine, tetrametine, teflutrine y lambda cihalotrine.

**Chloronicotinilios (neonicotinoids) Insecticides.** These insecticides were received recently by the agrarian community, since they only appeared on the market in the first part of the 90’s. They are now registered in over 100 countries and are among the most used. The active ingredients of this chemical group presents all the properties required from a modern plant protection product. The potential risk for the user and the consumer is minimum because these insecticides are used at low doses and have no potential for the bioaccumulation. They present very low acute toxicity for mammals. These products also have an excellent ecotoxicological profile, with a very low acute toxicity for soil worms, birds, fish and beneficial insects.

They act on a broad range of temperatures, with growing intensity as temperatures rise. Their photostability and resistance to rain are very good. Their absorption through the vegetable tissue can offer an optimum effect. They easily degrade on the ground. Their translaminar properties are good; in other words, the active matter deposited on the leaves’ top, penetrates the vegetable tissue and it reaches even the damaging insects that hide on the leave’s reverse. They act specially by ingestion. Their contact action is evidently less strong.

The action mechanism of the chloronicotiniles is completely different to the action mechanism of the phosphorates, carbamates and pyrethroids, since these active ingredients join the receptors of postsynaptic nervous fibres, in a similar way as the natural neurotransmitter (acetylcoline) does it, but opposite to what happens with this, the chloronicotiniles cannot be degraded by the acetylcolinesterase. The result is a persistent perturbation of the nervous system that kills the affected insect.

The special action mechanism of the active ingredients chloronicotililes does not allow a cross resistance with conventional insecticides (organophosphates, carbamates and pyrethroids).

The main active ingredients known are: acetamiprid, imidachlorprid, thiachloprid and thiametoxan.
**Insecticides derived from lactose:** Abamectine is an active ingredient from this group and is a broad spectrum insecticide-acaricide of contact and ingestion that acts paralysing the various species of mites and insects by promoting the presineptic liberation of neurotransmitter gamma aminobutilic acid (GABA) and blocking the transmission of nerve impulses. This causes that adults and larvae get paralysed and, therefore, they cannot move or feed themselves for 2-4 days after making contact with the product. As the pest does not dehydrate quickly, they die slowly; however, their presence does not cause any injury to the plant (because they do not eat). This active ingredient is absorbed by the foliage and accumulated in the foliar tissue, which permits a good and lasting control of mites and insects. This product also has after emergency control, affecting the larvae before they start feeding themselves. It does not have ovicide effect.

The action mechanism of the abamectine consists in blocking the transmission of nerve impulses by inhibiting the GABA neurotransmitter.

**Otros grupos químicos de insecticidas.** En el Cuadro 3.2 se encuentran otros grupos químicos de insecticidas, algunos ejemplos de ingredientes activos y modos de acción.

**Other insecticide chemical groups.** In chapter 3.2 there are other insecticide chemical groups, some examples of active ingredients and modes of action.

**Natural organic insecticides.** These are compounds directly derived from vegetables, such as nicotine, pyretrine, rotenone, rianodine, azadiractine, quasine and neoquasine. Not all of them present the same mode of action, since their chemical structure is different and complex. Generally, they are substances easily degradable under environmental conditions and, therefore, not very persistent.

**Microbiological insecticides.** These derive directly from micro-organisms (bacteria, fungus, virus, etc.). The most known is Bacillus thuringiensis. The commercial presentation of this insecticide contains toxic crystals of endotoxina delta, formed by a crystallised protein, which is synthetised during the sporulation process of Bt bacteria, and of Bt bacterial spores that have a spherical shape. The most used Bt varieties are: aizawa (controls lepidophterous larvae); issrailensis (controls dipherterous larvae); kurstaki (controls lepidopterous larvae); morrisoni (controls lepidopterous larvae) and tenebrios (controls colepterous larvae).

The toxic action falls on the Larvae because a few minutes after ingesting the treated foliage, they stop eating and a paralysis in the intestinal wall appears caused by the action of the endotoxine crystals. Subsequently, the bacteria’s spores invade the insect, causing their death 2-3 after the ingestion.

**Spinosad (spinosin A and D), derived from Actinomiceto Saccharopolyspora spinosa,** is an insecticide that acts on the insects’ nervous system. The action site is new; it does not show any cross resistance with known chemical or biological insecticides. Once the active ingredient has been ingested by the pest, an irreversible
process is generated, characterised by involuntary muscular contractions, shaking and prostration in a 24-hr. period. This neuromuscular fatigue conduces to paralysis, reflected in the fact that the pest objective stops feeding itself, producing its death in less than 72 hours.

**CHART 3.2 - Chemical classification of other insecticides.**

<table>
<thead>
<tr>
<th>CHEMICAL GROUP</th>
<th>ACTIVE INGREDIENT</th>
<th>MODE OF ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzoilurea</td>
<td>Chlorfluazuron</td>
<td>Ingestion</td>
</tr>
<tr>
<td></td>
<td>Flufenoxuron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teflubenzuron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hexaflumuron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triflumuron</td>
<td></td>
</tr>
<tr>
<td>Benzamida</td>
<td>Lufenuron</td>
<td>Ingestion</td>
</tr>
<tr>
<td>Hydracine</td>
<td>Tebufenozide</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Fiprol</td>
<td>Fipronil</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Carbamic Oxime</td>
<td>Butocarboxim</td>
<td>Systemic</td>
</tr>
<tr>
<td></td>
<td>Butoxicarboxim</td>
<td></td>
</tr>
<tr>
<td>Pirrol</td>
<td>Clorfenapir</td>
<td>Translaminar</td>
</tr>
<tr>
<td>Piridazinone</td>
<td>Piridaben*</td>
<td>Contact</td>
</tr>
<tr>
<td>Tiodiazine</td>
<td>Buprofezine*</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Triazina</td>
<td>Ciromazine</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Tritiane</td>
<td>Tiocyclam H-oxalato</td>
<td>Translaminar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Tiourean</td>
<td>Diafentiuron</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Urea</td>
<td>Diflubenzuron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flucofuron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indoxacarb</td>
<td>Contact and ingestion**</td>
</tr>
<tr>
<td>Metoxyfenozide</td>
<td></td>
<td>Contact and ingestion**</td>
</tr>
<tr>
<td>Enamectine benzoate</td>
<td></td>
<td>Ingestion</td>
</tr>
</tbody>
</table>

* It also has acaricide biological action.
** Do not have an assigned chemical group.
Description of main fungicide chemical groups

Inorganic fungicide based on copper. They present themselves as copper salts and are basically used as preventive products. They are toxic for fish and adhere strongly to the soil. Present certain phytotoxicity for plants. Among the most common products we can find Bordeaux mixture and fixed copper, such as the solutions from copper sulphate, hydroxide, oxichlorure and copper oxid. They are very effective to control a great variety of phytopatogens (fungus and bacteria).

Inorganic fungicides based on sulphur. Among the inorganic fungicides with organic base, elemental sulphur is included, which, in addition to its fungicide effect, it has insecticide and acaricide properties. It is very effective to control powder mildew (little ashes), although it is also effective on rust, leave blight and fruit rot.

Substituted aromatic fungicides. These fungicides are derived from the benzene. Among them we can classify fungicides as PCNB, bifenile, chlorotalonile and dichlorane. PCNB is used to control earth fungus and seeds. Bifenile to control postcrop diseases in citrics. Chlorotalonile is a broad spectrum fungicide that controls various foliage diseases (blights, mildews, rusts and antracnosis). Dichlorane is used to control earth fungus that cause stem diseases and postcrop rot.

The actino mechanism of the substituted aromatic fungicides acts by inhibiting the production of amino acids and fungus enzymes.

Fungicides derived from fitalimides (dicarboximides). They are broad spectrum organic fungicides. Among them we find Captan, Captafol and Faltan. Captan is a protective and eradicate fungicide, used to control diseases such as powdery mildew, early blight and late blight, as well as antracnosis; also fruit rot, vegetables rot and fusariosis. Captafol and Faltan are wide spectrum protective fungicides, with similar characteristics to Captan.

It is known that the mechanism of its fungicide action interrupts the Krebs cycle and causes accumulation of piruvic acid, provoking the fungus death.

Toxicity for mammals is low, being one of the fungicides with less toxicity that are known.

Acilalaminas o fenilaminas fungicides. These constitute a group of systemic fungicides, widely used at world level to control late blight, mildew and the "almacigo fall", caused by Phyllum. Among the most known active ingredients we find metalaxil, bealaxil and furalaxil. These products are used to control diseases caused by the fungus ficocimetos, using foliar spraying, treatment of seeds and soil. These products have a very low toxicity for mammals.
This group of fungicides has little or no activity whatsoever to control actinomicetos, basidimicetos and imperfect fungus.

**Chlorated quinone fungicides.** The fungicide properties of the quinines were known when the natural product named *juglone* that is found in nut skin was studied. Although this product can be obtained in natural form in the plant tissue, it can also be obtained through the oxidation of the fenolic compounds of the plants. Benzoquinona and Naftoquinona have outstanding fungicide properties but their chlorated derivatives are much more active.

The most important are chloranil and dichlone. Dichlone is the only product widely used for seed treatment and algae control. It is a product with low toxicity, although it can be irritant to skin and mucous membrane. Some oximes and hydrazones from the quinines are also fungicides. Benquinox is used to disinfect seeds.

**Fungicides dithiocarbamates.** Organic fungicides, derived from dithiocarbamic acid are the most commonly used from all organic fungicides. They are very effective against a wide range of fungus from which the amino acid is disactivated. Among the most common active ingredients the following are found: Ferbam, Maneb, Mancozeb, Propineb, Tirad, Vapam, Zineb and Ziram. These products have a low toxicity, although they can irritate the skin and mucous membrane.

Thiram is used to treat seeds and for foliar spraying. Maneb, Mancozeb, Propineb, Ferbam and Zineb are used for foliar treatments.

**Benzimidazole Fungicides.** Some derivatives from benzimidazole have a great fungicide activity. Some important active ingredients are carbendazim, benomil, fuberidazole, thiabendazole methyl thiofanate. Benomil is a broad spectrum fungicide, with systemic action and very low toxicity. It also acts on mites and certain nematodes.
Thiabendazole and methylthiofanate, are preventive and eradicating fungicides for many phytopathogens. They also have systemic action. If they are managed incorrectly, a resistance problem might appear.

| The action mechanism of the benzyimidazole fungicides is to inhibit the myhosis process in fungus. |

Imidazole fungicides. In this group there are some active ingredients as glicophene, imazalil, imazaquin, procimidone, and procloraz: These are products with protective, eradicative and curative properties against several phytopatogens.

| Their action mechanism is to inhibit the synthesis and function of the cell walls in fungus. |

Organophosphate fungicides. This chemical group of fungicides includes some active ingredientes, such as amprophilfos, edifenphos, iprobenphos and pirazofos. Edifenphos is a preventative and eradicative fungicide, used for rice diseases. Meanwhile, amprophilfos, iprobenphos and pirazofos have preventative and curative properties.

| The active ingredients from this group have as action mechanism to inhibit the synthesis and function of the walls and cell membranes in fungus. |

Pirimidine fungicides. These fungicides are excellent to control powdery mildews. The most known active ingredients are: dimetirimol, etirimol y bupirimato. The first two mentioned are eradicative; the last one, besides being eradicative is also protective. Some other active ingredients are fenarimol, ferimizone and nuarimol, with similar mode of action.

| The action mechanism of pirimidine active ingredients is to inhibit the action of the enzymes that participate in the biosintesis of “purines” and aminoacids. |

**Triazole fungicides.** Some active ingredients with fungicide activity have been obtained from triazol. These fungicides control a broad range of diseases caused by fungus that pertain to the ascomicetos, basidiomicetos and deuteromicetos. Among the most common active ingredients are triadimefon, triadimenol, hexaconazole, imibenconazole, bitertanole, ciproconazole, dichlobutrazole, difeconazole, fluzilasole, tebconazole, propiconazole and fluinazole. All of them act systemically.

| The action mechanism of this group of fungicides is to inhibit the biosynthesis from sterol. |

Morfoline fungicides. In this group the following active ingredients can be found: dodemorf, fenpropimorf and tridemorf. All of eradicative and systemic action.
Tridemorf is used as preventative and eradicative to control powdery mildew and Sigatoka in banana plantations. Dodemorf is used for foliar spraying to control powdery mildew and rust.

The action mechanism of this group of fungicides is to inhibit the biosynthesis from sterol.

Fungicides from the group of the anilidas (oxantinas). The most known active ingredients from this group are: Carboxine and oxicarboxine. The first one is used for seeds treatment and the second one is specific for rust treatment. Other active ingredients, such as sonclozolinat, fenfuran, flutolanil, metfuroxan, mepronil and metsulfovax, act systemically and are excellent to control rust, carbons and Rhizoctonia sp. species.

The action mechanism of these compounds is to inhibit the synthesis from deshidrogenasa succinica, an enzyme that regulates the respiration.

Fungicides of the group of the bencilamides. They have systemic properties. The active ingredient caproamid is an specific fungicide to control Pyricularia in rice. Its action mechanism is based in the inhibition of the melanine sintesis in the fungus metabolism. This point of action differs from that of classic products.

The action mechanism of this group of fungicides is to inhibit the action biosynthesis from the fungus melanine. Without melanine, germinated conidias cannot enter the plant’s tissues.

Fungicides of the group of the hydroxinalides. The main active ingredient in this group is fenhexamid. This active principle has a long lasting high effect that lasts until the storage phase. In addition, it has other excellent qualities, it is effective for rot provoked by Botrytis and Monilia, in grapes, bone fruits, berries, citrics, legumes, as well as ornamental plants. It is also effective against Sclerotinia in vegetables and it has secondary effects against Colletotrichum and Gnomonia. Fenhexamid is not distributed systemically; however, it does exist certain locosystemic effect. It does not inhibit the germination of the spores but it does inhibit the growth of the germinated tube and the “micelio” extends to the interior of the of the plant tissues. The treatment must be concentrated on the early stage in which the fungus is still exposed. For this reason, it can only be applied as a protection before the fungus tries to enter the plant.

Its mechanism action is only to inhibit the growth of the fungus germinating tube.
**Fungicides of the group of the bencilamides.** Trifloxystrobin is the most modern fungicide of the strobilurina group. Due to its exceptionally broad spectrum and easy penetration and redistribution, it can be considered a representative of the second generation of this relatively new type of active ingredients. Trifloxystrobin is a fungicide with protective and partially curative action, for foliar application against several diseases that damage the plants in tropical, subtropical and template climates.

These compounds have an inhibiting effect in spores germination and other early phases of fungus development, and perform an excellent preventative action.

The chemidynamic properties of trifloxystrobin on top and inside the plant, differentiate it different from contact, penetration and systemic fungicides. Its high affinity to the vegetal surface gives it an excellent persistence and resistance to rain wash. Over 50% of the dose of tryfloxystrobin applied crosses the waxed coat, which protects it against photolysis and thanks to its reduced hydrosolubility, it is also protected from rain wash. A small amount of product penetrates in the plant’s tissues, which results in a translaminar and curative activity against specific patogens. The concentration of Trifloxystrobin in the epidermis is 4-5 times higher than in the rest of the leaf. Induced redistribution by superficial vaporisation gives a significant protection to the untreated tissue. Since Tryfloxystrobin does not translocate through the plant’s vascular system, there is no dilution effect. The term “mesostemic” has been proposed as a new type of fungicide to describe the combination of properties exhibited by Tryfloxystrobin.

This compound presents some very favourable toxicological characteristics. It blows away quickly from the soil and superficial waters and is very unlikely that it will cause damage. It does not represent any risk to consumers and operators. It has a low toxicity for mammals.

**Antibiotics.** This group includes products such as streptcomicine, kasugamicine, polioxine B and polioxine D. These compounds are among the first ones developed in agriculture and due to their specific action, the microorganisms soon developed resistance against them.

Streptomicine controls plants bacterial diseases by foliar applications. It is also used for seed treatment, specially in bean seeds and potato tubercules. Kasugamicine is a product with preventative and curative properties that controls a large number of pathogens. Polioxina is used to control *Rhizoctonia, Alternaria Botrytis, Sclerotinia* and other patogens.

Its action mechanism is to inhibit the protein synthesis.
**Other fungicide chemical groups.** Examples of active ingredients and mode of action are shown on Chart 3.3.

### CHART 3.3

<table>
<thead>
<tr>
<th>CHEMICAL GROUP</th>
<th>ACTIVE INGREDIENT</th>
<th>MODE OF ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conazole</td>
<td>Azaconazole</td>
<td>Systemic</td>
</tr>
<tr>
<td></td>
<td>Tetraconazole</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triflumizole</td>
<td></td>
</tr>
<tr>
<td>Fenilo</td>
<td>Cloroneb</td>
<td>Protective</td>
</tr>
<tr>
<td>Fosphonic</td>
<td>Fosetil – Al</td>
<td>Systemic</td>
</tr>
<tr>
<td>Nitrofenile</td>
<td>Fenitropan</td>
<td>Protective</td>
</tr>
<tr>
<td>Oxazol</td>
<td>Drazoxolon</td>
<td></td>
</tr>
<tr>
<td>Oxazolidine</td>
<td>Oxadixil</td>
<td>Systemic</td>
</tr>
<tr>
<td></td>
<td>Vinclozolin</td>
<td></td>
</tr>
<tr>
<td>Piranosido</td>
<td>Kasugamicine</td>
<td>Protective and systemic</td>
</tr>
<tr>
<td>Pirazol</td>
<td>Pirazophos</td>
<td>Systemic</td>
</tr>
<tr>
<td>Piridazine</td>
<td>Diclomezine</td>
<td>Protective and eradicative</td>
</tr>
<tr>
<td>Pirrol</td>
<td>Fenpichlonil</td>
<td>Protective</td>
</tr>
<tr>
<td>Spiroquetalamines</td>
<td>Spiroxamine</td>
<td>Systemic</td>
</tr>
<tr>
<td>Sulfamide</td>
<td>Diclofluanide</td>
<td>Protective</td>
</tr>
<tr>
<td></td>
<td>Tolyfluanide</td>
<td></td>
</tr>
<tr>
<td>Tiadiazine</td>
<td>Dazomet</td>
<td>Protective and eradicative</td>
</tr>
<tr>
<td>Tiodiazol</td>
<td>Etridiazolo</td>
<td>Protective and eradicative</td>
</tr>
<tr>
<td>Triazine</td>
<td>Anylazine</td>
<td>Protective</td>
</tr>
<tr>
<td>Urea</td>
<td>Cimoxamil</td>
<td>Systemic</td>
</tr>
<tr>
<td></td>
<td>Pencycuron</td>
<td></td>
</tr>
</tbody>
</table>

**Description of main herbicide chemical groups.**

**Inorganic Herbicides.** These were initially used but later were discontinued for safety reasons, due to their little or non-selectivity, their persistence on the soil and other negative factors. Among them, we can classify: Sulphuric acid, iron and copper sulphates, sodium arsenic and sodium chlorate.
**Aliphatic herbicides.** They have a non-anular structure, with chlorine elements and CH₃ radical. The main characteristics of this group are: the power to be absorbed through the foliage or roots; their stability on the plant and instability on the soil, because they are biodegraded by microbe action and their control of perennial pastures, such as Johnson and Bermuda pastures. In this group we can classify TCA active ingredient and Dalapon.

Their action mechanism lies in the inhibition of the metabolism and the synthesis of the panthotenic acid.

**Amidas herbicides.** Their basic structure is the Amide group. These are herbicides that can be applied in pre-planting, pre-emergency and some of them in post-emergency. In general they are not effective to control already established perennial and annual plants. Their main use is for selective control of pasture seedlings and certain broad leaf weeds. The main active ingredients in this group are: Alachlor, benoxachlor butachlor, butenachlor, dichlormide, difenamide, metolachlor, napromide, propanyl. Propizamide and tebibat. Alachlor and metolachlor can be used in pre-emergency, applied to the soil, inhibiting the radicular growth.

**Acetanilide Herbicides (chlorine acetamide).** The main active ingredient of this group is Acetochlor, which is a pre-emergent herbicide, selective to sugar cane to control gramineas, broad leaves and annual cyperaceas. It affects emerging weeds and to a lesser degree already emerged weeds.

It has a multiple action mechanism. It inhibits various biochemical processes, in which cellular division and elongation, protein synthesis, lipids, fatty acids, flavonoids and hormonal balance are included, which gives it effectiveness on several weeds.

**Benzoic herbicides.** These are products derived from benzoic acid. In this group there are very few herbicides. They are usually applied to the foliage and the stems of the plants, being absorbed by these and by the roots. They are relatively persistent on the soil, maintaining the phytotoxic action for several months. The most important active ingredients are: Chloramben, Chlortal and Dicambe.

**Bipiridile Herbicides.** These are cathionic products from ammonium cuaternary, very soluble in water. They are applied to foliage and have a burning or contact effect. They are not selective and are quickly inactivated on the soil. These herbicides are absorbed by the leaves; they are phytotoxic for many vegetal species by mere contact action. They do not translocate through the phloem nor destroy subterranean parts of the plant. For this reason they are effective against perennial weeds. The most known active ingredients are Paraquat and Diquat. Diquat is most frequently used as an aquatic herbicide.
Carbamate herbicides. These products are classified in two sub-groups, according to their origin and basic structure: Fenilcarbamates are derived from carbamic acid and thiocarbamates that originate from thiocarbamic acid. Most of these herbicides are relatively volatile and, some of them, for this reason, need to be incorporated to the soil immediate after their application. Generally, they are quickly absorbed by the roots, coleoptile and leaves. The easiness with which they degrade in plants and soil is an advantage because they leave no residues but at the same time it is a disadvantage because it reduces the period for weed control.

Among the fenilcarbates the main ingredients are: Prophen, chloroprophen, and Barben and among the thiocarbamates the main active ingredients are: butilate, cycloate, dymepepirate, Esprocarb EPTC, molinate, organocarb, penbulate, pyributicarb, prosulphocarb, thio carbazil, trialate, vernolate and thiobencarb.

Dyphenil ether herbicides. The main active ingredients in this chemical group are: chlometoxiphene, chlornitrophen, fluoronitrophen, fomesaphen, furiloxiphen, and oxyfluorphen. Fomesaphen is a selective herbicide of systemic contact, post-emergent, that executes its action on the photosynthetic mechanism. The photosynthesis is altered by the generation of superoxid radicals in the chloroplasts. Oxyfluorphen is a pre and post emergent herbicide that controls a broad spectrum of gramineas, broad leaves and cyperaceas; its action is strictly by contact, is not absorbed by the roots and does not have a systemic effect either.

Phenole herbicides. These are herbicides derived from Benzene monohydroxil. They act by contact, mostly on annual weeds. When they evaporate, damage can be caused to the plants during seed’s pre-emergency. Their main active ingredients are: Pentachlorofenol, dynozeb, bromophenoxim and Dynotherb.

Anyline and Dynithroaniline herbicides. These products are derived from the anylines with radicals with two groups NO2. Almost all the products are yellow and water soluble, generally volatile and susceptible to photodegradation. They are applied in pre-emergency, affecting the weeds, preferably if they have not germinated. For best effectiveness some of them must be incorporated to the soil. They do not have post-emergent activity and for this reason they do not control annual or perennial plants already established. Although they are absorbed by the roots and the seedling’s sprouts, they cannot be translocated. Main active ingredients in these groups are: Trifluraline,
oryzaline, prodiamine and pendimetaline. Other active ingredients are: Butaline, dietalil, difluphenican, fluocoralin, isopraline and profuraline.

**Phenoxiacetic herbicides.** They derive from phenoxiacetic acid. These products have a strong herbicide activity against broad leaf weeds; therefore, they are mostly applied to gramineas. These herbicides are easily absorbed by plants with broad leaves through the roots and leaves and translocated in the plant via transpiration and photosynthesis. They are effective for annual and perennial broad leaf weeds and for woody bushes.

<table>
<thead>
<tr>
<th>Their action mechanism is hormonal. Its effect shows in the curving of the stems, chlorosis, withering and malformation of leaves and roots and plant’s death.</th>
</tr>
</thead>
</table>

Most known active ingredients are: 2,4-D (2,4 acid - didloropheniacetic acid) MCPA (acid 2 - methyl - 4 - chlorine - phenoxiacetic).

**Phosphonic herbicides.** The main active ingredients of this chemical group are phosamine, ammonium gluphosinate, glyphosate and trimesium glisophate. The first two active ingredients act as contact herbicides, while the other two act as systemic post-emergent, broad spectrum, non selective herbicides. Ammonium gluphosinate acts by contact in the green tissues of susceptible plants; it penetrates mainly through the cuticle. Glyphosate penetrates only through the foliage and other green tissues of the plant. It is translocated by the phloem to the growing points or meristematic tissues of the plant. It does not remain on the soil and it does not have pre-emergent activity. Trimesium glisophate acts in a similar way.

<table>
<thead>
<tr>
<th>Glisophate action mechanism consists on the inhibition of aromatic amino acids.</th>
</tr>
</thead>
</table>

**Triazine herbicides.** These are products with herbicide action whose basic structure is centred on the amine group. The most known active ingredients are: atrazine, ametrine, metribuzine, simazine, terbutrine and tebutilazine. The action of these active ingredients is related to soil behaviour, wash and decomposition of the product on the soil. The presence of organic matter on the soil has a decisive influence on these phenomena because it favours adsorption and development of micro organisms that accelerate the product decomposition. That is why in soils with abundant organic matter, it is recommended the use of the high dose recommended in the product’s pamphlet. It has been proved that triazines penetrate the leaves’ cuticle and move on to the tip of the leaves; they are also absorbed through the roots and circulate by the xylem toward the upper part of the plant, accumulating on the leaves’ edge.
The fundamental action on the leaves’ cells is to inhibit the photosynthesis process. In sensible treated plants the first symptom is the leaves chlorosis. The action is performed mainly on the developing young plants, in the first days of germination, but it does not affect the seeds germination. Other active ingredients in this group are: desmetrine, dimetametrine, dipropetrine, eglinazine, hexazinone metametrine, metoprotine, metribuzine, progainazine, propazine, simetrine, terbutemton y trietazine.

Herbicides from the group of substitute ureas. These products are usually applied to soil and are relatively non-selective at high concentrations, although they are selective at a low dose. Their main use is selective in early pre-emergence and post-emergence. The selectivity of these herbicides depends fundamentally on the tolerance of certain crops and the depth at which seeds germinate and roots develop. Crops whose seeds or roots develop at a greater depth than weeds are not affected by superficial applications.

They are relatively persistent on the soil, although some of them are affected by the soil microbial activity (presence of organic matter favours its decomposition). Herbicides derived from urea favour loss of strength by the plant due to photosynthesis inhibition. The first symptom appears in the chlorosis of the leaves’ tips, starting by the oldest ones and extending until the green colour is completely lost and, finally, the plant dies. These herbicides hardly have any effect on germinating seeds but do have effect on plants developing in treated fields. They are easily absorbed by the roots and slowly carried to the leaves by the xylem, accumulating in the sprouts.

Main active ingredients are: linuron, metobromuron, chlorobromuron and diuron. Other active ingredients are: chlorotoluron, chloroxurone, dimuron, difenoxyuron, dimefuron, fenuron, flazasulfuron, fluometuron, isoproturon, isouron, karbutulate, metalbenziazuron, metaboluron, metoxuron, monolinuron, neburon, siduron and tiazafluron.

**Herbicides from the group of sulphonilureas.** These are systemic, post-emergent herbicides that are absorbed by the foliage and at a lower scale by the roots of the weeds being controlled. They are then translocated by the xylem and the phloem to the growing points. Weeds stop growing a few hours after the application of the product; however, the symptoms appear in 5-12 days. Plants treated develop a chlorosis, followed by reddening of young tissues, which progresses, moving toward the oldest parts, ending with the plant’s death.
Main active ingredients are: Methyl bensulfuron and methyl metsulsuron. Other active ingredients that can be mentioned: cynosulfuron, ethyl chlorimuron, chlorsulfuron, nicosulfuron, pyrazosulfuron, primesulfuron, sulfometuron, triasulfuron and tribenuron.

**Uracile herbicides.** The active ingredients of this group are: bromacile, lenacile and terbacile. Bromacile is the most known active ingredient and it is a systemic herbicide with contact action and great residuality that can be used in pre and post emergence. Although part of the product penetrates through the leaves, bromacile penetrates in the weeds, mainly through the radicle system. When the product is applied to the soil, the roots absorb it and is translocated via xylem to the foliage, where the photosynthesis action is blocked. It is used mainly for post emergence control of gramineas, broad leaves and cyperaceas that affect pineapple and citrus fruits. It can also be used to control vegetation in industrial areas, roads and railroads.

**Herbicides from the group of oxadiazoles.** The most important active ingredient in this chemical group is oxadiazon, which is a selective herbicide, recommended for application in pre and post emergence in rice sown directly with covered seed. It acts mainly by contact, affecting the stem of the weeds after germination. It is strongly adsorbed by the soil colloids; therefore, it does not have much movement. Remains on the soil for approximately 40 days, what gives it the property to control new weed generations.

**Herbicides from the group of the oxyacetamides.** Fluphenacet and mephenacet, are the main active ingredients in this chemical group. Fluphenacet has a broad spectrum action. This active ingredient controls effectively gramineas and some dicotyledonous. The active ingredient is absorbed through the soil and partly through the seeds sprouts, controlling weeds in early pre and post emergence. Distribution is performed from the roots, mostly through the vessels, together with water transportation up to growing green tissues. Mephenacet is an active ingredient much more effective against gramineas than against dicotyledonous.

The action mechanism of these herbicides is based on the inhibition of the cellular division of young tissues from the root and sprouts, stopping the longitudinal growth immediately and withering the plant.
These products are applied at very low doses; besides, they are more benign to the environment and the user. They degrade fast when in contact with the environment and their translocation on the soil is very reduced.

Herbicides from the group of the Imidazolinones. The main active ingredients of this chemical group are: imazamabencene, imazapic, imazapir and imazaquin. Imazapir is a systemic herbicide with residual action, non selective, absorbed by the foliage and roots and translocated via xylem and phloem to the meristematic regions. It is used for post emergent applications. Imazapic is a herbicide that controls a broad spectrum of gramineas and dicotyledonous. It is also absorbed by foliage and roots and translocated via xylem and phloem to the meristematic regions.

<table>
<thead>
<tr>
<th>CHEMICAL GROUP</th>
<th>ACTIVE INGREDIENT</th>
<th>MODE OF ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzoic</td>
<td>TAB</td>
<td>Systemic</td>
</tr>
<tr>
<td></td>
<td>Chlorambene</td>
<td></td>
</tr>
<tr>
<td>Benzamid</td>
<td>Isoxaben</td>
<td>Contact</td>
</tr>
<tr>
<td>Benzofuran</td>
<td>Etofumesate</td>
<td>Contact</td>
</tr>
<tr>
<td>Benzofuranyl</td>
<td>Benfuresate</td>
<td></td>
</tr>
<tr>
<td>Benzonitrite</td>
<td>Bromoxynil</td>
<td>Systemic and contact</td>
</tr>
<tr>
<td></td>
<td>Ioxinil</td>
<td></td>
</tr>
<tr>
<td>Benzothiazol</td>
<td>Benzoline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzothiazuron</td>
<td></td>
</tr>
<tr>
<td>Benzothiadiazol</td>
<td>Bentazen</td>
<td>Contact, selective</td>
</tr>
</tbody>
</table>

Herbicides from the group of the propanoate arilics. Fluazipoph P-Butil is an active ingredient from the group this group; it is a systemic, post emergent, selective herbicide that controls perennial and annual gramineas. This product is quickly absorbed by the leaves and other green parts of the weeds, being translocated through the xylem and phloem and finally it is accumulated in the growing points. It affects the meristematic tissues in the stems knots and the rhizome buds, stopping the growth in 48 hours. In 8 to 15 days, the weed is totally dry.

Other herbicide chemical groups. Other herbicide chemical groups or families are shown on chart 3.4. The name of some active ingredients are also included, as well as their use and mode of action.

Chart 3.4. Chemical classification from other herbicides

- Imidazolinones have as an action mechanism to inhibit the synthetase enzyme of the acetohydroxic acid, affecting the proteid synthesis and interfering with the ADN synthesis and the cellular growth.
<table>
<thead>
<tr>
<th>Herbicide Family</th>
<th>Chemical Name</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carboxiprimidinil</td>
<td>Sodium Bispiricarb</td>
<td>Post emergence &amp; systemic</td>
</tr>
<tr>
<td>Cyneol</td>
<td>Cinmetaline</td>
<td></td>
</tr>
<tr>
<td>Eter difenile</td>
<td>Acifluorophene</td>
<td>Post emergence</td>
</tr>
<tr>
<td>Phosphynil</td>
<td>Bilanphapes</td>
<td></td>
</tr>
<tr>
<td>Phosphates</td>
<td>Anylophes</td>
<td></td>
</tr>
<tr>
<td>Phosphates</td>
<td>Bensulide</td>
<td>Systemic</td>
</tr>
<tr>
<td>Phosphates</td>
<td>Bulamiphes</td>
<td></td>
</tr>
<tr>
<td>Nitroaniline</td>
<td>Benfluranyl</td>
<td></td>
</tr>
<tr>
<td>Nitroaniline</td>
<td>Ethalfluraline</td>
<td></td>
</tr>
<tr>
<td>Piradizanone</td>
<td>Chloridazone</td>
<td>Selective, post emergence</td>
</tr>
<tr>
<td>Piradizanone</td>
<td>Norflurazone</td>
<td></td>
</tr>
<tr>
<td>Piperidine</td>
<td>Piperophos</td>
<td>Systemic</td>
</tr>
<tr>
<td>Piridine</td>
<td>Chlorpiralide</td>
<td>Systemic</td>
</tr>
<tr>
<td>Piridine</td>
<td>Dithiopir</td>
<td></td>
</tr>
<tr>
<td>Piridine</td>
<td>Fluroxipir</td>
<td>Systemic</td>
</tr>
<tr>
<td>Piridine</td>
<td>Piclorane</td>
<td></td>
</tr>
<tr>
<td>Pirazol</td>
<td>Benzophenap</td>
<td>Selective pre and post emergence</td>
</tr>
<tr>
<td>Pirazol</td>
<td>Diphenzoquat</td>
<td></td>
</tr>
<tr>
<td>Pirrolidone</td>
<td>Flurochloridone</td>
<td></td>
</tr>
<tr>
<td>Anilide</td>
<td>Bromobutide</td>
<td>Selective pre and post emergence</td>
</tr>
<tr>
<td>Anilide</td>
<td>Chlomeprop</td>
<td></td>
</tr>
<tr>
<td>Anilide</td>
<td>Dimethachlor</td>
<td></td>
</tr>
<tr>
<td>Anilide</td>
<td>Dinitramine</td>
<td></td>
</tr>
<tr>
<td>Anilide</td>
<td>Metazachlor</td>
<td></td>
</tr>
<tr>
<td>Anilide</td>
<td>Propachlor</td>
<td></td>
</tr>
</tbody>
</table>
Description of main acaricide chemical groups. Mites are small invertebrates that, same as insects, belong to the arthropods. However, morphology and physiology of insects and mites present many differences, and most products used as insecticides do not have acaricide effect. For this reason, even though several insecticides have acaricide effect, to control mites some specific active ingredients have been developed. In addition, due to the application of some insecticides that have destroyed existing predators, mite related problems have increased, which has made it necessary to develop this type of active ingredients.

As it was previously indicated in the part related to insecticides, some phosphorus derivatives have acaricide activity, being this the group of products that gathers a larger number of active ingredients with this double purpose. For example, forate, formotion, fosalone, fosmet, methacrifos, mevinphos, omethoate, oxydemethon methyl and quinalphos. Some nitroderivative and sulphocianure insecticides also have acaricide action, standing out DNOCHP, as it happens with some pyrethroid insecticides as bifétrine and fluvilinate – TAU. Fungicides, such as dynobuton, chinomethionate, morestan and thioquinox, also have an acaricide effect.

It is important to highlight the activity differences of the acaricides in the three phases of their development: egg, nymph and adult. There are some acaricides that are preferably ovicides; other are nymphicide and other adulticicides. There are also those that can affect 2 or 3 stages of their development; therefore, it is of utmost importance to read the label and the pamphlet of the products before using them.

Acaricides

Other acaricide chemical groups. In chart 3.5 there is a list of other active ingredients, taking in consideration their chemical group and mode of action.

CHAPER 3.5 Chemical classification of other acaricides

<table>
<thead>
<tr>
<th>CHEMICAL GROUP</th>
<th>ACTIVE INGREDIENT</th>
<th>MODE OF ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbamoiil</td>
<td>Thiofanox*</td>
<td>Systemic</td>
</tr>
<tr>
<td>Piridazinone</td>
<td>Piridaben*</td>
<td>Contact</td>
</tr>
<tr>
<td>Organochlorate</td>
<td>Endosulfan</td>
<td>Contact</td>
</tr>
<tr>
<td>Tiourea</td>
<td>Diafenthiuron*</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Formamidine</td>
<td>Amitraz*</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Thiodiazine</td>
<td>Buprofexin*</td>
<td>Contact and ingestion</td>
</tr>
<tr>
<td>Tetrazine</td>
<td></td>
<td>Contact</td>
</tr>
<tr>
<td>Nor pyrethroid</td>
<td>Acrinatrine</td>
<td>Contact and ingestion</td>
</tr>
</tbody>
</table>
Imide | Benzoxtimate | Contact
---|---|---
Bencile | Bromopropilate | Contact
Thiazolidone | Hexitiazox | Contact
Carbamate | Formetan Oxamil | Contact
** | Fenpiroximate** | Contact

* Products with insecticide and acaricide effect  
** No chemical group has been assigned

Description of main fumigant and nematicide chemical groups.

Fumigants are a group of products for plant protection that act in a gaseous form. Following a biological criteria, they do not constitute a special class of pesticides since they have effect on various types of organisms. Chemically, they do not form an homogeneous group either, since they are chemical compounds of diverse structure; the only common property is the physical state in which they are when executing their action. Before being used, fumigants may be in a solid, liquid or gaseous state, but to act, they must volatise.

**Fumigants**

**Methyl bromide.** It is one of the most used fumigants. It is used to control rats and insects at farming storage places, as well as to fumigate the soil, where it has a biocide effect. It is phytotoxic and at high concentrations, with much humidity, decreases the germination power of seeds. Toxicity for mammals is important.

**1,3 Dichlorpropene.** It is a soil fumigant that acts as nematicide. It is injected on the soil in a liquid form and quickly becomes a gas. This gas is extensively distributed through the soil profile and later it dissolves in the water absorbed by soil particles. 1,3 dichlorophene transforms into 3-chloroalyl alcohol, which is firmly retained by soil particles, causing an enzymatic unbalance in the nematodes and consequently they die.
1.3 Dichlorpropene + chloropicrine. This product is used to fumigate soils for the control of nematodes, diseases and weeds. It is injected to the soil in a liquid form and it acts in a similar way as 1,3 dichloropropene.

Aluminum phosphorus. It is a fumigant in form of tablet that issues the phosphine gas. This fumigant, when in contact with humidity it detaches hydrogen phosphorus, a toxic gas that acts by contact and ingestion to control insects that attack stored grains and seeds. Out in the open it can be used to control rodents.

Magnesium phosphorus. This is a fumigant that comes in tablets, pellets and plaques and is used to control insects in grain, dry fruit and seeds storage silos.

Nematicides. Some phosphorated insecticides and carbamates have a important nematicide effect, inhibiting the development of nematodes and causing their death. They have the characteristic of translocating inside the plant through the root when they are applied to the soil. To obtain the best penetration results and nematicide effect, certain soil conditions should be considered, such as textural class, humidity conditions, temperature and soil pH. In chart 3.6 there is a list of main nematicides.

CHART 3.6 - Chemical classification of some nematicides.

<table>
<thead>
<tr>
<th>CHEMICAL GROUP</th>
<th>ACTIVE INGREDIENT</th>
<th>MODE OF ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorate</td>
<td>Cadusafos</td>
<td>Contact and systemic</td>
</tr>
<tr>
<td></td>
<td>Etoprofos</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forato</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terbufos</td>
<td></td>
</tr>
<tr>
<td>Carbamates</td>
<td>Aldicarb</td>
<td>Contact and systemic</td>
</tr>
<tr>
<td></td>
<td>Carbofurane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbosulfane</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxamile</td>
<td></td>
</tr>
</tbody>
</table>
Description of rodenticide chemical groups

Rodenticides are products used to protect crops from rodents. Some rodenticides are highly dangerous and can be fatal if they are ingested by humans, pets or cattle, even in small quantities; therefore, they should be managed correctly, following the safety the instructions that appear in the label and pamphlet.

At present there are several rodenticide groups, although in a general way they can be classified in two categories: anticoagulants and non-anticoagulants.

Anticoagulants:

Anticoagulants provoke the death of rodents by interrupting the normal mechanisms of blood coagulation; this causes their death due to internal bleeding. Apparently all act interfering the metabolism of K vitamin in the liver, affecting the coagulation and they die from hemorrhagic syndrome. As with all anticoagulants, death can occur several days after having ingested a lethal dose. Commercial anticoagulants that are available come in many presentations, such as bait in form of food (grain pellets, granulated food, paraffin blocks, etc.), liquid bait and tracking powder.

Modern anticoagulants are classified as: first generation of anticoagulants and second generation of anticoagulants.

First generation of anticoagulants. Generally, these are considered as multiple dose rodenticides. This means that rodents must feed themselves several times with the bait so that this can work (a period of 4 – 10 days and in some occasions more days, as it occurs with mice). Among the most used are included: warfarine, chlorofacinone, difacinone, cumachlor, cumafurile, flocoumaphen, pindone and valone.

Second generation of anticoagulants. These were designed to control rats and mice that were resistant to the first generation. Brodiphacoum, bromadiolone, cumatetrile and difenacum represent this group of anticoagulants. These kill rodents the same way than the compounds from the first generation but are more effective; they can cause death after only one dose or at least at a lower dose.

Non anticoagulants:

Some anticoagulant rodenticides act as one-dose products, while others probably need to be consumed during several days. Death can occur in several ways. This group includes rodenticides such as brometaline, coleclaciferol, fluoracetate and sodium (compound 1080), fluoracetamide (1081), Strychnine and zinc phosphorus.
**Brometline.** Brometline is a rodenticide unique on its kind because just one dose of bait is lethal most of the time, although death takes place 2 – 4 days after ingestion. It kills rodents interrupting energy production in the body’s cells. This causes a blood clot, specially around the spine and the cerebrum, causing a reduction of nerve impulses, paralysis and death.

**Colecalciferol.** The rodenticide colecalciferol is really D3 vitamin, which is needed in small quantities by most mammals to remain healthy. However, in massive doses D3 vitamin is toxic, particularly for rodents. Besides, rodents, due to their small size, die when they ingest amounts relatively small. It can act as a one-dose rodenticide when rodents consume the necessary dose, but it can act as a multiple-dose rodenticide if it is consumed in smaller quantities during a couple of days. Colecalciferol works liberating and moving calcium from the bones into the blood flood. This action produces a condition called hypercalcemia (too much calcium on the blood) and, in the long run, it produces death by cardiac arrest.

Brometline as well as colecalciferol are considered little or moderately dangerous for humans and other mammals.

**Sodium Fluoracetate (1080) and fluoroacetamide (1081).** These two rodenticides are very effective and highly dangerous for most mammals. Before even thinking about using them, the future user must make sure that there are significant problems with rodenticides and only then, they should be used, but following great safety measures.

**Strychnine** is used on occasions as a rodenticide, in the form of a poisoned bait. Strychnine is a very dangerous material. In case of using it, proper safety measures must be taken.

**Zink Phosphorous.** This is a rodenticide effective to control rats and mice. It can be obtained as a bait, a tracking powder and also as a concentrated powder to prepare baits. Zinc Phosphorous acts disintegrating the tissues of the liver, kidneys and heart, and finally killing the rodents.

**Description of main mollusquicide chemical groups**

To avoid damage caused by molluscs (slugs) to farming products, several chemical products have been used, which, even though they are not similar in chemical structure, they have the common characteristic to be toxic to these invertebrates. There is a series of products derived from carbamates, organophosphates, copper sulphate and methyldehide that have a mollusquicide effect. Nichlosamide is a contact active ingredient from the group of the salicylanilides that acts as mollusquicide. Methiocarb (carbamate) and trifenmorph (morpholine) are active ingredients with the same effect. The solutions of copper sulphate have also been used as mollusquicides. Usually, they are not very effective and are a little phytotoxic.
**Metaldehyde.** The most known and effective product, that has a great toxicity for molluscs and at the same time is an effective bait, attracting and controlling them, is metaldehyd. Acts by contact and ingestion and it produces loss of coordination, immobilisation and dehydration of the molluscs. The mollusquicide effect is based on two properties: At high concentrations it produces an irritant effect that makes the molluscs excrete large amounts of mucus, resulting in dissection and toxic effect on the nervous system.

**Carbamates.** Carbamates mollusquicides are derived from methylcarbamate and they are: carbaryl, mexacarbate and methiocarb. The general action of these products is to cause metabolic disturbance.

**CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO THEIR MODE OF ACTION**

This classification is based on the form which plant protection product act on the pest’s organism. In general terms and in the case of insecticides, acaricides and nematicides, these can be:

**By contact:** These are products that exercise toxicity once they get in contact with the objective organism; it can be by direct or residual contact.

**By ingestion or digestive.** These are products that act after the product has been ingested by the objective organism.

**Asphyxiating:** Penetration is in gaseous state through the respiratory system of the objective organism.

**Penetrant (translaminars):** These can reach up to certain depth inside the treated part, but cannot translocate or store in other organs located further away in enough quantity to make it effective.

**Systemic:** These products are absorbed by the plant’s treated part and are transported through the tissues—specially vascular tissues—in enough quantity to be effective at the action points (leaves and sprouts). They are used to control chewing and soaking insect pests.

**Polyivalent:** These are products that can act in more forms than the ones mentioned before.

In the case of fungicides, these can be classified as:

**Protecting or contact fungicides:** The mode of action of these fungicides is limited to avoid the development of reproductive structures in the fungus. They have external action and protect the plant against fungus only in the place where there are rests of the product applied. These products demand coverage and must be applied before the fungus establishes on the plant, in order to avoid infections.
**Eradicative, curative, or with local action:** These products, besides providing a protective effect, stop or destroy an established infection in the place where the fungicide was applied. They have certain penetration power on the treated surface without translocating through the plant.

**Systemic:** These fungicides prevent fungus development and have the capacity to penetrate and to be translocated through the plant’s vascular system. This permits certain control of infections present.

In the case of herbicides, these can be:

**Foliar contact:** Contac herbicides act only on the plant’s exposed parts; therefore, spraying must be made thoroughly. When weeds growing among trees and bushes are sprayed, an impact nozzle must be used or apply low pressure to reduce the drift to a minimum. This is also important when the spraying is being done by a crew.

**Systemic of foliar translocation:** Herbicides of foliar translocation are absorbed through the leaves and translocated by the stem to the plant’s roots. They must be applied when weeds are vigorously growing. Due to their absorption and movement through the plant, their coverage must not be very complete as in the case of contact herbicides.

**Systemic, translocated by the root.** Most residual herbicides must be applied on a humid, finely cultivated soil. Some need to be incorporated to the soil by mechanical means, immediately after their application. Selectivity of residual herbicides depends on the crop’s tolerance regarding the herbicide, or that the crop has been sown deep enough to prevent any damage. When using a residual herbicide it must be taken in consideration whether crop rotation is being done. Some herbicides will remain active enough time to damage next crop. Atrazine should not be used in corn crops if next crop is sensible to atrazine, such as tobacco, vegetables, alfalfa or wheat.

**CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO THEIR SPECIFIC ACTION SPECTRUM**

“Specific” is a characteristic of plant protection products to control a variety of pest organisms; thus, they can be classified as follows:

**Plant protection products with specific action.** These are products that control a pest organism or a determined group of them. This happens with the active ingredient fluazifop-butil that is a herbicide gramicide. It is important to clarify that when a plant protection product is identified as specific, this does not mean that it is specific in the whole sense of the word, because, since it is a toxic substance, it can damage directly or indirectly all the organisms in the farming system.

**Multiple action plant protection products.** This type of products are also called broad spectrum or polytoxic products. An example of them are the following active ingredients: paraquat, mancozeb, carbofuran, metamidofos, aldicarb, etc.
CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO THEIR FORMULATION

Most of the ingredients in plant protection products are organic compounds that many times are hard to dissolve or water insoluble. They belong to the most unlike chemical matters, have different physical properties, can be solid or liquid and have a consistence similar to wax. The active ingredients can only develop their biological action if they definitely arrive to the point where they should act in the organism objective. And the purpose of the formulation is to make sure that this happens.

Formulation is the form in which an active ingredient is prepared, accompanied by coadyuvant matters, such as solvents, bearers or vehicles, emulsifiers, moisturisers, surfactants and dispersants. These aid matters serve specially to assure an homogenous distribution of the active ingredient in the application formulation of a plant protection product, which could be, for example, a spraying mixture. That is an essential requirement for the active matter to be distributed uniformly; for example, on a hectare of farming land, through a refined spraying technique, which is an authentic challenge for specialist formulators, according to the following examples regarding imidachloprid and tebuconazole.

When applying imidachloprid, for the control of cut worms and thrips in citrus fruit crops, it is recommended a dose of active matter of 200 gr. per hectare. That means that if 2,000 lts. of mixture per hectare are pulverised, the concentration of the active ingredient would only be 0.01 %.

Now, for the pesticide to develop its capacity the ideal way, it must be spread evenly in the foliage area, whose total area is ten times bigger than the ground; that is, around 10 has. Which means that is almost as big as 20 football fields put together. In other words, the formulation technique must solve the test consisting in homogeneously spreading 200 grs. of active matter in 10 has., meaning that every sq. cm. of the foliage should receive 0.0000002 grs. of active ingredient.

The seed disinfectant tebuconazole serves to control fungus diseases in cereals. When it is necessary to use it against carbons (fungus of the species Tilletia and Ustilago), for example in wheat and barley, it is recommended that the centres to disinfect seeds apply 150 grs. of commercial product for each 100 kgs. of grain. As the product only contains 2% of active ingredient because the remaining 98% are formulation coadyuvants, that implies the need to proportionally divide 3 grs. of active matter into 100 kgs. of seed, equivalent to 2.5 mio. grains. That means that each grain should receive an average of 12 hundred millionth gr. of active ingredient. If seeds are treated at a high capacity plant that can disinfect 12 tons per hour, the indicated result could be obtained in 30 seconds.
An efficient phytosanitary control also involves a distribution problem and that problem is now much more troublesome than in the past. Thanks to the development of new active substances even more efficient that the ones that already exist, and due to better application techniques, it has been possible to reduce even more the dose needed per hectare, so that if 30 years ago the dose varied between one and more kgs. per ha., at present, only a few hundred grams are necessary for the treatment to succeed and, in exceptional cases, even a few grams per ha. (Charts 3.7 and 3.8).

**CHART 3.7  Evolution of dose used for several plant protection products.**

<table>
<thead>
<tr>
<th>TYPE OF PRODUCT</th>
<th>ACTIVE INGREDIENT</th>
<th>DOSE (gram ai/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicides</td>
<td>TCA</td>
<td>12.000</td>
</tr>
<tr>
<td></td>
<td>Trifluraline</td>
<td>960</td>
</tr>
<tr>
<td></td>
<td>Bentazone</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>Flumetsulam</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Chlorimuron ethyl</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Metsulfuron ethyl</td>
<td>4</td>
</tr>
<tr>
<td>Fungicidas</td>
<td>Mancozeb</td>
<td>4.800</td>
</tr>
<tr>
<td></td>
<td>Miclobutanil</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Fanarimol</td>
<td>72</td>
</tr>
<tr>
<td>Insecticidas</td>
<td>DDT</td>
<td>1000 – 1500</td>
</tr>
<tr>
<td></td>
<td>Parathion</td>
<td>250 - 800</td>
</tr>
<tr>
<td></td>
<td>Deltametrine</td>
<td>5</td>
</tr>
</tbody>
</table>

**CHART 3.8 - Evolution of dose and toxicity on plant protection products.**

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>OSE (grs. ai/ha)</th>
<th>DL 50 ORAL ACUTE (Rat)</th>
<th>RELATION Dose/Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parathion</td>
<td>800</td>
<td>7mg/kg</td>
<td>114</td>
</tr>
<tr>
<td>Deltametrine</td>
<td>5</td>
<td>135mg/kg</td>
<td>0,037</td>
</tr>
<tr>
<td>Teflubenzuron</td>
<td>5</td>
<td>&gt;5.000mg/kg</td>
<td>0,001</td>
</tr>
<tr>
<td>Fenoxaprop-ethyl (racemet)</td>
<td>144</td>
<td>3.000mg/kg</td>
<td>0,048</td>
</tr>
<tr>
<td>Fenoxaprop-p-ethyl (isomer)</td>
<td>88</td>
<td>3.000mg/kg</td>
<td>0,029</td>
</tr>
</tbody>
</table>
The variety of quality requirements that a pesticide must meet has originated a high number of formulations. The formulation should have maximum strength and be phytocompatible. Its action should start quickly enough and have a good residuality. The formulation should be easily applied and mixed with other pesticides, without any inconvenience. Its stability is of utmost importance; therefore, if the product is stored for a long time, specially if it is subject to high temperatures, the formulation should remain chemically and physically stable; in other words, the active matter should not decompose and the product’s properties should not deteriorate either.

The environment, working hygiene and toxicology also present some conditions; for example, scarce drift, no accumulation on the soil, low toxicity for the user, minimum irritation power and no risk, or maybe a slight contamination risk for the person who applies it.

Each case requires specific formulation and application techniques, depending on the organism trying to control. For phytocompatibility reasons, the control of a fungus disease in cereals, for example, demands a different application technique from the one used in fruit plantations. The control of soaking insects should be made in a different way than it is done for chewing insects, and these, likewise, differently from soil pests. The control of pre-emergency weeds presents other formulation requirements than in post-emergency.

**CHART 3.6 - Requirements for any formulation and factors that should be optimised**

Physical and chemical properties from the active ingredient also play an important role in the selection of a suitable formulation. To uniform and harmonise its denominations at international level, CropLife International (formerly GCPF), edited a catalogue that contains over 60 formulation types, which are shown on chart 3.9.
Depending on the application method, formulations are divided on:

- Products to spray
- Products to disinfect seeds
- Products to treat soil

Since spraying is the most frequent application method, 80% of world’s offer of plant protection products is used that way. Next, that type of formulations is described, divided in liquid and solid products, with an estimate of future trends.

![Chart 3.7 Main formulation types and their quota in world’s market](image)

**Liquid products:**

Emulsion concentrate (EC). These are solid or liquid active matters and organic solvents. Adding the proper emulsion, such solvents can be mixed with water. The original transparent liquid turns into a whitish and milky emulsion, whose drops measure approximately one micro. Emulsion concentrates are easily produced and managed. The necessary dose for a treatment can be easily measured and dosed with a graduated glass. It is fundamental that the emulsion or spraying mixture be kept stable for a long time (24 hours), but in case the components separate, the emulsion’s homogeneity should be restored by shaking and pumping it. The empty container can be simply cleaned with a washing object. However, emulsion concentrates also have their disadvantages. For example, some solvents are not accepted anymore, due to the damage they cause to the environment and to the danger they represent because they are inflammable. That will make that EC formulations lose acceptance in the future.
Emulsion, oil in water (EW). In comparison with EC formulations, in EW formulations the dissolvent has been totally or partially substituted by water. There is a difference between microemulsions and macroemulsions. Concentrates made from microemulsions are transparent solutions, whilst macroemulsions have a cloudy and milky aspect. As for their behaviour when they are being applied, EW formulations are similar to the EC type.

Water soluble concentrate (SL). Formulations of this nature consist on concentrate solutions made of active matters or their salts, with water base or solvent mixable with water. Therefore, it is essential that the active matter be soluble in water, a characteristic that only a few active substances have. Known examples are glisofate and hormonal herbicides. Also, the new insecticide imidachloprid is formulated as SL. The containers of SL formulations can be cleaned very easily.

Concentrate suspension (CS). This type of formulation is also called flowable formulation. They are stable suspensions made of water soluble active matters. The average size of the particles is from 1 to 2 microns. Their aspect is similar to the macroemulsions. The essential advantage of the CS is that they do not drop powder and do not contain any solvent, and therefore, the user is not exposed to contamination when preparing the spraying mixture.

Besides, the concentrated suspensions can be easily measured and be well dosed. As an inconvenience, it can be pointed out that CS formulation can decompose during storage and it can be troublesome to empty completely the containers. Development and manufacturing of concentrated suspensions is more expensive than with the other liquid formulations. In spite of all this, it is expected that in the future this type of formulation will be gaining more acceptance due to its considerable advantages.

Microencapsulate; capsule suspension (CS). This type of suspensions represent a different type of formulation, with slow liberation, characterised by the fact that, when they are applied, the active matter is slowly liberated. The main objectives of this formulation are: to reduce acute toxicity and, therefore, less risk to the user (more personal safety). To prolong the action period, in order to decrease the number of treatments (less environmental contamination). To lower toxicity and avoid loss of active matter due to evaporation.

CS formulations have been on the market about 15 years; however, their market participation is very low (less than 1%), because their manufacture is more complex and, therefore, more expensive than for conventional formulations. Besides, for this type of formulation it cannot be used any kind of active matter. However, as user’s personal safety and environmental protection are each time more important, in the future there will be a larger demand for formulations with controlled liberation.
Solid products:

Wettable Powder (WP).

These are solid active matters that are not soluble enough and, therefore, do not admit EC or SL formulations. They used to be launched in the market as wettable powder (WP). These formulations are manufactured by grinding the active matter, together with solid dispersing and moistening vehicles and reducing them to powder.

The wettable powders are sold as highly concentrated products with a proportion of active ingredient of up to 80%. They are mixed with water for their application, mixing them in a container; this way a stable suspension is obtained. The calibre of the solid particles contained in the mixture is usually close to 5 microns and, therefore, larger than the calibre of the drops from an emulsion prepared starting from concentrate. In view that the powder is so fine, the user may be exposed to contamination derived from powder emanations when the mixture is being prepared. Another inconvenient is that the powder has to be weighed if only part of it is taken out of the container.

Some difficulties found in wettable powders can be avoided if the material is packed in plastic bags made of polyvinylalcohol (PVAL), or water soluble plastic bags, but this procedure does not have a very broad acceptance up to now, even though the bags have been in the market for many years. These bags are made from a non-toxic material that is biodegradable. In addition to protecting the user from the powder when preparing the pulverisation mixture, there are more advantages: the small plastic bags, which are sealed before putting them inside the tank, fully comply with FAO’s Code of Conduct.

Water dispersible granules (WG).

This is a safer formulation for the user; it was created specially to replace wettable powders. In comparison with these, water dispersible granules need a larger proportion of dispersible granules so that when they are mixed with water the active matter disperses spontaneously. Their main advantage is that no powder comes off when the mixture is being prepared.

Water dispersible granules are flowable and their apparent density is constant, which makes it easy to measure them with a graduated glass. On the other hand, the container can be emptied without leaving any residues inside. Regarding stability during storage, they are similar to EC and WP formulations. Although the WG formulation is more expensive due to a more complex manufacturing procedure, its use will increase in the future because it is safer to user.
Future scenery

Whilst in the past the biological action and application technique of a formulation played an important role, now, users safety and environmental compatibility are the main phytosanitary premises.

Today, the main requirements any pesticide must satisfy, besides biological action, are easy dosage, low powder scattering and the possibility to empty the container completely. This means that in the future powder products shall be replaced by concentrated suspensions and water dispersible granules.

Coadyuvants will be in the future even more important. Their influence to the biological effect and effectiveness of the product is not insignificant at all, according to what modern scientific research proves. Since they focus on incrementing their biological action, this will help to reduce dosage even more.

Some innovations on application techniques, such as the use of direct injection systems and band spraying instead of total aerial application will contribute to stop harming the environment.

Formulations for solid applications

**Baits.** They are usually used to control rodents and molluses. Inert material is formed by some substances that protect the active ingredient. Among the special baits we can mention concentrated baits (CB); granulated baits (GB); plaques (PB); preparations (RB) and small bait (SB).

Granules. This type of formulations are applied directly to the plant or to the soil. Inert matter is a pre-formed material. It must be manufactured very carefully to obtain a good homogenisation and distribution of the active ingredient in the inert matter. The concentrations of these formulations vary between 2.5 and 10%. Among these types of formulations are the granules (GR), fine granules (FG), fumigious granules (FW) and capsulated granules (CG). The latter are capsulated in a protective cover and are liberated under control. Depending on the diameter of their particles, granules are classified in macrogranules (600 to 2000 m) and microgranules (100 to 600 m.)

Pastes (PA). Their main role is to protect the plant from the attack of insects, fungus and bacterium, when wounds have been caused by pruning, grafts or natural causes.

Tablets. These are formulated specially to control aunts. The percentage of active ingredient in the final formulation is usually very low. The tablets have a cylindrical shape and are approximately 5 mm. long. There are also some mollusquicides with this type of formulation.
**Spreading Powder.** These are formulations with solid consistency and very fine particles, where the active ingredient adheres to the inert materials. They are sprinkled to the plants.

**Formulations to be applied as fumigants**

**Sprays.** These formulations are sprayed through the impulse of the valve’s movement, in the form of particles or little drops. Due to their characteristics, the most used solvents of this type of formulation, among others are deodorized kerosene, xylene and dichlomethane. The most used propellents are the chlorofluoromethanes, liquid buthane, CO2 and NO.

**Smoke or fumigenous.** This combustible formulation is usually solid; it liberates the active ingredient in the form of smoke through ignition or chemical reaction produced upon contact with air,. Among the presentations there are the small bars, spirals, granules, candles, pills, tablets and cartridges.

**Pressure gases.** In this case the active ingredients are usually sold in pressurized metal containers. These formulations are applied with a special device, since it is required that the products that will be treated be in a hermetically closed place or protected with a waterproof cover.

**Hot nebulisation products.** It is the adequate formulation to be applied with equipment for hot nebulisation, either directly or after dissolving it.

**CHART 3.9 Formulation codes from CropLife International (formerly GCPF) for plant protection products**

<table>
<thead>
<tr>
<th>FORMULATION</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray</td>
<td>AE</td>
</tr>
<tr>
<td>Fumigenous bar</td>
<td>PR</td>
</tr>
<tr>
<td>Fumigenous container</td>
<td>FD</td>
</tr>
<tr>
<td>Fumigenous cartridge</td>
<td>FP</td>
</tr>
<tr>
<td>Fumigenous candle</td>
<td>FK</td>
</tr>
<tr>
<td>Concentrated bate</td>
<td>CB</td>
</tr>
<tr>
<td>Granule bait</td>
<td>GB</td>
</tr>
<tr>
<td>Plaque bait</td>
<td>PB</td>
</tr>
<tr>
<td>Ready bait</td>
<td>RB</td>
</tr>
<tr>
<td>Cut bait</td>
<td>SB</td>
</tr>
<tr>
<td>Product Description</td>
<td>Abbreviation</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Emulsion concentrate</td>
<td>EC</td>
</tr>
<tr>
<td>Soluble concentrate</td>
<td>SL</td>
</tr>
<tr>
<td>Seed disinfectant</td>
<td>LS</td>
</tr>
<tr>
<td>Emulsion, oil in water</td>
<td>EW</td>
</tr>
<tr>
<td>Emulsion, water in oil</td>
<td>EO</td>
</tr>
<tr>
<td>Fumigant</td>
<td>GE</td>
</tr>
<tr>
<td>Gas (pressure container)</td>
<td>GA</td>
</tr>
<tr>
<td>Granules</td>
<td>GR</td>
</tr>
<tr>
<td>Fine Granules</td>
<td>FG</td>
</tr>
<tr>
<td>Fumigenous granules</td>
<td>FW</td>
</tr>
<tr>
<td>Granules or dispersible tablets</td>
<td>WG</td>
</tr>
<tr>
<td>Granules or soluble tablets</td>
<td>SG</td>
</tr>
<tr>
<td>Capsuled granules</td>
<td>CG</td>
</tr>
<tr>
<td>Liquid mixed with oil</td>
<td>OL</td>
</tr>
<tr>
<td>Macrogranulate</td>
<td>GG</td>
</tr>
<tr>
<td>Microgranulado</td>
<td>MG</td>
</tr>
<tr>
<td>Paste</td>
<td>PA</td>
</tr>
<tr>
<td>Powder dissolved in Oil</td>
<td>OP+</td>
</tr>
<tr>
<td>Wettable powder</td>
<td>WP</td>
</tr>
<tr>
<td>Seed disinfectant powder</td>
<td>SS</td>
</tr>
<tr>
<td>Dusting powder</td>
<td>DP</td>
</tr>
<tr>
<td>Powder to make seed disinfectant paste</td>
<td>WS</td>
</tr>
<tr>
<td>Powder for dry seed treatment</td>
<td>DS</td>
</tr>
<tr>
<td>Soluble powder</td>
<td>SP</td>
</tr>
<tr>
<td>Steam diffusing product</td>
<td>VP</td>
</tr>
<tr>
<td>Fumigenous product</td>
<td>FU</td>
</tr>
<tr>
<td>Hot nebulisation product</td>
<td>HN</td>
</tr>
<tr>
<td>Cold nebulisation product</td>
<td>KN</td>
</tr>
<tr>
<td>ULV product</td>
<td>UL</td>
</tr>
<tr>
<td>Contact Rodenticide (spreading powder)</td>
<td>TP</td>
</tr>
<tr>
<td>Pill seed</td>
<td>PS</td>
</tr>
<tr>
<td>Concentrated suspension</td>
<td>SC</td>
</tr>
<tr>
<td>Concentrated suspension to treat seed</td>
<td>FS</td>
</tr>
<tr>
<td>Capsule suspension</td>
<td>CS</td>
</tr>
<tr>
<td>ULV suspension</td>
<td>SU</td>
</tr>
<tr>
<td>Fumigenous tablet</td>
<td>FT</td>
</tr>
<tr>
<td>Tablet impregnated with a Phytosanitary product</td>
<td>PR</td>
</tr>
</tbody>
</table>

**CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO RISK**

Plant protection products are useful to manage and control pest organisms. However, they can also cause intoxication to persons who handle them. In order to determine whether they are harmful to humans, toxicological studies are being performed in other mammals, such as rats, mice, rabbits and dogs. The results of these tests help to predict their risk to humans, establish safety measures during handling and classify products according to their risk. In the following chart a classification of plant protection products is shown, according to their toxicity.
CLASSIFICATION OF PLANT PROTECTION PRODUCTS ACCORDING TO WHO (World Health Organisation).

Chart 3.10

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>PICTOGRAMME WARNING</th>
<th>COLOR</th>
<th>DL 50 ACUTE ORALLY (SOLID)</th>
<th>THROUGH SKIN (LIQUID)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a/1 Extremely dangerous</td>
<td>Very toxic</td>
<td>&lt; 20</td>
<td>&lt; 10</td>
<td>&lt; 40</td>
</tr>
<tr>
<td>Ib/2 Highly dangerous</td>
<td>Tóxic</td>
<td>&gt; 50</td>
<td>&gt; 100</td>
<td>&gt; 1000</td>
</tr>
<tr>
<td>II/3 Moderately dangerous</td>
<td>Dangerous</td>
<td>&gt; 100</td>
<td>&gt; 1000</td>
<td>&gt; 4000</td>
</tr>
<tr>
<td>III/4 Slightly dangerous</td>
<td>Careful</td>
<td>&gt; 1000</td>
<td>&gt; 4000</td>
<td></td>
</tr>
<tr>
<td>IV/5</td>
<td>Precaution</td>
<td>Over 3000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CLASSIFICATION OF PLANT PROTECTION PRODUCTS, ACCORDING TO LEGAL ASPECTS

To be able to use a plant protection product in a determined country, this must have the approval from a government organism or organisms in charge of regulating its manufacture, commercialisation and use. Taking this in consideration, the products are classified in registered products, non-registered products, restricted products, and prohibited products.

The Food and Agriculture Organization of the United Nations (FAO), in cooperation with the plant protection industry and other international organizations, including NGOs, developed a voluntary code of conduct, the International Code of Conduct on the Distribution and Use of Pesticides. This Code has been adopted by FAO’s Conference and member nations have decided to support it, and all the parts, included the industry, have the joint responsibility to make sure that the Code is applied.

It is important that the spirit as well as the letter of the Code be observed. Management has a clear responsibility to initiate appropriate actions to ensure that the Code is being followed within all the companies.

The Code, as published by FAO, is lengthy and detailed, because it attempts to discuss the responsibilities of all stakeholders involved in the distribution and use of pesticides. The leaflet “The International Code of Conduct on the Distribution and Use of Pesticides” is a summary of the responsibilities advocated by FAO and their implications for the industry and it appears in Annex 01.
CLASSIFICATION OF PLANT PROTECTION PRODUCTS
ACCORDING TO THE APPLICATION SEASON

Plant protection products can also be classified according to their application season, in relation to the various stages of phenological development. So, taking as a starting point the crop’s sowing or emergence, these products can be classified in:

Pre-sowing. When they are used before sowing.

Pre-emergence. When they are used after sowing and before germination.

Post-emergence. When they are used after germination.

Flowering stage. Regarding the flowering stage, plant protection products can be classified as follows:

Pre-flowering. If they are used before flowering occurs.

Flowering. If they are used during flowering.

Post-flowering. If they are used after flowering occurs.
WORKSHOP 3:
TECHNICAL ANALYSIS OF LABELS AND PAMPHLETS

At this workshop participants will analyse agricultural technical aspects from labels and pamphlets of at least ten main plant protection products that are being used in their working area. The main subjects and titles to cover at the workshop are:

A. Label and pamphlet
B. Importance of label and pamphlet
C. Technical information of label and pamphlet

OBJECTIVES:

After completing the workshop, the participants will be able to:

- Know the difference between a label and a pamphlet
- Recognise that both label and pamphlet complement each other giving all the necessary technical information to manage correctly the plant protection products.
- Identify in what part of the label or pamphlet they can find the information needed
- Present a mural report with all the technical information on the labels and pamphlets supplied, which should include: Commercial name, concentration, formulation, biological action, name of chemical group, name of active ingredient, toxicological category, colours code, type of danger, warning phrase and antidote. In addition and in the case of pamphlets, the mode of action, phytotoxicity and compatibility.

REQUIRED TIME

One hour

MATERIALS

- Labels and pamphlets (minimum 10 of each)
- Flipchart paper
- Rulers and masking tape
- Markers
STEP No. 1 – PRESENTATION AND DEMONSTRATION
What is a label? and What is a pamphlet?

The label from plant protection products is defined as any written, printed, or engraved material, adhered to the container, package or exterior wrapping for retail sale or distribution.

The pamphlet is an additional informative sheet that must be included with the product when the purchase takes place. That document contains very important agricultural information to manage and use the product in a safe and responsible way.

Recommendations for the Instructor: He should supply himself with several label and pamphlet samples of plant protection products being sold or distributed in the geographical area in which the persons being trained are working. He should expose the material, comment and clarify any doubts.

STEP No. 2 – PRESENTATION OF THE IMPORTANCE OF LABEL AND PAMPHLET

The label and pamphlet are the legal documents that should be handed to the buyer in most countries. It is required that these documents be written in the country’s official language and, in addition, they should show all the information and instructions for the safe and responsible management of plant protection products; therefore, the information must be written in a language that can be understood by the user.

Following is some of the information that should appear on the label: Name of the formulator, commercial name of the product, concentration, formulation type, biological action, name of active ingredient, use precautions and warnings (with their respective pictogrammes), intoxication signs and symptoms, first aid, antidotes, some environmental issues (also with pictogrammes) and the colour band that identifies its danger, with the corresponding warning phrases.

The pamphlet, besides containing most of the information that appears on the label, it should mention agricultural aspects, such as, action mode, application equipment, how to prepare the mixture, recommendations of use against pest organisms, recommended dose, application intervals, waiting time between last application and crop, waiting period to return to treated area, phytotoxicity, compatibility, etc.

Recommendations for the Instructor: Using the board, group the information that appears on the label and compare it with the information on the pamphlet. Have the participants discuss the subject and come to their own conclusions.
STEP No. 3 – DEMONSTRATION: TYPES OF LABELS AND PAMPHLETS; THEIR PARTS

There are three types of labels: With one body (one face); with two bodies (two faces) and three bodies (three faces). These are used for obligatory labelling of products formulated for agricultural use, according to their size. One-body labels are used on small containers and the three-body labels in larger containers. Pamphlets constitute an informative document that must be handed to the buyer when he buys the product, regardless of size. All pamphlets contain the same information.

Recommendations for the Instructor: Organise some working groups and give them labels and pamphlets so the participants can find out the differences between the two. Ask them to study carefully the labels and pamphlets and answer the questions that you have prepared on a sheet of paper. Some examples of questions can be the following: What is that product for? What products control pest “X”. Which is the most dangerous product? Which is the least dangerous? Use your creativity to make other questions. Correct errors and clarify doubts.

STEP No. 4 – SUMMARY: USE OF LABEL AND PAMPHLET

The best way to use labels and pamphlets is to read them to solve any doubts about the correct and safe manner to use a plant protection product. It is important to recognise that there are at least five situations on which it is necessary to read the label and pamphlet. These are:

Before buying the product. Selecting the product is easier if the label and pamphlet are read thoroughly before purchasing. Both documents help to identify the appropriate product to treat the problem that the crop presents. Before buying or using a product, the user should recognize the risks or problems that could emerge.

Before preparing the dosage and the mixture or applying a product. The label and pamphlet have the instructions and warnings about the use of the product; for that reason, it is always necessary to read both documents before preparing the dosage and the mixture or applying a product. This will give assurance that the product is being used correctly.

Before storing and transporting the product. The label as well as the pamphlet indicate the proper procedures for storage and transportation.

Before eliminating empty containers. These documents contain the procedures for a correct elimination of empty containers, including triple rinse.

At the time of an accident or an emergency caused by the incorrect use of a product.

Always remember how important and useful it is to read both the label and the pamphlet!

The instructor should end the unit making a recapitulation. He should evaluate the level of learning of the participants and clarify their doubts.
**Consulte al profesional en ciencias agrícolas**

**Manufacturer's Logo**  
Product commercial name

<table>
<thead>
<tr>
<th>COMPOSITION QUIMICA:</th>
<th>P/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azufre</td>
<td>80.00%</td>
</tr>
<tr>
<td>Ingredientes Inertes</td>
<td>20.00%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Contiene 850 gramos de ingrediente activo por kilogramo de producto comercial.

**Precaución**  
En caso de intoxicación llame el siguiente número y déle esta información al profesional:

**Manufacturer's Logo**  
Product commercial name

<table>
<thead>
<tr>
<th>COMPOSITION QUIMICA:</th>
<th>P/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-metil metil carbamato</td>
<td>80.00%</td>
</tr>
<tr>
<td>Ingredientes Inertes</td>
<td>20.00%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Contiene 850 gramos de ingrediente activo por kilogramo de producto comercial.

**Precaución**  
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**Manufacturer's Logo**  
Product commercial name

<table>
<thead>
<tr>
<th>COMPOSITION QUIMICA:</th>
<th>P/P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingredientes Inertes</td>
<td>10.00%</td>
</tr>
</tbody>
</table>

**Precaución**  
En caso de intoxicación llame el siguiente número y déle esta información al profesional:

**Manufacturer's Logo**  
Product commercial name

**LABELS IN ENGLISH SHOULD BE INSERTED ON THIS PAGE**

**ONE-BODY LABELS**
TWO-BODY LABELS

LABELS IN ENGLISH SHOULD BE INSERTED ON THIS PAGE
THREE-BODY LABELS

LABELS IN ENGLISH SHOULD BE INSERTED ON THIS PAGE
PICTOGRAMMES
**CARACOLEX 5.95 RB**

**CUIDADO**

- **Antidote:** Sulfato de Triatoma, Solvent, Vaselina Líquida.
- Este producto puede ser mortífero si se inhala. Indique a los niños, personas que normalmente ingresan a áreas domésticas, a niños y ancianos:

**REAR BODY**

**LABELS IN ENGLISH SHOULD BE INSERTED ON THIS PAGE**
**RECOMENDACIONES DE USO: PROWLS 50 EC es un herbicida que combate las siguientes malezas:**

<table>
<thead>
<tr>
<th>Malezas</th>
<th>Concentración</th>
<th>Concentración</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gramíneas</td>
<td>2.0 litros por hectárea</td>
<td>2.5 litros por hectárea</td>
</tr>
<tr>
<td>Sida</td>
<td>2.0 litros por hectárea</td>
<td>2.5 litros por hectárea</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2.0 litros por hectárea</td>
<td>2.5 litros por hectárea</td>
</tr>
</tbody>
</table>

**AGLONDÓN:** Aplique en presiembra incorporada, con un punto de aplicación de 6 a 8 cm, de profundidad o preemergencia inmediatamente después de la siembra, máximo 24 horas después, si el suelo está húmedo o se han presentado lluvias. No realizar aplicaciones a postemergencia ya que puede ser muy fotonóxico al cultivo.

**MAÍZ:** Aplique preemergente, solo o en mezcla con atrazina (1 kg.a.i./ha), en postemergencia total al cultivo antes de que crezcan las raíces del dañador. El maíz debe sembrarse a una profundidad de 4 cm.

**ARROZ:** Aplique preemergente, inmediatamente después de siembra. Debe ser tomado a la medida del producto y no puede tratarse de las semillas antes de la aplicación. Nunca se aplique antes de la siembra. El suelo debe estar bien preparado y dispuesto para absorber el hidróxido de cálculo de agua. Aplique cuando se esperen lluvias o se va a iniciar dentro de las 7 días siguientes a la aplicación. En arroz de nido es recomendable esperar un periodo no menor de 48 horas entre la aplicación y el establecimiento del siguiente rega. En postemergencia temprana, PROWLS 50 EC se puede mezclar con dosis de preparación de 2.5 o 2.0 kg.a.i./ha, cuando los malezas tienen de 0 a 3 hojas. Es conveniente el uso del cebador de suelo antes de la aplicación para uniformar la superficie del mismo y la germinación de la maleza. Para el control de arroz indesembrable en arroz de nido y nivel el suelo, realice un riego de germinación (2-5 litros de agua). Aplique 4-5 litros de PROWLS 50 EC, establecer una lámina de agua con vida durante 12 días. Drene el campo y sométalo a nuevas arrocerías, así 7 a 14 días. Aplique gisocloro (3 l/ha). Siembre el arroz comercial 2 a 3 días después de aplicar gisocloro. Una semilla pregerminada, tan pronto como el arroz lo permita, se establece la lámina de agua permanente. En este tratamiento se debe esperar un periodo de 24 días después de la aplicación para poder sembrar arroz.

**SOYA Y YUFROL:** Como preemergente aplicar inmediatamente después de la siembra (máximo 24 horas después) al suelo está húmedo o se esperan lluvias. En presiembra incorporado, antes o el mismo día de siembra, a una profundidad de 6 a 8 cm mediante derrame de estípulas o entre los实施 con el cebador de suelo. En este periodo se puede tratar con atrazina (1 kg.a.i./ha) cuando el arroz ha nacido y tiene de 3 a 4 hojas. Aplique antelación a la emergencia del soya cuando esté emergiendo, son fotonóxicos, portan no deben hacerse. Medio surtido de malezas será el más cuando las malezas ligan 2 hojas o menos a la hora del momento de la aplicación.

**CEDBOLLA:** Aplique 0-5 días después del transplante.

**CÉCARA DE AZÚCAR:** En preemergencia absoluta a dosis de 2 a 3 litros por hectárea. En postemergencia se puede usar en mezcla con Terbutrina, Atrazina, Diurad 2 a 4,4,4. En suelo seco, el suelo debe estar libre de residuos para que el herbicida pueda llegar al suelo. Si hay interferencia se recomienda un labor de cultivo mecánico para exponer el suelo al tratamiento con herbicida.

**TABACO:** PROWLS 50 EC puede ser aplicado en forma incorporada antes de realizar el trasplante.

**AGROPECUARIO:** Aplique preemergente después de la siembra y antes de la emergencia de las malezas. Para todas las malezas es necesario una buena preparación del suelo.
REAR BODY

LABELS IN ENGLISH SHOULD BE INSERTED ON THIS PAGE
CHAPTER 4

COLLATERAL CONSEQUENCES DERIVED FROM
THE USE OF PLANT PROTECTION PRODUCTS
CHAPTER 4

COLLATERAL CONSEQUENCES DERIVED FROM THE USE OF PLANT PROTECTION PRODUCTS

SPECIFIC OBJECTIVES:

That the participant:
- Identifies and recognizes the processes that implicate environmental dynamics of plant protection products upon being liberated in the environment.
- Recognizes the manner as how the contamination with these products occur in the soil, the water, the air and other substrates (food residuals).
- Recognizes the direct and indirect effects over beneficial enthomofauna and other organisms no objective.
- Identifies the problem of tolerance and resistance development to the plant protection products.
- Identifies product debris problem and empty containers of the plant protection products.
- Knows and identifies some measures tending to diminish this problematic.

METODOLOGY:

The instructor should present in a chat the problematic related with the incorrect use of plant protection products trying to undertake the proposed specific objectives. He should also facilitate the discussion of this problematic from the participants and guide them in the search of those measures that permits to diminish it.

NECESSARY MATERIALS:

- Audiovisual equipment and screen.
- Blackboard, whiteboard markers or chalk according to the case.
- Acetates, slides or presentations in CD’S or diskettes.

REQUIRED TIME:

An hour

STUDY DOCUMENT:

To develop this chapter is necessary that the instructor reads, studies, analyses and understands the following study document.
COLLATERAL CONSEQUENCES DERIVED FROM THE USE OF PLANT PROTECTION PRODUCTS

ENVIRONMENTAL DYNAMIC OF THE PLANT PROTECTION PRODUCTS

When plant protection products are applied, the objective is to contact these substances with the organisms that have reached its pest condition in most of the cases. A minor percentage of 5% enters in contact with the pest and a 95% remains in the environment. These products that remain in the environment start to be degraded by the action of diverse biotic and abiotic processes, for example: can be putrid by the action of the light, water, air and by diverse organisms, also can be adhered, vaporised, leached, drained and have a different destiny as planned initially, provoking contamination of other environments. Everything mentioned before constitutes the environmental dynamic for the plant protection products. To understand this dynamic, is very useful to know and predict the environmental risks that implicates the use of those products, likewise to adopt the measures and actions that permit to reduce or minimize them. Figure 4.1

FIGURE 4.1
DEGRADATION MECHANISM

All chemical substances including the plant protection products upon being liberated in the environment are degraded by the action of biotic and abiotic factors, through diverse reactions (figures 4.2, 4.3 and 4.4). The main reactions that participate in the degradation process of plant protection products are: Photolysis, degradation by lighting energy in the soil and water; the oxidation, by adding oxygen; the reduction by hydrogen addition; the hydrolysis by water partition; the isomerization, by changes that occur in the spatial ordering of the atoms, of the molecules and the conjugation by the mix of the original substance, or some of its metabolic products to other substances.

FIGURE 4.2
FIGURE 4.3 ABIOTIC DEGRADATION

FIGURE 4.4. BIOTIC DEGRADATION

CONTAMINATION OF PLANTS, WATER, SOIL AND AIR; SOME ACTIONS TO COUNTERACT

When a plant protection product is liberated in the environment, this will follow the same dynamic as any chemical substance diffusion and transport, which would depend on the physic-chemical properties of the product, of thestract where they are, of the predominant environmental conditions, of the type of application that were made, as
well as the multiple interactions that could present within these and other environmental factors. By this reason, it is essential to have knowledge of the most important physic-chemical properties of plant protection products, to get to understand and estimate its performance in the substrates plant-water-soil-air and other organisms.

The necessary basic information to reach that purpose are the data of certain key properties as the water solubility and other dissolvent, the adsorption, the vaporization and the way how they react with the soil, the plants and other organisms that are objective of control. The composition and chemical structure of the product, guides towards the type of reactions that may occur, and therefore the compound persistence according to the environmental prevailing conditions.

The solubility, indicates the ease with which the plant protection products dissolves in the water or other dissolvent; the adsorption, the strength with which the product adheres to the soil particles and organic matter; the volatility, the facility with which it vaporises to the atmosphere; the degradation, indicates the rapidity with which the chemist dissipate or changes in simple compounds as carbon dioxide, ammonia, etcetera, by biotic or abiotic factors; the persistence, the time that a product and its metabolites perform its action and the toxicity, the capacity of producing damage. Generally the better option for the environment is to select a plant protection product that has lower solubility, high capacity to be bonded to the soil, lower volatility and a short persistence period.

To continue, the environmental dynamic of plant protection products in different substrates is explained:

**PLANT CONTAMINATION:** The plant protection products can reach to the plant surface through some of the following actions, whether if it is in an individual or combined way: direct application, drag or drift effect, residual precipitations that are in the atmosphere and the irrigation with contaminated waters with rests of these products, once they reach the plants surface are metabolised and transformed, to activate or deactivate, increase or diminish the capacity of producing toxic effects for the same plant or for other organisms and contaminate the vegetables that we consume, making them no apt for its consumption, because they contain residual levels that surpass the maximum limits of residuals permitted and established by Comité Conjunto del Codees Alimentarius FAO/OMS. Some actions that can reduce this risks are: Use plant protection products, that are authorized by the competent organism that watches for the harmless food; respect the lacking periods; avoid the crossed recontamination of other agricultural fields; application in adequate hours, to avoid drift and drag of contaminants; use good quality water, etcetera.

**WATER CONTAMINATION:** The contamination of superficial and underground waters with plant protection products can be provoked by various actions and/or processes, for example: direct applications, drift or drag during the application; deposit of soil particles with remains of adhered products; drag of superficial layers of contaminated soils, wash dawn by rainwater; wash of application and protection equipment in superficial water fountains (rivers, lakes, ponds, etc) leaching of product
residues localized in the application surface, etcetera. The establishment of mitigation areas is very important to avoid the contamination of water fountains, channels and irrigation ditches; the methods of soil management and conservation, also reduces the risks by this type of contamination to occur. To minimize these risks, must be followed the precaution measures and management that are offered in the label and pamphlet of the plant protection products.

**SOIL CONTAMINATION:** Soil is the final receptacle of residuals of plant protection products as water contamination, the actions and processes that take part in its contamination are the same. The adsorption degree of plant protection products in the soil is influenced by its textural class, as by its organic matter content. Those products of polar nature, are more predisposed of being adhered, persisting more time in this substrate. (Figure 4.5)

The mobility and percolation of plant protection products leftovers in the soil, is influenced, by the presence of water, its quantity and quality, as per the physic-chemical properties of the soil (textural class, presence of organic matter, pH, depth, pending, temperature) and its interaction with three main properties of this phytosanitary: solubility in water, the soil adsorption and its persistence. (Figure 4.6)

The persistence of a plant protection product in the soil relates to the capacity to resist the degradation process through the time. The permanence or disappearance of a plant protection product in the soil, is the result of its movement and degradation and depends of the factors that appear in Figure 4.1.

![FIGURE 4.5 SOIL ADSORPTION AND DESORPTION](image-url)
PICTURE 4.1 Factors that influence the product permanence in the soil

<table>
<thead>
<tr>
<th>MOVEMENT</th>
<th>DEGRADATION</th>
</tr>
</thead>
</table>
| - Adsorption degree in the soil (which is function of the soil type, product nature, humidity, pH, temperature and others).  
- Frequency and volume use  
- Assimilation by plants and animals  
- Leaching aptitude  
- Soil erosion aptitude | - Microbiological activity  
- Chemical stability  
- Biodegradation  
- Photo-degradation |

**AIR CONTAMINATION:** The dynamic of plant protection products leftovers in the atmosphere is influenced by the product concentration in the air, the temperature, the wind, the product volatility, and other physicist-chemical characteristics. Processes as the evaporation, eolic erosion and the drift, are responsible of this type of contamination, the vaporization process is very important, in some cases, the loss percentages reach until a 90%, in the course of the first 24 hours after the application.
The vaporization of this soil phytosanitaries towards the atmosphere is also influenced by the humidity content of the soil. Thus, it is known that some applied products over dry soils are strongly adsorbed in its particles, declining in a meaningful manner the steam pressure, which inhibits substantially the vaporization of these. Some useful actions to reduce these risks are: to make the application in the freshest hours and without much wind, select products of lower volatility, select application technologies that reduce the drift and drag, etcetera.

RESISTANCE PROBLEM AND DESTRUCTION OF BENEVOLENT ORGANISMS

Other of the environmental problems derived of the misuse of plant protection products, and that has repercussions over the control possibilities of pest organisms, are the resistance and the destruction of benevolent organisms. The application of plant protection products in a repeated manner, the dosage increment, the decrease of intervals between one application and other, the product mixture, the dependence of a unique control alternative, propitious the selection of pest organisms that can tolerate or resist higher dosage than the required to kill the majority of the population, at the same time destroys and/or reduces the benevolent organisms population. To manage the problem of resistance and destruction of population of benevolent organisms, the IPM adoption, the selective use of plant protection products and the guidance recommendations that appear in the label and the pamphlet would be some of the actions to follow.

PROBLEM OF EMPTY CONTAINERS, DEBRIS AND EXPIRED PRODUCTS

The disposition and destruction of expired products, holdovers, empty containers, spilled recollections, debris and trash coming from production sites and formulation of plant protection products, thus as the utilization by the users or these empty containers and application holdovers, constitute other contamination problem, if they are not treated adequately. So the FAO directions to give a technical solution to this problematic as the efforts of the Management Programme of Containers of CropLife Latin America, constitutes two examples to follow to solve this situation.

MEASURES TO PREVENT CONTAMINATION WITH PLANT PROTECTION PRODUCTS

ADOPTION OF THE INTEGRATED PEST MANAGEMENT

The Integrated Pest Management (IPM) is a group of alternatives for the pest control. This combines some components to minimize the damage occasioned by pests, considers the environmental impact of pesticides and the development of pest resistance towards these products. El IPM includes:
The pest identification

- Monitoring pest population growth and determination of the climatic conditions that guides to this.
- Evaluation of pest population growth to determine if it is necessary to apply a control method.
- Consideration of all options of pest control, including the following:
  - Cultural practices
  - Biological practices
  - Chemical methods
  - Physical methods
- Selection of an appropriate combination of control methods. This can include the rational use of plant protection products.
- Consideration of climatic conditions as for example temperature, wind and precipitation.
- Register of the control measures taken in basis of growth levels of pest populations and their life cycle.
- Rotation of plant protection products of different chemical groups to reduce the possibility that different pests develop resistance to specific active ingredients.
- Evaluation of effectiveness of control methods used.
- Monitoring methods, action levels (economic threshold) control methods vary with the crop and the pest.

When it has been decided to use a plant protection product, the following recommendations must be followed:

- Follow carefully the label instructions.
- Do not overdose the products. The overuse increases the risk to contaminate the superficial and underground waters.
- Keep in mind that the chemical injection in the soil, makes it more possible that this percolate themselves, than those that are applied as sprinklings over the crop.
- Avoid to water the plants after short periods of time have passed after the application of plant protection products. This practice increases the possibility of contamination of superficial and underground waters.

All cultural practices are important in a programme of integrated pest management. Vigorous and healthy plants would be less inclined to pest attack. It is specially important to accomplish the pest monitoring because this can reduce the quantity of plant protection products to the necessary, even though no biological or cultural controls are used.

The monitoring permits plant protection products to be applied in critical times, which makes the control more effective. This can also permits the treatment to be limited to the affected part of the crop, which has economic and environmental benefits.
Selection of a plant protection product: As mentioned before the plant protection products are not the only option for pest control. Before the decision of using a plant protection product is taken the following recommendations should be followed:

- Correct identification of the pest, in this case if oneself does not count with the necessary experience, should be considered the possibility of seeking specialized help in pest identification.
- Monitor the crop regularly, to determine the presence, ripening and pest population growth levels before taking a decision to apply a plant protection product.
- Reduce the use of crop protectors. Sometimes, no chemical or biological control methods can be more recommendable. When it is necessary to apply protective substances, select those that are less toxic for the environment and harmful for the benevolent organisms. It is necessary to follow the indicated advices in the precaution section of the label and pamphlet, only the recommended products should be used and the ones that are registered for a determined pest or crop. In the label or pamphlet, it is clearly explained the practices of the correct use of these products.
- At the moment of applying them, use personal protection equipment and make sure that the application equipment is in perfect working conditions and correctly calibrated.
- Be prepared for accidental spill cases and other type of emergencies.

Filled equipment station and mixture preparation: The filled equipment station is often located in the place where the mixture is prepared. Extra precautions should be taken to prevent the spilled contamination during the filling of the equipment. Choose a place where the spilled or overfilled of the equipment do not reach water supplies. Have a contingency plan in this place for spilling cases. It is convenient to consider the following aspects:

- Locate the filled station to at least 10 meters of a water body or similar.
- Locate the filled station to such highness that could manage the equipments with comfort.
- It is necessary to build a contention wall around the station and along the water courses, to avoid that the spilled plant protection products, get into these.
- Mix only the product quantity required to accomplish the application.
- Always have a water fountain in disposition.
- Have the equipment ready for spilled cases in the mixture and storage place, this must include absorbent material, shovels, protection equipment, etcetera.

Plant protection products application. During the application of plant protection products, the following recommendations must be followed:

- Do not apply plant protection products to at least 10 meters of a natural water course as rivers, lakes, waterfall, etcetera.
- Observe the climate conditions. Do not apply when winds or storms are bigger than smooth breezes or just before a storm. It is preferable to apply in the freshest hours
of the morning and the evening. If the conditions of the climate station permits to apply during the night, it can be effected.

- Observe that the application equipment is in perfect working conditions and correctly calibrated.
- Close the exit of the application equipment when this is not being used.
- Do not exceed of the established use level indicated in the label.
- Avoid the presence of people or animals in the area that is going to be treated.
- Protect the animals or benevolent insects (bees, predators, parasitoide) applying the product when there is a low presence of these.
- Use the specific personal protection equipment, according to the plant protection product that is going to be applied, follow the label or pamphlet recommendations.
- Write down the application dates, conditions and effectiveness results of the control strategy used.

APPLICATION FORMS:

**Application from the soil.** When a plant protection product is applied in the soil, this emerge from it in little drops, and by the wind action these are moved to another zones of the application, to avoid that this occurs, the following recommendations should be taken:

- Use products of low volatility.
- Apply them in an ordered and appropriate form.
- Use an adequate pressure in the application equipment to reduce the number of fine drops, increasing its size (remember the vmd concept)
- Use exit nozzles that produce large drops or rain drops. When the product thus requires it.
- Choose chemicals that do not required high pressures.
- Change damaged nozzles or clean the exit nozzles every time an application is done.
- Use additives that increases the viscosity and thus produce few fine drops.
- Do not apply when the wind exceeds 7 km/h and the temperature is higher to 30ºC.

**Application from the air:** Some plant protection products can be applied by airplanes or helicopters, for this it is necessary to have some recommendations:

- All kinds of plant protection products that are going to be applied in aerial manner, must be transported and applied by qualified experienced pilots in this type of application.
- Read the label and watch the indications for aerial application, do not use those that say "**Do not apply by air**".
- Review local restriction laws for aerial application of plant protection products.
- Delimit the area that is going to be treated with flags or other visible indicators.
- The company that is going to accomplish the application must have some controllers in land equipped with radio to be in contact with the pilot and guide him.
WASH DOWN BY RAINWATER CONTROL OR DRAG OF PLANT PROTECTION PRODUCT

The wash down by rainwater of plant protection products of some treated areas can contaminate water fountains such as seas, lakes, lagoons, rivers, etcetera. There are some basic precautions that should be taken in consideration to avoid this type of contamination:

- Review the climate forecast as not to apply before strong storms, because this can remove the product from its contact zones and drain in the soil causing the its erosion.
- Use some management techniques for soil and water conservation, to avoid the erosion and superficial drain, therefore the product cannot abandon the treated environment.
- Leave plant edges or some class of vegetation around the ditches or water courses to avoid the wash down by rainwater.

CONTAINERS TREATMENT:

Empty containers could be dangerous for the environment if they are not treatment properly, some precautions must be taken for this:

- Use the complete content of a storage container whether this is a cover or plastic bag, plastic or metal bottle, etc.
- Wash the containers three times according to the procedure, whether these are metal or plastic.
- Destroy or make holes to the containers so they cannot be reused.
- Deposit the containers in a collect for their correct elimination.
- Identify correctly the collects and restrict the accesses of strange people to it.
- Use personal protection equipment in the work area.

LEFTOVER DISPOSITION OF PLANT PROTECTION PRODUCTS.

- If it is possible return the not opened containers to their manufacturers or distributors.
- Do not pour product leftovers in the drains or pipelines, soil, water.

HUMAN INTOXICATIONS.

The plant protection products can cause problems in the human health and these would be studied in the workshop 3 Human intoxications: Signs and symptoms. First Aid.

WORKSHOP 3: INTOXICATIONS: SIGNS AND SYMPTOMS OF INTOXICATION. FIRST AID.

INTRODUCTION
The participants should understand that when one is constantly working with plant protection products, it is necessary not to forget and to follow the warning and precaution measures that appear in the label and the pamphlet; on the contrary, accidents may occur.

For this reason, it is essential to know, the danger that involves the use and management of plant protection products; the way how these can enter to the human body, the different absorption degrees in the skin; the signs and symptoms of an intoxication associated with the main chemical groups someone works with; the types of intoxication that may occur (acute, retarded and chronic), and the First Aid that can be given in the case an intoxication occurs. These knowledge would allow to prevent and avoid accidents that could have fatal consequences.

The main titles of the subjects in this workshop:

- Risks or associated dangers to plant protection products.
- The media lethal dosage (LD50).
- Ways through which the plant protection products enter to the human body and absorption degrees in the skin.
- Signs and symptoms of intoxication by the more common chemical groups.
- Types of intoxication: Acute, retarded and chronic
- First Aid in case of intoxication

OBJECTIVES

At the end of the activity, the participants would be capable to:

- Recognize the dangerous categories that identify the different plant protection products.
- Identify and recognize the risks to which they are exposed when they use plant protection products; recognize the routes through which the plant protection products enter to human body;
- Understand the different absorption degrees of the skin when this is exposed to plant protection products.
- Recognize the different signs and symptoms of an intoxication provoked by plant protection products; and how to provide First Aid when an intoxication occurs.

REQUIRED TIME

45 MINUTES

STEP # 1 PRESENTATION AND DISCUSSION: HUMAN RISKS ASSOCIATED TO PLANT PROTECTION PRODUCTS.

The plant protection products are useful for the control of pest organisms, but used in an inappropriate way causes accidental and occupational intoxications, besides of the intoxications and death for intentional ingestion with suicide purpose.
The previous situation proves that the plant protection products used in an irresponsible manner may be dangerous, the way to identify the toxicity of the plant protection products, consist in identifying the color band in the labels, thus the red band means extremely or highly dangerous; the yellow, moderately dangerous; the blue, lightly dangerous and the green of very but very low danger. Also the pictogrammes and warning phrases in the labels and the pamphlets.

For the instructor: Organize a discussion about intoxication experiences with plant protection products. Ask any of the participants if any of them has been intoxicated with these products, or if they know someone that has suffered this type of experience. Motivate them to talk and discuss their experiences. During the discussion, determine if the people involved knew that it was an intoxication, or if they recognized the signs and symptoms and did not know how to act.

STEP # 2 PRESENTATION: LD50

All plant protection products represent a risk or danger of intoxication or death, but some of them are more dangerous than others, to determine the endanger (toxicity) of these products, scientists achieve experiments with animals such as: rats, mice, rabbits, guinea pigs, dogs and hens. In these experiments the scientists determine the quantity of product that is necessary to kill half (50%) of the treated animals. This quantity is called the media lethal dosage and is used to assign the danger band to the plant protection products. It is important to know, that when less the dosage is, the product endanger is higher.

For the instructor: accomplish a summary getting as a result, the following conclusions:

- Incorrectly use of plant protection products may cause intoxications and possibly death.

- The LD50, permits to classify the plant protection products from high to low danger.

WAYS TO DETERMINE THE LD50
STEP # 3 PRESENTATION AND DEMOSTRUCTION: ROUTES THROUGH WHICH THE PLANT PROTECTION PRODUCTS ENTER TO OUR BODY
ABSORPTION GRADES BY THE SKIN.

There are four ways for a plant protection product enter to the human body: By the mouth (orally); by the nose and the mouth (inhalation); and through the skin (dermal) and by the eyes. The entrance by the mouth, is the less probable route, but it can be particularly dangerous; nevertheless, the precautions to avoid it are simple:

- Neither eat, nor drink, do not smoke with the hands contaminated by these products.

- Do not store plant protection products in bottles of drinkable products or food containers.

- Do not transport or store the products together with the food, to avoid contamination.

- Keep away the rodenticide baits and the treated seeds from the food, to avoid accidental consumption.

The inhalation could be dangerous, when very volatile products are used in closed environments or because the application method produces liquid or solid particles, quite fine can be inhaled. The use of respiratory masks and to accomplish the applications in appropriate hours are precautions that must be considered.

The most probable contamination is through the exposed skin. It can occur not only by the effect of a spilled or splash of a concentrate or a mixture, but also using contaminated clothing, the use of defective equipment or by continuous exposition to the pulverization. These products pass rapidly from the clothing to the skin and can enter the organism inclusive, through healthy skin and without wounds. The eyes, mouth, tongue and the genital region are zones particularly vulnerable. During hot weather, special measures should be taken due that the sweat increases the absorption capacity by the skin.

For the instructor: Use illustrated sheets where the penetration routes of plant protection products are signed, and the different absorption grades by the skin. Help yourself with the enclosed sheets.
BODY ABSORPTION ROUTES

Eyes
Nose
Mouth

SKIN
SKIN ABSORPTION GRADES

35% Skull
40% Forehead
50% Ear conduit
20% Abdomen
8% Forearm
10% Palm
99% Scrotum
15% Foot
STEP # 4 PRESENTATION: SIGNS AND SYMPTOMS OF INTOXICATION.

When an intoxication occurs, there are many indications that allow to recognize it, those indications, are known as symptoms and signs. The symptoms are sensations that only the intoxicated person can feel, for example: headache, anxiety, blurry vision, etcetera. The signs are manifestations that occurs in the patient but can be observed by a second or more persons, as for example: sweating, corporal tremors, vomits, etc. The symptoms and signs of a light intoxication include: headache, fatigue, dizziness, blurry vision, sweating, nausea, vomits, abdominal cramps, salivate and contractions (dwarf) of the pupils. A moderately serious intoxication, besides the previous symptoms, can produce indisposition and chest pressure, the pupils contraction, low cardiac rhythm, muscular tremors, confusion, lack of muscular coordination, difficulty to speak and Psychosis (strange and maniac behavior). The mortal intoxication can have many manifestations that includes fecal and urinary incontinence, heart irregularities and deteriorated respiratory function.

For the instructor: present a story about an intoxication experience that allows to distinguish symptoms of signs. Ask the participants to distinguish these signs and symptoms. Clear doubts. Present the enclosed material.

An 18 year old worker asked for medical attention to the health by nausea, dizziness, salivation, blurry vision, respiratory difficulty, weakness and uneasiness for two hours of duration. He informed that he started the plant protection products application at six O’clock in the morning, at seven drank water from a water bottle, he ate a pair of tortillas with beans. An hour later he began with discomfort, reason why he decided to suspend the application and consult a health.
SLIGHT SIGNS AND SYMPTOMS

- tired
- headache
- dizziness
- sweaty

MODERATE SIGNS AND SYMPTOMS

- blurry vision
- vomiting
- cramps
- stomachache
DANGEROUS SIGNS AND SYMPTOMS

difficulty to breathe
unconscious
dripping nose and slobbering
small pupils
STEP # 5 PRESENTATION: TYPES OF INTOXICATION.

The provoked intoxications by plant protection products are of three types: acute, retarded and chronic. The acute intoxications, are of short term. A person can intoxicate entering in contact once or many times in less than 24 hours with the plant protection products. The symptoms and signs of intoxication develop rapidly. The retarded occur by frequent expositions, repeated to the plant protection products during periods of many days or weeks. The symptoms and signs appear in a light intermittent manner or after months of expositions. The chronic intoxications that show in a long term due to the plant protection products accumulation in certain tissues and body organs, until long time later, inclusive years the intoxication symptoms appear. All persons that use plant protection products must recognize which are the symptoms and signs of intoxication by chemical groups with which they work, reason why here are described:

Intoxications with organochloride: The first symptoms and signs are: General pain, headache, irritability, dizzy, nausea, vomiting. Later the intoxicated person might present involuntary muscle contractions, tremors, respiratory difficulty, convulsions and enter in a state of comma.

Intoxications with organophosphorus and carbamates. At the beginning the following effects are observed: headache, dizzy, fatigue or tiredness, blurry vision, excessive sweating, abundant saliva, tearing, stomachache, diarrhoea, nausea and vomiting. The subsequent steps are characterized because the patient presents weakness, incapacity to walk, chest pain, contractions and muscle spasms, contracted pupils that do no react to the light. The final step comprehends the following characteristics: Loss of reflections, unconsciousness, breathing difficulty, involuntary urinate and defecate and death comes if medical treatment is not administered.

Intoxications with pyretrines and pyrethroids. The first symptoms that the intoxicated person show are: tingling in the eyelids and the lips, conjunctive and mucous irritation, sneezing. Afterwards he presents intense itching, skin stains secretion and nasal obstruction, excitation and convulsions.

Intoxications with bypiridiles. In the intoxicated person it might produce skin irritation, irritation of the conjunctives, general discomfort, weakness, sores and burns in the mouth, abdominal pain, respiratory failing, thirst, bleeding nose, lung, kidneys and liver damage.

Intoxications with herbicides of the phenoxi group. The acute intoxications with herbicides of the phenoxi group at the beginning provoke loss of appetite, irritation of the exposed skin, dizziness and intestinal tract irritation. Later, the intoxicated presents exhaustion, vomiting, thoracic and abdominal pain, muscle tremors, mental confusion, convulsions and comma.

For the instructor: Use the illustrated sheets that appear in this presentation, they will help you in the teaching process.
Signs and Symptoms of Organochloride Intoxication

General discomfort
Headache
Dizziness
Vomiting
Nauseas
Tremors
Convulsions
Comma
Lack of breathing
Signs and Symptoms of Organophosphorus and Carbamates Intoxication

- Headache
- Contracted pupils
- Dizziness
- Abundant saliva
- Blurry vision
- Breathing difficulty
- Vomiting
- Transpiration
- Nauseas
- Tremors
- Stomach Cramps
- Diarrhoea
- Weakness
- Convulsions
- Comma
Signs and Symptoms of intoxication by Pyretrines and Pyrethroids

Tingling:
• in eyelids
• in lips

 Conjunctive and mucous irritation

Sneezing

Intense itching

Spots in skin

Secretion and nasal obstruction

Excitation

Convulsions and comma

Lack of breathing
Signs and Symptoms of intoxication with Bypiridiles

Skin irritation

Conjunctive irritation

General discomfort

Weakness

Sore spots and burns in the mouth

Abdominal pain

Respiratory failure

Thirst

Bleeding nose

Lungs, kidneys and liver damage
Signs and Symptoms of intoxication with Herbicide of the Phenoxi Group

Appetite loss
Skin irritation
Dizziness
Intestinal tract irritation
Exhaustion
Nausea and vomiting
Thoracic and abdominal pain
Muscular tremors
Mental confusion
Convulsions and comma
Lack of breathing
STEP # 6 PRESENTATION AND SIMULATION: FIRST AID IN CASE OF AN INTOXICATION WITH PLANT PROTECTION PRODUCTS.

The First Aid consist in the help that a person that is not a doctor could give to an intoxicated person with plant protection products, with the purpose of:

- To preserve his life
- to prevent health deterioration, and
- to promote the recuperation

It is convenient to remind that First Aid are useful to help and relieve the intoxicated person until he or she reaches medical assistance. First Aid cannot replace medical support.

The procedures of specific First Aid, according to the entrance route of the plant protection product to the organism, is described as follows:

Intoxication by dermal via:

- Act with rapidity avoiding the auto contamination during the procedure.
- Remove the intoxicated person of the area where the accident occurred (stop the exposition).
- Take off the contaminated clothing.
- Shower the intoxicated or wash the skin completely with water and soap.
- Ask for medical help and must carry the label and the pamphlet.
**Intoxication by respiratory via:**
- Act quickly avoiding to auto contaminate
- Remove the intoxicated person of the contaminated area
- Loosen the clothing of the intoxicated or take it off if it is contaminated, the skin must be washed with water and soap.
- Help the intoxicated person with artificial respiration or with oxygen by nasal via, if it is necessary.
- Ask for medical help and carry the label or the pamphlet.

![Respiratory Intoxication Illustration](image)

**Intoxication by oral via:**
- Act quickly, stop the exposition, take off the contaminated clothing and shower the intoxicated person,
- Induce to vomit if there is no contraindication in the label or the pamphlet;
- Give a drink of activated coal suspension (3 pills of activated coal in half glass of water)
- Ask for medical help and carry the label and the pamphlet.

![Oral Intoxication Illustration](image)
Intoxication by ocular via:
- Wash quickly any splash that occurs in the eyes during 15 minutes; with plenty of clean water, every ten seconds, must turn over the eyelids. Avoid to contaminate the other eye.
- Cover and immobilize the eye using a clean and dry cloth.
- Ask for medical help, carry the label and the pamphlet.

In all cases of intoxication it is necessary to determine the causes that occasioned the accident, to execute the pertinent corrections.

For the instructor: Consult the document: First Aid: Procedures” that appears in annex 02, so that better options could be proposed. Organize work groups and assign them an intoxication by plant protection products case so they achieve a First Aid simulation.
CHAPTER 5

SAFETY NORMS FOR THE CORRECT USE AND MANAGEMENT OF PLANT PROTECTION PRODUCTS
CHAPTER 05

NORMS FOR THE CORRECT USE AND MANAGEMENT OF
PLANT PROTECTION PRODUCTS.

SPECIFIC OBJECTIVES:

That the participant:

- Knows some basic principles of toxicology.
- Identifies and knows the basic components necessary for correct use of plant protection products.
- Use those components and acquire the habit of following the precaution measures necessary for the correct use of plant protection products.
- Develop a methodology to transfer those principles to future objective groups.

METODOLOGY:

Develop a chat that includes all aspects detailed in the study document titled “Norms of Precaution for the Correct Use and Management of Plant protection Products”.

Discuss the participants experiences about problems related with the correct use and management of plant protection products.

Develop a method that permits the transfer and improvement of the proposed norms.

NECESSARY MATERIALS:

- Blackboard (depending on this chalk or whiteboard markers should be proportioned)
- Slides projector, acetate projector, multimedia projector and screen.
- Slides, acetates, diskettes or CD’S (according to the case)
- Basic study document

REQUIRED TIME:

One (1) hour.

STUDY DOCUMENT:

To develop the chat, the instructor must help himself with a study document titled “Norms of precautions for the correct use and management of plant protection products”.

NORMS OF PRECAUTIONS FOR THE CORRECT USE AND MANAGEMENT OF PLANT PROTECTION PRODUCTS.

BASIC PRINCIPLES OF TOXICOLOGY:

Toxicology is a multidisciplinary science that studies the damaged effects of the chemical substances in the biologic systems, also the way to prevent and treat them. Paracelsus, the father of this science, affirmed in the last century that there is nothing that is not poison, that the dosage makes the poison; that applied to the knowledge and actions in front of the toxic effects of these substances, he established the importance of the exposition faced to the toxicity, thus the prevention.

The plant protection products are chemical substances that may result dangerous if they are used in an incorrect way, which represents a risk for the user. To understand the norms for the correct use and management of these, by the users, it is necessary to know some basic principles of toxicology.

**Toxic kinetics:** Is the way the product enters, distributes, metabolises and eliminates in a living organism.

**Toxic dynamic:** Is the mechanism through which the product or its active principle enters in contact with the target organ (in which is going to develop its harmful effect).

**Exposition Phase:** Is that in which the product enters in contact with the live organism, through a route: the air, the water, the food or others, so in this phase can be known which was the entrance door: respiratory via, digestive via, by the skin or mucous. It is important to point that the most dangerous via is the respiratory, because is difficult to control, and because if it is about a volatile or similar, can enter and distribute rapidly in the blood circulation. This phase is fundamental in the preventive actions, once the kind of substance is known, its physic-chemical characteristics and its toxicity degree, can be recommended measures of personal protection (glasses, masks, gloves, boots, work equipment, etc.) turns and rotation of the groups in risk, hygiene and security measures.

**Phase toxic kinetics:** Starts from the entrance of the product to the organism until its elimination. Applying the solubility principles, kinship by the proteins, link formation, can help the elimination, accelerate the metabolism and degradation.

**Phase toxic dynamic:** Is more complex, since from the great number of products that exist, the spectrum of the known with respect to its action mechanism is reduced. In this phase the toxicologist acts with the symptomatic treatment, but in a more specific manner with the help of the antidotes, which are substances that antagonize, interfere and neutralize the toxic effect of the xenobiotics (substance or external agent that has entered to a live organism). Unfortunately, the development and availability of antidotes is very scarce, reason why the acting way in this phase is restricted to the symptomatic treatment.
Toxicity: Is the capacity that a product has to produce any organic or functional alteration and even death, when it is ingested, inhaled, absorbed or enters in contact with the skin, due to its physic-chemical properties.

Danger: Toxicity combination and exposition intensity. Without toxicity and exposition, there cannot be harm or risk. A very toxic product is harmless if there is no exposition. A product of very low toxicity could be harmful if there is high exposition.

Risk: Is the probability that a damage can be produced by the use of a product. The risk includes three components: danger, time and exposition probability. Security is the opposite to the risk.

Security: The security is determined by the risk. The risks capacity is higher when the exposition increases to a determined product, depending on the toxicological category of the plant sanitation, so that the security degree is higher or lower.

One of the ways of minimizing the risks before, during and after the application of a plant protection product is to reduce the exposition through the faithful fulfillment of the prevention measures, precaution and protection, besides of the use of the common sense. The grower of the left photography is more exposed to risk than the one on the right photography.

<table>
<thead>
<tr>
<th>RISK DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RISK = TOXICITY x EXPOSITION</td>
</tr>
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</table>

CropLife • International • Representing The Plant Science Industry
Independently of the danger and toxicity of a plant protection product, the prevention practices; reading the label and the pamphlet, reviewing the good state of the application equipment (backpack sprayer, thus the personal hygiene measures, as washing the hands and the face before eating, drink or smoking, to shower after each application activity and put on clean clothing, permits to minimize that intoxication risks may occur.
The red arrow indicates that in the measure that increases the danger of a plant protection product, also its toxicity increases; nevertheless, using the clothing and personal protection equipment recommended in the pictogramme, the risks of suffering an intoxication can be minimized (yellow arrow). It is convenient to insist that a product of very low toxicity badly managed may provoke intoxications, and to the inverse one of a very high toxicity correctly manipulated can avoid them. In some cases, according to the product the type of mask recommended may vary, reason why it is very important to read the label and the pamphlet.
BEFORE USING A PLANT PROTECTION PRODUCT.

Adoption of the IPM. The IPM adoption as a pest control technology, is a tool that permits to rationalize the use of plant protection products. The IPM as has been indicated previously includes: the monitoring of population growth of organisms which permits to identify the natural mortality factors inside the farming ecosystem, and determine the critic moments in which some of these organisms reach their pest condition. In this system of plant protection, an appropriate combination of selected control alternatives in which, the use of plant protection products results complementary and where these are used in a way that cause the minimum environmental, social, economic and ecologically impact.

Selection and purchase of the product. When the use of plant protection products results necessary, the identification of pest organism should be a previous step to the product selection.

Never try to control a pest organism that has not been fully identified.

The products that have the better ecotoxicological profile should be selected; those that represent less risk for the environment, the benevolent organisms, the users and the consumers. The strictly necessary should be bought to avoid leftovers and examine that there are original products, the container are correctly labelled and are not in bad condition (spilled, broken or dented) to avoid accidents; additionally it should be reviewed that they have the guarantee seal and ask for the respective pamphlet. It is also
convenient, to review the expiration date of the product, since expired products shouldn’t be bought. Then they must be transported separate of foods and people, in a safe package and perfectly placed to avoid its break and spill during the trip, store them out of the house in a high, safe, fresh and ventilated place separated of foods, people and animals.

**Read the label and the pamphlet.** Before using a plant protection product, it is necessary to read the label and pamphlet to know and comprehend the danger and toxicity of the product, the precautions and warnings of its use, the way the products should be stored and transported, the intoxication signs and symptoms, the kind of first aids that should be given in case of intoxication, the type of agricultural recommendations (way of action, way of mixture preparing, dosage, application intervals, deficiency periods, phytotoxicity, compatibility, etc.) and some type of environmental recommendations. (triple washed and elimination of empty containers).

![Image of a person using a pressure sprayer]

**DURING AND AFTER THE USE AND MANAGEMENT OF PLANT PROTECTION PRODUCTS**

It should be remembered that plant protection products were designed to perform a toxic action over the pest organisms and therefore, they can also result dangerous for people who manufacture, investigate, manage, manipulate, transport, distribute and apply these products, specially when they do it an unsafe way, without care and without taking the precautions that the case deserves. For this reason the security factor not only constitutes a precaution, but the responsibility of the many that are involved in this process.
The exposition risk to plant protection products in the field, is higher for people that prepare the phytosanitary mixture, since they work with the formulated product, much more concentrated, that in the mixture that is going to be applied in the field or greenhouse.

During the use and management of plant protection products and with the purpose of minimizing or reduce the risks to the user health and the environment, the following elements should be considered:

1. The label, the pamphlet and the container.
2. The protective clothing and the protection equipment.
3. The application equipment.
4. The precaution measures in the management and application or plant protection products.
5. The intoxication signs and symptoms and emergency measures of first aid.

The importance of rereading the label and the pamphlet before using the product. In a previous section it is explained the importance of reading these legal documents to be in the capacity to manage and use in a correct way the plant protection products. Never use a product without having consciousness over the risks that its use involves, thus for the user, the consumer and the environment.

Review and correct management of the containers. It is convenient to review the state of the product containers, subdued products or of a doubtful origin should not be used, by the dangers that this implicates. Information as how to manage correctly the empty containers will be commented on later.

Use protective clothing and personal protection equipment. Thus in the label as in the pamphlet appear the recommendations about the kind of protective clothing and personal protection equipment that must be used. These recommendations should be respected. The components of the protective clothing and of the personal protection equipment are the following:

Overalls: The overalls are the ones that give basic protection to the user. There are cloth and plastic overalls. As well the shellacking, not perforated and confectioned in a base of polyethylene or chloride of polyvinyl, are effectively more resistant to the penetration of organic solvents, are also uncomfortable specially in warm climate. Therefore it is recommended to use in these circumstances washable clothing overalls and long sleeve to cover the arms. The pants sleeves should be placed over the boots to prevent spilling or splatter in them. The shirt sleeve must be placed on top of the gloves neck. The use of overalls is an exigency for all that formulate, use, mix, apply, manage and manipulate plant protection products.
Aprons: The mixers, loaders, applicators, etcetera of plant protection products in aerial and terrestrial applications must use an apron as complementary protection. Only the material or proof of organic solvents will be acquired, as for example nylon recovered of PVC, nitrile or neoprene. The use of textiles should be avoided.

Boots: The rubber boots smooth, not lined and tested against liquids, must be a fundamental part of the clothes of mixers, loaders and applicators, since these have to walk often over spilled products. It must be remembered that the leather boots absorb the plant sanitary products, reason why they must be avoided.

Gloves: The gloves constitute the essential protection for mixers, loaders, applicators, mechanics and equipment operators for terrestrial applications. The best are the synthetic gloves of flexible rubber, not lined and made of nitrile and neoprene or viton. These gloves have showed to be effectively resistant to the majority of the solvents used in formulations of plant protection products. The gloves must resist also the mechanic damages.

We have to remember that the gloves lined with cloth, thus the leather gloves, absorb these products, representing a dangerous and constant fountain of contamination. It is impossible to decontaminate completely those materials, reason why, they should not be used in applications of these substances.

Hat of wide wing or cap: All people that apply plant protection products need to protect their head, as for example the operator who could be exposed to the sprinkling mist produced by his backpack pump, or by the tractor that realizes the applications in fruits.

Facial protection: During the operations of mixture and loaded of plant protection products, the operator must protect his eyes and his face of eventually spilled or splashes. This is obtained by using a PVC facial shield that covers all frontal part of the head. The air circulation between the shield and the face is adequate and its use is comfortable even in very warm climates.

Respiratory protection: The application of aerosols and powder formulations require protection of the mouth, nose and lungs with a facial mask or respiratory mask, approved by the use of these products, specially when they are achieved in closed environments.

The protection of the respiratory via is an obligation in all cases where small particles are produced, as in the use of highly concentrated products applied by equipment of ultra low volume, or in aerosol generators used in public health or in plant protection products.
The tractor drivers that constantly accomplish sprinklings and fine mist for propagation in fruit crops, producing thus mist, they must be well protected against skin and respiratory contaminations using a mask that provides them filtered air.

The people that manage products with high pressure steam should also use a respiratory mask, the steam could produce dangerous concentrations of toxic gases in plant protection products storage places.

**TYPES OF PROTECTION SUITS**
Maintenance of the protective clothing and personal protection equipment. The maintenance of protective clothing and personal protection equipment is very important, since it is obvious, that only the clothing and the protective equipment, well conserved, offer the proper protection.

Each time that gloves and rubber boots are used, as the shellacking aprons, these must be washed inside and outside with water and soap. Examine them regularly to detect eventual fails. The same can be done with the components for the facial protection and for the frontal part of the respiratory mask.

The fabric overalls must be washed in a habitual manner but without mixing them with the rest of the family’s clothing and it is necessary to wash them after each use. After the components of the protective clothing and the personal protection equipment are washed and dried, they must be stored in a clean and dry place, far from the plant protection products and of the application equipments. The respiratory masks that has been cleaned will be preferable placed in plastic sealed bags.

It is convenient to remind that the use of protective clothing and the personal protection equipment, is always recommended and an emphasis is made only at the moment of accomplishing the application, but it is forgotten to recommend its use, during the storage, during the process of accomplishing the mixture, which is the time where the exposition degree is higher, by being working with a commercial product in a direct form.

For small farmers, where the equipment cost is a limitation for its use, at the moment of doing and applying the mixture of plant protection products, the use of alternative clothing is recommended, which would be designed in workshop # 4 “The protective clothing and personal protection equipment: Design, use and correct management”.

Review and calibrate the application equipment. In the label and the pamphlet of the plant protection product appear the technical criteria that permit to select the more adequate application equipment, using protective clothing and the personal protection equipment, we must proceed to review the application equipment which should fulfill with required requisites for the documents mentioned and be in good management conditions. Never use damaged equipment (with leaks or dripping), since that represents a danger and risk for the operator. After the equipment review, this must be calibrated (to deep in the aspects related to equipment calibration, it is convenient to refer to Chapter 06 “Technology and Application Equipment”).

Dose and mix plant protection products. The dose is one of the factors where the majority of growers fail in the product application for plant protection is presented. This is intimately linked to the equipment calibration. The term dose expresses the quantity of commercial product or of active ingredient that would be applied in a given area by surface without being worth the water volume to be used and is expressed in dosage by surface unit (Ex: l/ha, kg/ha, lbs/mz) or by concentration, depending on the water volume to be used and can be expressed in percentage terms (ex. 5%, 10%, etcetera). In
general terms and to achieve the correct use and management of plant protection products, should count with the clothing and personal protection equipment, the recommended dosage given by the manufacturer and that appear in the respective label and pamphlet should be respected, and so avoid problems of sub or overdose and other associated problems as the appearance of pest resistance, phytotoxicity in the crops, environmental damage, and farmers economical loss. At the moment of doing the product mixture, the relative to its compatibility and miscibility should be considered.

At the moment of dosage application, empty, pour and mix the concentrated product, containers, and adequate equipment should be used to measure, transfer and mix the products. Never use bare hands to mix or move the products. Also should be avoided the splatters and spills over the skin and the protective clothing. In case that it might occur, remove the contaminated clothes and wash immediately the affected area with plenty water and soap, the same should be done with the contaminated clothes.

Accomplish mixtures in free air, in a well ventilated and illuminated place, keep the animals and people out of the working area, to avoid spills, replace the covers and close the containers as soon as the dosage has been measured or the quantity to be used.
**Applying the plant protection product.** Once the mixture is prepared in the application equipment and with the clothing and personal protection equipment already dressed, review the area where the application will be done, move people and animals that are eventually inside the area and proceed to the application.

It is convenient to consider the wind direction and to apply with its help. Avoid to get in contact with the dew, or touching the leaves and plants recently sprayed. If during the application, wind blows between moderate and strong, the activity should be suspended at once. Clean the nozzles correctly when they are obstructed, use water and wood splinter or a grass straw. Avoid its cleanliness blowing with the mouth or well using a nail or wire.

Other important warnings are: Do not eat, drink or smoke, while plant protection products are being manipulated and used, do not touch with dirty gloves, the face or any other region of the skin. If there are leftovers of the mixture, should be eliminated in the edges of the treated lot, until pouring the tank of the application equipment totally the hoses or nozzles. The period of reentry to the treated area should be respected.
Clean the application equipment. Finished the application of the product mixture, and with the clothing and the personal protection equipment dressed, should be proceeded to clean the application equipment. It is necessary to clean it inside and outside and pay special care in giving maintenance and reparation to those pieces or parts that are damaged. Finally eliminate correctly the empty containers and the contaminated waters. The clean equipment should be stored correctly.

Manage and eliminate correctly the empty containers. As a fundamental recommendation, even the last drop or particle of plant protection product, should be used in the sprinkling, and thus clean the container in the appropriate way. Unfortunately in the practice, certain amount of the product remains impregnated in the containers. This quantity product has an economic value that should not be wasted, at the same time, that product remainder, constitutes an environmental risk and possibility of intoxications if they are used to store water or food.

The triple washing of empty containers constitutes the correct manner to manage the containers. To accomplish it, the clothing and personal protection equipment should be used. Once the container content is finished, the following procedure should be done:

1. Immediately, add to the container an equal or superior water volume to a quarter of its capacity, for example: to a container of 20 liters, add 5 liters of water. Close the container lid, well tighten, to avoid the liquid spills during the agitation.

2. Shake well the container, as much vertical as horizontal way, during 30 seconds approximately to remove the product residuals that have adhered in the internal walls.

3. Uncover the container and pour with care the total content in the tank of the sprinkler.
Repeat the procedure until completing the TRIPLE WASHING of the container. Once finished apply on the field the sprayer pump (sprinkler) content. The triple washed containers should be perforated and eliminated correctly.

With containers of 50, 100 or 200 liters, add an adequate volume of water for the wash, place the lid and wheel them during 30 seconds approximately, taking care that the container is closed correctly. To complete the agitation, elevate alternately the container extremes during 30 seconds approximately.

Pour the wash residuals in the tank of the sprinkler, the same way that was indicated for the wash of the small containers. Have in mind that the triple washing must be accomplished with plastic containers, metallic and other type of material. The triple washing should be achieved immediately after the container content is finished and during the application, to have the opportunity of using the washed liquid in the application.

**REMEMBER TO ALWAYS USE PROTECTIVE CLOTHING AND PERSONAL PROTECTION EQUIPMENT AS SHOWN IN THE FIGURE**
Eliminate the empty containers once the triple washing has been done. Depending on the containers quantity, its individual capacity and the manufactured material (paper, plastic, metal), the final destiny of empty containers should be:

1. Elimination in the same field.
2. Industrial recycling.
3. Recycle under certain standards (depending of the country)

The user must be informed by the supplier about the in force norms related to empty plant protection products containers, and about the risks of improper use.

1. **ELIMINATION IN THE SAME FIELD**
Is the procedure for small farmers to follow, whose containers quantity is not representative and/or where there is no adequate recollection and gathering system.

The recommended system to destroy empty plant protection products containers, depends on the type of material; its final destiny is the triple washing, make useless and bury. It should be kept in mind, that the place for such purpose, should not represent any contamination risks for water fountains (irrigation ditches, channels, rivers, etc.) and be far away from housing.

2. INDUSTRIAL RECYCLE

Is the utilization of the empty containers as raw material in the manufacturing or certain products or as fountain of energy recuperation upon being incinerated. The use of the manufactured product, is ruled in many countries, not permitting in any case, to be used as implement of human use. The incinerated containers are eliminated under environmental acceptable standards.

3. REUTILIZATION UNDER CERTAIN STANDARDS

The empty containers of plant protection products must NOT be destined for domestic use. Metallic tanks of 200 liters can be used for garbage recollection, previous perforation, as ducts for agricultural watering, for fuel transportation, as energy fountain or for certain economic viable uses and reasonably safe for health and the environment.

Some local enterprises buy the empty containers to reuse them. To be acquired, the containers should submitted to the triple washing and be in good conditions. Consult with the distributor enterprises to obtain adequate information.

THE ELIMINATION PROGRAMMES FOR EMPTY CONTAINERS OF THE INDUSTRY OF CROP PROTECTION

The general objective of these programmes pursue to recover energy from plastic residue and for its fulfillment, the empty containers are subject of the triple washing, taken to collect centres, places where they are processed, and later sent to the place where they will be used for the thermic reuse.

Although the basic condition for recollection campaigns consist in accomplishing the triple washing, CropLife Latin America, dissuades not to recycle plastic material. The methods to reuse this type of containers, must be very strict, and that increases considerably the costs. From the point of view of security, as for economic reasons, its elimination in concrete ovens is recommended. This system, besides being the safest and more economic to use in high temperatures, permits to take advantage of the plastic containers as alternate fuel inside the same cement factories.
The container elimination program, carries a double purpose: The elimination of contaminating substances in the environment and at the same time the use of energy as alternative fuel, if it is not employed as such, it would be loss. Reliable studies made together with cement enterprises, have demonstrated that the plastic incineration in high temperatures, generates no emanation of toxic gases, such as dioxines or furanes.

Several countries of Latin America have initiated and strenghthened of their programmes for container elimination (Mexico, Guatemala, Brasil, Argentina, El Salvador, Dominican Republic, Venezuela, Costa Rica, Ecuador and Chile). The promoting function of these programmes in each country, is assumed by their respective Associated Industry. This, together, works in close coordination with the different national, regional and zone agricultural dependency. In some countries, it is counted with the collaboration of no governmental organizations that, in one way or another, have interest to support security measures that benefits the environment.

In order to obtain the desired outcome through the respective programmes, the intervention of the agrochemical network distribution is indispensable, which groups distributors, cooperatives or associations, between others. These entities are the primary collectors. From these, the containers are collected and distributed to the collection centres. In each of them, there is enough infrastructure, as to compact the containers in bundles. They can be also triturated in adequate particles to use them thermically in the cement factories. The role of the cement factories in this process is of vital importance.
MINICENTRES OF CROP PROTECTION PRODUCTS
EMPTY CONTAINERS RECOLLECTION TRIPLE WASHED AND USELESS
COLLECT CENTRES OF PLANT PROTECTION PRODUCTS EMPTY CONTAINERS
**Personal Hygiene:** Concluded the previous activities, it is necessary that the user takes off in a safe way the clothing and personal protection equipment contaminated, for its pre-wash or wash; this clothing as indicated previously must be washed separately from the rest of the family’s clothes. Then the farmer must shower, with plenty of water and soap, and dress with clean cloth. He must wash his face and his hands, before drinking, smoking or eating.

**Suggestions to wash the clothing after applying plant protection products.** To continue a developed list by the Illinois University and the Nebraska University is described, that explains how to wash and to decontaminate appropriately the protective clothing used with plant protection products.

1. Read the product label. Even though the label recommendations can vary in the foreseen details for the wash, this is a good point of departure. Thus it is important to remember that to remove the products do not depend on the toxicity, but of the solubility of the water formulation.

2. Always use protection when managing contaminated clothes with plant protection products.

3. Clothing that has been saturated with a high concentrated product must be eliminated in the same way as the empty containers (it is considered waste).

4. Wash the clothing daily when applications with plant protection products are accomplished. It is convenient to remember that many investigations have proved that it is much easier to remove the plant protection products daily than to remove them when they are been accumulated.

5. Wash the plant protection products contaminated clothing separately from the clothing that is not. This product residuals can transfer from the contaminated cloth to the ones that are not, during the wash.

6. Always pre-wash the contaminated clothing. This can be done soaking the clothes in an adequate container spraying it with a hose. The pre-wash is specially effective to take off particles when powders are use.

7. Wash only a few contaminated clothes using enough water each time.

8. Use warm or hot water. Cold water is not effective to remove the products during the wash cycle. Wash two or three times the contaminated clothing.

9. Clean the washing sink after using it with contaminated clothing.

10. Dry the washed clothing in the sun.

Remember how convenient it results to use some way of protection equipment, as plastic bags to protect the hands while clothing and personal protection equipment is being washed.
Management of drain residuals. The water residuals from washed clothing and personal protection and application equipment, should not be poured in any place close to the house or close to water fountains. Contaminated water must go to a hole or a ditch far from the house, avoiding to contaminate other sites. This way, it is contributed to the adequate management of the environment.

Transportation of plant protection products. The plant protection products can be dangerous products if they are not carefully manage in every moment. When these products are not transported in a safe way, they can represent danger for:

- The people who transport them.
- For the environment.
- For all people in general.

When these products are going to be transported, from the purchase store up to the farm or ranch, the following must be considered:

- Ask the warehouse keeper for a safe packing.
- Suit correctly the plant protection products, inside a box, to avoid that the containers may be broken during the trip, specially for liquid formulations. If various types of product containers are bought, place them inside a box, the liquids with the cover upwards and over them, those that come in powder or granules, separating them with a piece of cardboard.
- Separate them from people, humans or animal food, domestic ware and medicines.

1. At the moment of boarding the vehicle. The safest manner of transporting these products, is in a vehicle that does no carries other merchandise or passengers, but if they have to be transported in public vehicles, the following instructions must be followed:

- Handle with care the box where the products are carried, avoid throwing it during the loading and unloading to prevent breaking the containers and other containers. Place them on the vehicles floor.
- Place it in a low place inside the vehicle and far from food, medicines, animals food and clothing.
- Do not put heavy objects over the plant protection products packages to avoid damaging the containers.
- Observe that the floor where the box is going to be placed, is dry and does not have stitches or any other type of salient that might break the box or the containers.
During the trip, be pending of the transported products. Warn the driver and the other passengers about the contents of the piece of luggage.

- If plant protection products have to be transported in bicycle or load animals, a safe box must be used, with keys, to put and maintain them isolated.

2. **At the moment of unloading the plant protection products.**

- Unload them carefully, without throwing them. Check if during the trip any container was damaged or if there was any spill.

- Once in the farm assure that all containers arrived in good condition, store them immediately in a safe place while the moment of applying them arrives, preferably lock them and out of the reach of children or alien people to the use of these products. The site must be dry and well ventilated.

3. **What to do in case of accident during the transport.** If during the transport any spill is presented, the following precautions should be taken:

- Move away other passengers that travel in the vehicle and specially the ones that are close.

- Protect yourself before gathering the spill. Use earth, sand or any absorbent material, use rubber gloves, rubber boots and an impermeable apron. If you do not have security elements, use plastic bags to cover hands, also do an apron and cover the footwear.

- Remember that these plastics must be managed as any other contaminated material.

- Cover the spilled product with earth or sand to absorb it and then pick it up in a thick plastic bag.

- This bag and the broken containers must be buried in a place where there is no possibility to contaminate water fountains.

- The vehicle must be well washed. It must take care of not throwing contaminated water or products, in the drains, culverts, rivers and other water fountains. The used water, the sand or earth should be picked up again and manage it as indicated in the previous paragraphs.

- Eliminate in a safe way everything that has been contaminated by plant protection products: clothes, food, animals food, etcetera.

Remember never to use objects or consume food that have been contaminated with plant protection products, it could be fatal.
If someone splashes the skin with plant protection products, he or she must wash immediately with abundant water and soap.

If a spill of product occurs over the clothing; this contaminated clothing should be taken off immediately and take a general bath, with water and soap.

4. **Transportation from the storage place of plant protection products up to the application place.** Take off the plant protection products from the places where are usually stored, only when they are going to be used. Load them in a cardboard box. Count with a destined box only for this purpose. Handle them with care so they don’t break or spill. Always review that containers are not broken and are well closed.

5. **Upon storing:** Keep them in their original containers, separated from other merchandise and locked, out of the reach of children, out of the sleeping rooms and in a fresh place, safe and well ventilated. While the products is not been used, keep the container well closed.

**Urgent measures and first aid in case of an intoxication.** The urgent measures and first aid in case of an intoxication, are studied in workshop 03. “Intoxications”: Signs and symptoms of intoxication. First Aid.
WORKSHOP 04. CLOTHING DESIGN AND PERSONAL PROTECTION EQUIPMENT.

INTRODUCTION:
In this workshop the participants would know about different kinds of protective cloth and personal protection equipment, and its safe use. They would also learn to design and manufacture clothing and alternative equipment.

WORKSHOP OBJECTIVES:
That the participant:

- Know about the components of protective cloth and personal protection equipment.

- Learn how to use those components in a safe manner.

- Know about different alternatives of protective cloth and protection equipment.

- Design and manufacture some clothing components and alternative equipment.

REQUIRED MATERIAL:
- Different types of protective clothing and personal protection equipment.

REQUIRED TIME:
Half hour.

METODOLOGY:

STEP # 1 PRESENTATION AND DEMONSTRATION. THE CLOTHING AND THE PERSONAL PROTECTION EQUIPMENT: SAFE WAY TO DRESS AND UNDRESS.

To reduce the intoxication risks, besides the used precautions and measures of personal hygiene described previously, the use of clothing and personal protection equipment is recommended. The basic components of clothing and personal protection equipment includes:

- Long sleeve shirt and long pants, both should lack of pockets.

- Rubber gloves without lining

- Rubber boots without lining

- Wide wing hat;
- Water proof apron
- Sunglasses or protective mask for the face.
- Mask and/or respirators with filters when products high or extremely dangerous are going to be used.

For the instructor: Provide of different kinds of suits, protection equipment and show them to the participants, so they can see and analyse them. Answer their questions. Ask someone to dress with them and explain the safe way of putting on the suit and the equipments. Explain the safe way to remove it.

STEP #2. PRESENTATION AND DEMOSTRATION: EQUIPMENT AND PROTECTIVE CLOTHING DESIGN.

Explain that a good number of farmers do not use all the clothing and the personal protection equipment for different reasons; some argue discomfort; others the high cost of the components, and also exist those that ignore its importance. The truth is that there does not exist cheap clothing and protection equipment, flexible, easy to use, and that at the same time provides complete protection. Nevertheless, there are alternatives for people of limited resources, that can be manufactured depending on the characteristics of each country and that offer an acceptable degree of protection. It is convenient to indicate, that the clothing and the inadequate protection equipment or the negligence in its maintenance and wash can increase the risks instead of diminishing them. In the enclosed material, some designs to elaborate clothing and some protection equipment are proportioned.

For the instructor: Make demonstrations about the way to manufacture clothing and protective equipment with local resources.
TWO PIECE PROTECTIVE SUIT

(All dimensions in centimeters)
ONE PIECE SUIT

(All dimensions in centimeters)

ALL EDGES FOLDED AND JOINT BY HEAT

SHOULDER JOINT OF DOUBLE THICKNESS AND JOINT BY HEAT

ALL CORDS OF DOUBLE THICKNESS FOLDED AND JOINT BY HEAT
PROTECTIVE MASK

(All dimensions in centimeters)

FLXIBLE ACETATE
(FRONT)

ROUNDEND EXTREME

*SPONGE
ALTERNATIVE CLOTHES

This kind of cloth and protection equipment is of low price and some of the garments can be manufactured by the same farmer and/or housewife with easy acquired resources.

MATERIALS

- Cap or hat
- Long sleeve shirt
- Plastic bags or gloves
- Pants
- Boots
- Plastic apron (It can be done using a meter of plastic)
- Mask (It can be done using a plastic bottle)
- Two meters of plastic rope or strap
- Adhesive tape
- Scissors
- Jackknife / knife
- Marker
- Meter (Ruler)
- Rubber bands
STEPS TO MANUFACTURE A PLASTIC APRON.

REQUIRED MATERIALS: Scissors, marker, meter, rubber bands, adhesive tape, a meter of thick nylon.

Step # 1: Cut the meter of nylon in one of the extremes, as shown in the photograph.
Step #2: Fold the meter of nylon in half. Mark in the corner of the fold with a marker a ratio of 10.5 centimeters to make the neck hole in the apron, observe the photograph.

Step #3. With the scissor cut the mark in the fold to make the hole for the neck. Extend the apron and would remain a similar to the figure on page 188 of this manual.
Step # 4. Make a cut of 2 centimeters long, in a localized point at 70 centimeters from the inferior extreme of the apron and 4 centimeters of the closest edge. As shown in the photograph. Repeat the same operation in the opposite side.

Step # 5. Using adhesive tape reinforce the surrounding areas to the place where the described cuts in previous step were done to get a long lasting apron.
Step # 6. Cross an plastic rope or strap of 2 meters long by the cuttings previously done, this will permit you to fasten the apron to the waistline.

Step # 7. **Congratulations!** You have made your own a protective apron.
PROCEDURE TO MANUFACTURE
A PROTECTIVE MASK

Step #1 Use a discardable plastic bottle of 2 liters, using 2 rubber bands as a guide and a marker to delineate the places where the cuts are going to be done to eliminate the tip and the bottle base. The photograph illustrates the procedure.
Step # 2. Using a cutting tool, make a hole where the respective cuts should initiate. Observe the photograph for a better comprehension.

Step # 3. Cut the tip and the bottle base, leaving the cylinder that forms the central part.

Step # 4. Proceed to cut the cylinder as shown in the photograph. The clearest and more transparent part should remain intact, since it is going to be used in the front the face.
Step # 5. Adjust the plastic lamina obtained at your face size in order to be able to cut the excess. Observe the photograph.

Step # 6. Cut the plastic lamina excess, as shown in the photograph.
Step # 7. With a cutting tool, make two lateral holes in the plastic mask. These holes would be used to place the plastic rope or strap that would permit you to fasten the mask to your head.

Step # 8. Cover the mask edges with adhesive tape to avoid being injured by the plastic edges when placing the mask over your face. Observe the photograph. Other alternative could be to refine the edges.
Step # 5. Congratulations! You can now wear your mask with a hat.

Step # 6. Very Well! If you made a cut of 20 centimeters long in the upper part of the mask, this can also be used with a cap.
CHAPTER 6
SPRAYING EQUIPMENT AND TECHNOLOGY
CHAPTER SIX

SPRAYING EQUIPMENT AND TECHNOLOGY

SPECIFIC OBJECTIVES:

The participants should:

- Acquire the concepts of the biological objective and the efficiency of its use.
- Classify the formulas of the products in order to protect the crops according to the method used.
- Point out the characteristics of these objectives and define the advantages and disadvantages of their use.
- Understand how important the density (coverage) and size of the drops is, to obtain a successful employment.
- Learn a method that will allow to monitor and count the drops
- Know the different kinds of equipment for the employment of products that protect the crops.
- Learn to repair and maintain a backpack sprayer.
- Classify and select the different types of hydraulic nozzles and their filters according to the product for the protection of the crops that will be treated.
- Calibrate and measure the dose of at least one backpack sprayer.

METHODOLOGY:

First a short talk will take place to explain all the theoretical concepts for the development of the practical area.

Simultaneously the group of participants will discuss their experiences and the problems they have observed in the use of products that protect crops in the field. They will analyse the situations that have been successful or that have failed, establishing the causes. The group will be divided into subgroups to perform a supervised practice. Each subgroup will have 8 participants at the most.

Finally a supervised practice that involves three stages will take place.

The first stage will be the presentation of the different kinds of equipment used on land, specially manual sprayers of the backpack type. They will be taken apart and put together again to learn about their use and maintenance; to know their components and discuss the benefits and disadvantages of each one. Other accessories, that can be added to the sprayers will be introduced to obtain better results with their use.

In the second stage a theoretical and practical description will be made of the different types of hydraulic energy nozzles, their durability, maintenance and care. A
demonstration will be given of the nozzles being used under different pressures, and heights to determine the discharge and effect on the size of the coverage and the effects according to the size of the opening, the size of the drops and drift. This second stage will conclude with the making of a catalogue of nozzles by the participants, in which they will make a classification according to the name, use, spraying angle and discharge.

Third stage, this stage will be for the calibration of the equipment and dosage of the product. For this they will use the guide entitled “Supervised Practice of Calibration and Dosage of the Equipment”, which appears at the end of the Chapter.

**TIME REQUIRED:**

Eight hours (theory in 4 hours and supervised practice in 4 hours).

**MATERIALS REQUIRED:**

Each subgroup must have the following materials:

- Protection Clothes and complete personal protection equipment.
- Spraying Equipment (Backpack Sprayer).
- A complete set of nozzles and filters
- A bucket for water.
- Plastic measuring liters.
- Complete set of tools (screwdrivers, pliers, a wrench, wire and Teflon)
- Measuring Tape
- Water - sensible Paper
- Notebook
- Markers
- Simulation supplies for mixing or spraying.

**DOCUMENT FOR THE STUDY:**

**SPRAYING EQUIPMENT AND TECHNOLOGY**

**INTRODUCTION:**

The technology that uses spraying products for the protection of crops includes all the scientific knowledge that will allow the correct use of the active biological product on the objective, in the amount needed, in an economical manner and with the minimal environmental impact to the areas not treated.

The objective of the application of the plant protection products is to obtain the maximum biological effect: with herbicides against weeds, with insecticides against
harmful insects; with fungicides against fungal diseases, etc. The plant protection products constitute a technology that has been invented and designed by man and has the capacity to protect the amount and quality of the harvest, controlling the pest that affect them, if they are used correctly.

According to previous studies, a series of undesired effects are caused when used incorrectly. Therefore it is important to use and handle them properly in order to reduce the costs originated by the need for more products to protect the crops, the extra energy and labor; as well as the environmental costs related to the contamination of the land, water, air and other organisms.

Success in the chemical control of pest depends not only on the products that protect the corps, but on other factors just as important that need to be considered in order protect the users, the consumers, the environment and avoid putting the investment at risk.

Generally there are three fundamental factors that define the success or failure of each activity and they are: the quality of the products used to protect the crops, the perfect moment of application and the quality. This study focuses on these and other factors.

THE BIOLOGICAL OBJECTIVE AND THE EFFICIENCY OF THE APPLICATION.

The Biological Objective. The main purpose of each application made for the protection of the crops is to obtain the maximum biological effect: with herbicides against weeds, insecticides against harmful bugs, fungicides against fungal deceases, etc. Any products that does not fulfill this objective (against insects, weed, fungus, mites, etc), will not be efficient and therefore will constitute a loss.

In order to define the exact objective we want to control, it is necessary to consider the biology of the organisms that causes the plague; its behavior, eating habits as well as the development of the plant that will be protected and the part of the plant that the organism is eating or affecting (Photograph 6.1) If our objective is not well defined we will have an inevitable loss of product because we will be spraying parts that are not directly related with the control.

Product Application Efficiency for Crop Protection. An effective control with products that protect the crops also concerns distribution. Precise and effective spraying means to apply the mix on the treated surface in such a way that a uniform application is obtained (Photograph 6.2). The efficiency of the application can be defined as the relation between the dose theoretically obtained and the actual effective dose used. This can generally be represented in percentages as follows:

\[
\text{Application Efficiency (\%)} = \frac{\text{theoretically required dose}}{\text{actual dose used}} \times 100
\]
One of the most efficient technological procedures invented by man is the application of products that protect the crops. And this can be improved in several ways by the capacity of the sprayers, the development of more efficient technology and spraying equipment.
CLASSIFICATION OF THE FORMULAS ACCORDING TO THE APPLICATION METHOD.

The formulas for plant protection products can be classified according to their application method. This is summarized on Chart 6.1. The general characteristics of the formulas can be reviewed on Chapter 3 of this manual.

<table>
<thead>
<tr>
<th>CLASSIFICATION CRITERION</th>
<th>NAME OF THE FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spraying Products</td>
<td>Emulsifying Concentrate</td>
</tr>
<tr>
<td></td>
<td>Soluble Concentrate</td>
</tr>
<tr>
<td></td>
<td>Oil in Water Emulsion</td>
</tr>
<tr>
<td></td>
<td>Water in Oil Emulsion</td>
</tr>
<tr>
<td></td>
<td>Dispersing Granules</td>
</tr>
<tr>
<td></td>
<td>Soluble Granules</td>
</tr>
<tr>
<td></td>
<td>Watering Powder</td>
</tr>
<tr>
<td></td>
<td>Soluble Powder</td>
</tr>
<tr>
<td></td>
<td>ULV Products</td>
</tr>
<tr>
<td></td>
<td>Concentrated Suspension</td>
</tr>
<tr>
<td></td>
<td>Suspension in capsules</td>
</tr>
<tr>
<td>Seed Treating Products</td>
<td>Seed disinfectant with water</td>
</tr>
<tr>
<td></td>
<td>Powdered seed disinfectant with water</td>
</tr>
<tr>
<td></td>
<td>Powder for a seed disinfectant in pap</td>
</tr>
<tr>
<td></td>
<td>Powder for dry treatment of seeds</td>
</tr>
<tr>
<td></td>
<td>Concentrate Suspension for the treatment seed with water</td>
</tr>
<tr>
<td>Soil Treating Products</td>
<td>Granules</td>
</tr>
<tr>
<td></td>
<td>Smoke Granules</td>
</tr>
<tr>
<td></td>
<td>Sprinkling Powder</td>
</tr>
</tbody>
</table>

CHART 6.1 Classification of Formulas According to their Application Method

APPLICATION METHOD OF PLANT PROTECTION PRODUCTS

The application methods currently used can be classified as follows: those used in solid form, in liquid form and in gas form, according to the physical status of the material being used. For a long period of time, the most predominant method has been the one that uses water as a solvent. Nevertheless when water is hard to obtain and transport, it may be necessary to use other methods of application in liquid but without water or by using the solid forms. The application in gas form is very restricted due to the difficulties associated to the procedure.
**Applications in Solid Form:** One of the main advantages in solid form is that water is not needed and the user does not have to dissolve anything. The formulas for these applications are ready to be used. This means that their concentration is correct and ready to be used in the field.

Nevertheless, the transportation of great amounts of inert solid material, may substantially increase the cost per unite of the active ingredient. Depending on the grading of the material, the application in solid form can be done in two ways: by the application of powder (sprinkling) or by dispersing the granules.

**Application of Solid Materials:** The application of powder known as sprinkling, consists of using a dry powder formula (DP). This method is not used very much because it has several disadvantages we will discuss as follows.

The dry powder is formed by very fine particles that are easily blown away by the wind, especially when the ground is hot and ascending wind currents are formed. The transportation of particles by the wind can frequently cause the contamination of other environments far away. For this reason the dry powder applications must take place during the cool morning hours or when the sun is setting and the ascending wind currents are gone.

Another disadvantage of the dry powder is their little adhesion capacity to the treated surfaces, and they are easily removed by the wind or rain.

The lack of homogeneity in the distribution of the active ingredient in the inert materials used in the formulas is another disadvantage. In this type of formulas only a few particles of the inert materials transport the active material. Therefore when being sprinkled it is unevenly distributed in the treated area. To compensate this problem a greater dose (10 to 40/kg.ha) is recommended.

Among the advantages of this method is the high operational capacity (ha/h) of the sprinkling machines which allow the treatment of great extensions of land. Also the direct access of the machine to the furrows, causes less harm to the crops.

**Application of Granules.** The application of granules can be done with a relatively simple equipment and this makes the method very acceptable for the users. Some of the advantages offered by this method are the following:
- It is a very safe method and the risks for the user are reduced because the active ingredient is within the solid particle that is heavy enough to resist the action of the wind during its application. When its formula is adequate there will be no dust.

- The active ingredients, highly volatile, can be slowly liberated. This characteristic of the capsulated granules, depending on the inert material used in the formula, the liberation of the active ingredient can be controlled in such a way that the residual action can be extended.

- The solid particles are heavier and can be sprinkled with more precision on the treated surface (ground or leaves).

- Because of the size of the particles, the distribution the active ingredient can be more precise.

- There is a lower risk of the drifting factor.

- The operating capacity with this application method is greater due to the small amount needed and that it does not have to be dissolved. The dose of granules is recommended according to the area (kg/ha); the length of the furrow (g/m of furrow) or per plant (g/plant). The dose according to the area is of 10/40 kg/ha.

- The calibration is easier and more exact.

**Application in liquid form:** In this application method called pulverization, the formula is diluted in a liquid. Water is mostly used and the main formulas are: Emulsion Concentrate (EC) Soluble Concentrate (SL) Dispersing Granules (WG), Soluble Granules (SG), Wetting Power (WP) Soluble Powder (SP) Suspension Concentrate (SC) and Capsulated Suspension (CS).

The name of the solvent and the formula is called mix which has the adequate concentration for the applications. Sometimes the application is done without diluting the formula in which case the application should be extremely low.

Other methods of application in liquid form are: showers (irrigation or injection) and a mist that almost forms fog (nebulize).

The density of the liquid particles on the objective is much higher than with the power and so is its adhesiveness, therefore the recommended dose is very low. There are several kinds of equipment for this application method which can also be adapted to different situations. The various formulas that exist are well developed to be mixed with water.
Diluents for the Liquid Form Application. The diluents are all the materials that are added to the formula with the purpose of increasing the amount and allowing its distribution.

The most commonly used dilutor is water because it is easy to obtain and at a low price because there are a great variety of compatible formulas. (As a rule, the cost of water is very low at its fountain, nevertheless, its price in the fields must be considered.)

There are two limitation with water as a dilutor:

a) **Superficial Tension:** Water has superficial tension. This is what makes the drops on the surface to remain with the shape of a sphere, causing it to have little contact with the surface. To avoid this problem we can add a tension active agent that will lessen the superficial tension. With this the drops will easily spread over the surface, wetting greater areas. Some additives which are part of the formula acting as wetting agents, emulsifiers, etc, are tension active agents and their presence in the formulas of the mixtures are sufficient to lessen the superficial tension of the water to the desired levels. On other occasion there will be a need to add this tension active agents that are currently known as adhesive spreaders or adherents.

b) **Evaporation:** The surface of the liquid is greatly increased when it is fragmented into small drops and looses the volatile portion of its surface. Water is a volatile liquid and can evaporate from the exit of the discharging hole to the objective.

The tropical conditions, the high temperatures, the evaporation phenomenon of the sprayed drops is a real problem and it becomes more serious on the dry days. Applications of middle and small size drops sometimes will not reach their objective because the will disappear during the trajectory.

The problem of evaporation keeps the water from dividing into fine drops, especially in tropical climates. For this reason, when we use a mixture with a base of water, the volume of application per hectare must be relatively large. When we want to apply small quantities (for example: below 50 l/ha) and it will be necessary to control the evaporation of water and then use another dilutor that is not so volatile.

The water evaporation phenomenon seems to be disregarded by the farmers. This is the reason why most the traditional application use big drops and the nozzle of the pump is close enough to the objective, so that this phenomenon will not affect the biological outcome of the plant protection product.

Nevertheless, when fine drops are used to travel short distances until they are finally deposited (application by plane or pipes on land), the phenomenon of evaporation becomes perceptible, and negatively influences the result of the application.
With any application form, a considerable amount of drops that evaporate, leave an active ingredient floating in the air and are transported to undesired environments, causing contamination.

When we use applications with small drops, water is not the most appropriate dilutor. For these cases we can use liquids that are not volatile. The forma of UBV is not volatile for immediate use and can be recommended for these situations. If you do not have a UBV formula with an active ingredient, and needs to be used in small amounts, the solution is to use a dilutor that is not volatile.

In these cases we can use mineral oil for agriculture. It must comply with certain specifications in order to be considered for agricultural use. One of the requests is the absence of phytotoxicity. The formulas are not always diluted with oil, as they were developed and prepared to be enlarged with weather. So the miscibility of the formulas in oil must always be checked.

<table>
<thead>
<tr>
<th>APPLICATION METHODS</th>
<th>DIAMETER OF DROPS OR PARTICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPERION</td>
<td>GRANULATES</td>
</tr>
<tr>
<td>SPRINKLE</td>
<td>0.05 mm (particle)</td>
</tr>
<tr>
<td>PULVERIZATION</td>
<td>&gt; 0.15 mm (drop)</td>
</tr>
<tr>
<td>ATOMIZATION</td>
<td>0.05 – 0.15 mm (drop)</td>
</tr>
<tr>
<td>FUMIGATION</td>
<td>&lt; 0.05 mm (particle or drop)</td>
</tr>
</tbody>
</table>

CHART 6.2 Classification of Application Methods according to the diameter of the drops or particles.
OTHER METHODS OF APPLICATION OF PLANT PROTECTION PRODUCTS

<table>
<thead>
<tr>
<th>METHOD</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPREGNATE</td>
<td>Seed disinfection</td>
</tr>
<tr>
<td>DRENCH</td>
<td>Water soluble products</td>
</tr>
<tr>
<td>BRUSHING</td>
<td>Bushes v diseases</td>
</tr>
<tr>
<td>BAITS</td>
<td>Insects, rats, molluscan</td>
</tr>
<tr>
<td>WATER VAPOR</td>
<td>Bacterias v fungus</td>
</tr>
<tr>
<td>HOT OR COLD AIR</td>
<td>Insects in empty rooms</td>
</tr>
</tbody>
</table>

CHART 6.3 Other Methods of Application of Plant protection Products

APPLICATION METHOD ACCORDING TO THE PLANT PROTECTION PRODUCTS.

<table>
<thead>
<tr>
<th>TYPE OF TREATMENT</th>
<th>IN A LIQUID FORM</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PULVERIZATION</td>
<td>ATOMIZATION</td>
</tr>
<tr>
<td>Fungicides</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Insecticides</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Acaricide, Nematocide and others</td>
<td>+++</td>
<td>-</td>
</tr>
<tr>
<td>Herbicides</td>
<td>+++</td>
<td>-</td>
</tr>
</tbody>
</table>

+++ : Very adequate, frequent use
++ : Adequate, less use
+ : Used in some cases

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CHART 6.4 Application Methods According to the Plant protection Products.

CLASSIFICATION OF APPLICATIONS IN LIQUID FORM ACCORDING TO THE VOLUME OF THE APPLICATION.

In the application in liquid form it is common to classify the process according to the amount of mixture need per hectare. In Chart 6.5 is the classification of this volumes and the equipment regularly used for the application.

Regarding the volume of application and due to the high costs for water transportation to the fields and the loss of time cause by the stops to refill the sprayer, the current tendency is to use those that require a smaller volume of application, with the purpose of lowering cost and increasing the speed of the treatment.

A decrease in the volume of application also implies the use of smaller drops if an adequate coverage is desired. In the high volume applications a good degree of coverage is obtained even when using big drops. In order to obtain a good coverage of a treated surface, you can use the high volume pulverization (until exhausted) using great application volumes (diluted mixtures or big drops). Therefore the same result can be obtained with smaller volumes, using smaller drips of a greater concentration. As a rule, smaller drops are more efficiently absorbed by the objective and therefore offer better results. The use of smaller drops does have certain limitations such as evaporation and drifting which are the most important.
SAMPLING AND OBSERVATION OF DROPS

In most of the liquid applications, the mixture is fragmented into particles called drops. These drops have a different behavior according to their size (mass).

When we are observing the drops, the first step is to collect a sample. For this, we need a surface that can be marked by the drops through the formation of stains, holes, or other visible phenomena. One of these techniques consists in the use of water-sensitive paper, which forms blue stains when it is in contact with water. See Photographs 6.3, 6.4 and 6.5.
Photograph 6.3
HYDROSENSIBLE PAPER: A) BEFORE BEING USED, Y B) AFTER BEING USED.

Photograph 6.4
VISUAL ESTIMATION OF ASPERTION PATTERNS
Photograph 6.5
DIFFERENT ASPERTION PATTERNS: FROM LEFT TO RIGHT, UNACCEPTABLE TO ACCEPTABLE

The number of drops per square centimeter that reaches the crop or the soil, as well as the size of the drops, determine the biological effectiveness of the treatment. (Other factors are: effectiveness of the product, dose, most adequate season of application.) For most products, the density of the drops must be of at least 20 drops per square centimeter, in the site where the insects are feeding or could feed; at the site where the weeds are growing or could grow (Photograph 6.6). But each rule has its exceptions. In some cases it will be necessary to apply more than 20 drops. For example when herbicides or fungicides are applied after and emergency. See the charts that offer examples of density and size of the drops and they approximate recovery (Charts 6.6, 6.7 and 6.8)
Photograph 6.6
DENSITY AND SIZE OF THE DROPS TO BE EFFECTIVE.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Drop Density Per cm²</th>
<th>Drop size in VMD um</th>
<th>Definition</th>
<th>Expected Recovery %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vector control</td>
<td>in the air</td>
<td>&lt;50</td>
<td>aerosol(fog)</td>
<td>Aprox. 15%</td>
</tr>
<tr>
<td>Vector Control</td>
<td>in the air</td>
<td>50-100</td>
<td>fog</td>
<td>15-40%</td>
</tr>
<tr>
<td>UBV &lt; 5 lts/ha</td>
<td>20 – 30</td>
<td>80-150</td>
<td>fine spray (mist)</td>
<td>40-80%</td>
</tr>
<tr>
<td>With pure prods.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BV 20 to 50 lts/ha</td>
<td>20 – 30</td>
<td>200 –400</td>
<td>reg. Mist</td>
<td>50-80%</td>
</tr>
</tbody>
</table>

CHART 6.6 Size and Density of Drops and Recovery Percentages for Insecticides

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Drop Density Per cm²</th>
<th>Drop Size in VMD um</th>
<th>Definition</th>
<th>Expected Recovery %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungicides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action by Contact</td>
<td>50-70</td>
<td>200 - 400</td>
<td>reg. Spray</td>
<td>50 – 80%</td>
</tr>
<tr>
<td>Systemic Action</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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CHART 6.7 Size and Density of Drops and Recovery Percentages for Fungicides

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Drop Density Per cm²</th>
<th>Drop Size in VMD um</th>
<th>Definition</th>
<th>Expected Recovery %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-emergency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BV 20-50 Its/ha</td>
<td>20 – 30</td>
<td>400 – 600</td>
<td>spray (heavy)</td>
<td>80 – 95%</td>
</tr>
<tr>
<td>Post-emergency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BV 20-50 Its/ha</td>
<td>30 – 40</td>
<td>400 – 600</td>
<td>spray (heavy)</td>
<td>80 – 95%</td>
</tr>
<tr>
<td>Total Control Of weeds</td>
<td>~ 1</td>
<td>600 – 1000</td>
<td>minimal drift</td>
<td>&gt; 95%</td>
</tr>
</tbody>
</table>

CHART 6.8 Size and Density of Drops and Recovery Percentages for Herbicides

APPLICATION TECHNIQUES AND EQUIPMENT.

There are many kinds of equipment for the application of plant protection products and they can be classified according to the material being used. There is a dry powder sprinkler, a granulator used to apply granules, a pulverizer that sprays drops and the nebulizer that applies a fog.

**Sprinkler.** The sprinklers are machines that distribute the active material, in the form of dry powder, with air currents. Basically, the equipment must have a deposit for the powder and a ventilation system. Some of this equipment have dosifiers that allow to control the power flow. The greatest problem with this techniques is the little adherence capacity of the powder on the plants, which last for a short period; therefore it is very important to do the application early in the morning with the plants are covered with dew. When great extensions are being treated it is done during the night, with little wind and without the heating of the soil that produces ascending currents and lifts the product from the ground.

The adherence of the powder particles on the plant, depends on the atmospheric conditions, that could be improved by wetting techniques or by an electrostatic charge of particles, though these methods are still under experimentation.

Photograph 6.7 and 6.8 show a manual backpack type sprayer.
Granulator. The granule applicator is even simpler than the sprinkler because it does not need a ventilator. To bury the granules one of the most popular pieces of equipment is the “matraca” (raddle), which is nothing else than a hand sewer and is frequently used for the application of granulated systemic insecticides directly on the ground around fruit trees and coffee plants. See Photograph 6.9.

The granulators used for applications on the furrows can be of a different type such as the manual backpacks and those hooked on a tractor. The ones used on a tractor have a deposit with a funnel, with a dosage system on the lower end and an exit conduct that can be directed towards the other side. See Photograph 6.10.
Liquid Form application Equipment. The equipment for the application of liquids can be classified as injectors, pulverizers and nebulizers. The injectors through a spur of liquid that does not fragment itself into drops. The pulverizers apply drops and the nebulizers, fog. Some still use the sprayers that do not have very clear characteristics.

Generally the pulverizers have ventilators and they are called atomizers.

In most developing countries, the application of plant protection products is done through by using atomizers and nebulizers. Some are small and manual others are hydraulic, according to the crop and the economical development of the area. Aware of the cultivation practices and economical development of an area, one can also use a nebulizer, an atomizer, or a motorized sprayers hooked on tractors or plane. Sprinklers with revolving discs and fumigators can also be used.

The most common type of sprinklers or pulverizers are:
- Pre-pressured Backpack Sprinkler
- Manual backpack sprinkler (Piston and diaphragm types)
- Motorized Backpack sprinklers
- Handy Type sprinklers for herbicides
- Manual sprinklers with revolving discs (to apply herbicides and insecticides).

The sprinklers or pulverizers have three basic characteristics that are very common: a tank to deposit the mixture, a pump (sometimes done by gravity) and one or more exits called nozzles.

Diagrams and Photograph 6.11 and 6.115 are examples of the equipment mentioned.
Photograph 6.11

PRE-PRESSURED BACKPACK SPRINKLER AND ITS PARTS
Photograph 6.12
CONSTRAINT PRESSURE SPRINKLER
(A) INTERNAL PISTON (B) EXTERNAL PISTON
Photograph 6.13
MOTORIZED BACKPACK SPRINKLERS AND THEIR PARTS
Photograph 6.14
HANDY TYPE SPRINKLERS FOR HERBICIDES AND ITS PARTS

Interchangeable nozzle.
Spraying turbine with electric engine and revolving disc
2200 r.p.m.

Mixture conduit

Air way

Stabilizer plate with a 0.5 mm mesh filter

5 liter can containing the liquid herbicide works as a tank
Among are the motorized sprinklers or pulverizers are the auto-propelled pulverizers that can cope with a plane, helicopter and tractor; such as the ones that are hooked to the three point system of the tractor, the ones that are hooked to the porta aperos and for large areas. See photographs (6.16 to 6.21) for examples.
Photograph 6.16  
*Spraying Area*

Photograph 6.17  
*Spraying Area.*

Photograph 6.18  
*Pulverizer on a three point Hydraulic system.*

Photograph 6.19  
*Pulverizer on a Porta Aperos Tracto*

Photograph 6.20  
*Pulled Pulverizer For Great Extensions*

Photograph 6.21  
*Motorized Pulverizer*
General Information about the Nozzles: This is one of the most important components of the equipment used for application in liquid form. In most cases it is not given the importance it deserves and this is one of the reasons why the application of plant protection products may be inefficient. So it is convenient to consider certain aspects in the selection of the proper nozzles before you begin the application of the products.

- Select the proper nozzle for the crop protector that will be applied, regarding its biological effect, its way of action, the season of application, the biological pest, and the phenology of the crop, etc. Use a guide to select the nozzle such as the one that appears on Annex 03 “A Guide for the Selection of Nozzles.

- After selection the nozzle, it is convenient to know the application angle, its volume of discharge and its percentage of efficiency.

- Verify the data previously mentioned, change the nozzle if it is worn out, broken or damaged clean it if it is dirty or obstructed. When finally placed it must be well adjusted to avoid dripping. Only a 10% of inefficiency is acceptable.

There are several types of nozzles according to the energy used to expel the mix, such as the hydraulic, gas, centrifuge, kinetic and thermal energy.

With this equipment we will analyse those that use hydraulic energy because they are mostly used with the manual sprayers. In some cases those of mechanical traction are also used. There are a variety of hydraulic nozzles, and each one is used for a specific type of application and according to the biological effect of the plant protection product that is being used. The nozzles have the following functions:

- Make drops of an optimum size and shape
- Provide an application pattern.
- Direct the mix towards the indicated place.
- Determine of dose of mix to be applied as the pressure and speed needed.

When the nozzles are checked you must follow the respective security roles. You must not forget to use protection garments and equipment of the personnel. The nozzle must be cleaned by blowing through the hole, but never inserting wire, nails or any other hard materials. Compressed air can be used or a special brush and as a last alternative the stem of a plant can also be used.
These nozzles are made of metal (bronze aluminum, stainless steel) ceramic and plastic (nylon and endurite). The cheapest and most common ones are made of bronze and aluminum, but the ware out quickly, especially when used with wetting powder and other abrasive or corrosive formulas (foliar fertilizer). The ones made of stainless steel and ceramic are more resistant, but also more expensive. The plastic ones are more resistant to corrosion and wearing out. On Charts 6.9; 6.10 and 6.11 is an example of the Codes of the materials, their durability and nomenclature of the Teejet nozzles. In Annex 03, are other examples of brands.

**CHART 6.9. Code of Materials for Teejet Nozzles.**
### Chart 6.10 Characteristics and Materials of Teejet Nozzles

<table>
<thead>
<tr>
<th>Materials</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramic</td>
<td>Excellent duration, highly resistant to abrasive materials and corrosive chemicals.</td>
</tr>
<tr>
<td>Hardened Stainless Steel</td>
<td>Very good duration and good resistance to chemicals.</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>Good duration, excellent resistance to chemicals, long lasting orifice.</td>
</tr>
<tr>
<td>Polymer</td>
<td>Good duration, good resistance to chemicals, orifice susceptible to be damage while cleaning.</td>
</tr>
<tr>
<td>Bronze</td>
<td>Short duration, susceptible to corrosion, specially with fertilizers.</td>
</tr>
</tbody>
</table>
Nozzle Nomenclature

Nozzle Components: The components of these two types of nozzles are illustrated in photographs 6.22, 6.23, 6.24 and 6.25. The function of the filters is to keep impurities away from the exit hole at the tip or disc of the nozzle, in order to extend its use. It is recommended to use filters of 100 mesh (100 openings per inch) for the emulsions and 50 mesh for the wetting powders. It is essential to clean the filters and exit holes to obtain efficient applications.

Photograph 6.22
CONE SHAPED NOZZLE COMPONENTS WITH CHANGEABLE DISCS
DISCS

Ceramic  Hardened Stainless Steel  Stainless Steel  Polymer

DIFUSERS

Ceramic  Hardened Stainless Steel  Aluminum  Bronze  Nylon

Photograph 6.23
CHANGEABLE DISCS AND DIFUSERS FOR A CONE SHAPED NOZZLE

Photograph 6.24
FLAT FAN SHAPED NOZZLE COMPONENTS
Application Discharge and Area Covered: The discharge is conditioned by the pressure generated by the pump. It is measured in bars, atmospheric pressure or pounds of pressure per square inch (psi). A bar equals 14 psi. Usually 2 to 4 bars are needed per application. When you increase the pressure, the size of the drops is reduced and the volume of the discharge is increased in proportion to the square root of the pressure. Charts 6.12, 6.13 and 6.14 show the application discharge for the Jacto, Lurmark and Teejet nozzles.

CHART 6.12
VOLUME OF PULVERIZATION FOR BJ JACTO SERIES NOZZLES
(Distance between Nozzles: 0.50m)
### CHART 6.13

**VOLUME OF PULVERIZATION WITH FAN SHAPED LURMARCH MIRROR NOZZLES**

<table>
<thead>
<tr>
<th>Color &amp; Code</th>
<th>Pressure (Bar)</th>
<th>Volume (l/hr)</th>
<th>Applied Volume (l/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Orange</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DT 0.5</td>
<td>1.0, 1.25, 1.5</td>
<td>103, 112, 126</td>
<td>46, 60, 60</td>
</tr>
<tr>
<td>100 mesh</td>
<td>1.75, 2.0, 2.0</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Green</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>109, 112, 120</td>
<td>106, 112, 110</td>
</tr>
<tr>
<td>DT 0.75</td>
<td>1.75, 2.0, 2.0</td>
<td>116, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>100 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Yellow</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 1.0</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Blue</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 1.5</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Red</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 2.0</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Pale Brown</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 2.5</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Gray</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 3.0</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>White</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 4.0</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Pale</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 5.0</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Lime Green</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 7.5</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Black</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 10</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Pink</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 15</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td><strong>Purple</strong></td>
<td>1.0, 1.25, 1.5</td>
<td>122, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>DT 5.0</td>
<td>1.75, 2.0, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
<tr>
<td>50 mesh</td>
<td>1.5, 1.75, 2.0</td>
<td>120, 119, 97</td>
<td>101, 100, 90</td>
</tr>
</tbody>
</table>
**CHART 6.14**

VOLUME OF PULVERIZATION WITH FULLJET NOZZLES

**Description of the hydraulic energy nozzles:** With these nozzles the liquid is forced through a small opening at a low pressure, and it spreads forming a curtain that is disintegrated into drops of different sizes. The pressure is a physical characteristic of the liquids (superficial tension, density and viscosity) and the condition of the environment that are present in the air and influence the development of the curtain of liquid. The size of the drops is vary a lot and this offers a wider spectrum. The hydraulic nozzles are more common and traditional; they are called conventional nozzles and practically control the international market.

Regarding the projection of the water, the hydraulic nozzles are divided into nozzles of a conic spurt and flat spurt (fan) nozzles. Those with a conic projection are subdivided into full cone nozzles and empty cone nozzles. Then the flat spurt nozzles are subdivided into different types of fans, normal fan, uniform fan and impact fan, etc. (Figures 6.1)
FIGURE 6.1 Hydraulic Energy Nozzles.
a) **Cone Nozzles:** These are the most common hydraulic nozzles, and the most predominant is the hollow cone, which are concentrated only at the periphery and its centre practically has no drops. (Photograph 6.26)

The most popular nozzles are from Spraying Systems (Nozzles Series D and X) and its components can be seen on figure 6.1, which are the cover (cask) and the body. These are the most common ones.

In the D Series nozzles, the filter is not a mesh (metallic or plastic cloth), it is slotted. The nucleus is known by other names such as snail, spiral diffuser, or “core”, etc. It provides a helicoidal movement to the spurt of liquid that flows though it. After making this movement the liquid passes though a circular hole in the disc and then opens out into a cone. In the D Series Nozzles from Spraying Systems, the nucleus (diffuser) is identified with numbers 13, 23, 25, 45, etc. The first algorithm indicates the number of the opening in the nucleus. For example No. 45 indicated there are for openings in the nucleus. The second algorithm indicates the size of the opening. The disc is also numbered as D2, D4, D5, etc. The D stands for diameter of the hole (2/64”, 5/64”) The identification of the nozzle is the result of the combination of the nucleus and the disc. For example D2-12, D4-45.

The Jacto nozzles have a nucleus that is identified by the number of holes: number 1 has one hole, nucleus 2 has two holes. The Jacto disc can be 10 or 14, which would be the numbers that indicate the diameter of the hole (1.0 mm and 1.4 mm respectively). The identification of the Jacto nozzle is done as follows: JD14-1 (disc 14, and the nucleus with 1 hole); JD10-2 (disc 10 and a nucleus with 2 holes).
There are several options regarding the materials, from bronze (the list resistant to friction and wearing out), and the alloys of very hard metals up to the founded minerals (ceramics) that are very hard and are therefore resistant to wearing out. Evidently, the better the material used the higher the price of the nozzle. Nevertheless, if the situation is well analysed, the nozzle must be of a good quality disregarding the price, especially if we compare it with the price of the products that will be flowing though the nozzle during the agricultural year. Then the price of the nozzle will be insignificant. The important thing is to make a good application and obtain the best efficiency from the agro-chemicals.

The nozzles with the conic spurt work with higher pressures that the nozzles with the flat spurt. Generally the conic ones work above the 60 psi. And according to the nozzle used they can stand up to 600 psi. Each manufacturer has a discharge table for the nozzle they make. Charts 6.15, and 6.16 illustrate the Flow Tables from Jacto and Spraying Systems.

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Pressure (bar)</th>
<th>Flow (l/min)</th>
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<th>6 km/h</th>
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<th>10 km/h</th>
<th>15 km/h</th>
<th>20 km/h</th>
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<td>135</td>
<td>90.0</td>
<td>67.5</td>
<td>54.0</td>
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<td>55.8</td>
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<td>31.9</td>
</tr>
</tbody>
</table>

**CHART 6.15**  
SPRAYING VOLUME OF CONEJET NOZZLES.
b) **Impact or Mirror Nozzles:** With the impact nozzle, the liquid flows out as a fan (Photograph 6.27). These nozzles work at very low pressures (10psi). Because of its open angle, it is easier to work near the objective (soil) and are therefore preferred for the application of herbicides under trees and bushes (fruits, coffee). Normally they have a very high discharge and produce big drops. Currently the impact nozzles of a low pressure are mostly used because they produce relatively smaller drops (TP – 0.5).

The discharge pattern of the impact nozzles is very irregular, and because of its use of bars it presents problems with super-positions. Consequently, the application of products is very irregular (Photograph).

When the high flow nozzles are used as specified (10 to 20 psi) they produce big drops and will not present any problems with the drifting factor. We have observed through practice that the nozzles are being used at higher pressures than recommended and the impact nozzle generate a great amount of small drops that are subject to drifting.
Photograph 6.27
IMPACT NOZZLES AND THEIR DISCHARGING PATTERN

Chart 6.17 shows the flow of some of the impact nozzles.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<td></td>
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<td>1.5</td>
<td>2.0</td>
<td>3.0</td>
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<td>l/min</td>
<td>l/min</td>
<td>l/min</td>
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<td>l/min</td>
<td>l/min</td>
<td>l/min</td>
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<tr>
<td>4 k/h</td>
<td>12.3</td>
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<td>8 k/h</td>
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<td>755</td>
<td>870</td>
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<td>685</td>
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<td>970</td>
<td>1185</td>
<td>800</td>
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<td>696</td>
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<td>548</td>
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<td>776</td>
<td>948</td>
<td>640</td>
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<td>16 k/h</td>
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<td>560</td>
<td>710</td>
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<td>560</td>
<td>647</td>
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<td>20 k/h</td>
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<td>343</td>
<td>420</td>
<td>485</td>
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<td>274</td>
<td>336</td>
<td>388</td>
<td>479</td>
<td>379</td>
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CHART 6.17
SPRAYING VOLUME OF THE IMPACT NOZZLES BY SPRAYING SYSTEMS
The nozzles Floodjet series manufactured by Spraying Systems are identified by the letters TK followed by a number (Example: TK-2. The number indicates the flow of 10psi. If is reads TK-2, the flowing pressure of 10psi is of 0.2 gallons/minute). When the nozzle is made of Stainless Steel, the letters SS will appear.

The filter for these nozzles is a 50 – 100 mesh (50 to 100 holes per square inch) and it must be adequate for the size of the hole. When the nozzles have small holes like the TK-1, the mesh must be very fine (100). For nozzles with bigger holes the filter must also have bigger holes (50). Nozzles that are bigger than the TK-3 do not need filters. There are also impact nozzles in the market that also follow these recommendations. Each manufacturer is able to provide this information for the nozzles they make.

c) Fan Nozzles – The fan nozzles produce a flat spurt and its use is indicated for flat objects such as the ground or walls. Like the majority of herbicides it is applied to the surface of the ground and because of this many believe that the fan nozzle is indicated to apply herbicides. Nevertheless, this nozzle is also used to apply insecticides and fungicides on the ground (and on the walls in the case of public heath issues). The choice of the nozzle is directly related to its purpose, just like a hunter would choose a weapon according to the prey.

The fan nozzles can have and even discharge when the distribution of the liquid in the application strip is even (Fig. 6.2) The discharge can be uneven (normal) when the application is greater at the centre of the strip and symmetrically decreases towards the sides. Figure 6.2 shows the discharge patterns of various types of fan nozzles.

The even discharge nozzles are indicated for applications in furrows, without the superposition of nozzles nearby. The uneven discharge (standard) is recommended to be used as a series of nozzles (overlapped 25 to 30%) mounted on a bar where the spurts of the nearby nozzles cross each other.

Chart 6.11 shows the diagram of the fan nozzles that belong to the Teejet series. In this series the numbers respond to the following information: Algorithms two or three indicate the angle of the opening of the spurt at the pressure of 40psi. The other algorithms to the right, indicate the flow (discharge), in gallons per minute. And the absence or presence of letter E indicates is the spraying patterns is normal (standard) or even, respectively. The other letter represent codes for the materials of which the nozzles are made. (Chart 6.18).

The number 8002, for example (is read as 80 02) indicates that the nozzle operated at the 40psi pressure, produces a spurt with an 80 degree opening and a flow (discharge) of 0.2 gallons/minute. Number 11004 (is read as 110, 04) indicates that the nozzles is producing a spurt with a 110 degree opening and a discharge of 0.4 gallons / minute, working at the 40 psi pressure. When the nozzle has an even discharge, the letter “E” is found after the number. The codes for the materials it is made of may also be added.
For example 6503 E VK means the spurt has a 65 degree spraying angle with a discharge of 0.3 gallons per minute and the spraying pattern is even (E). The (V) is for the Visi-floo plastic it is made of and the (K) means that the exist hole is ceramic.

The most common angles are 65, 80 and 110 degrees and the discharges are usually 0.2, 0.3 and 0.4 gallons per minute.

Several brands also have color codes like the Teejet (Photograph 6.28), Albuz, Jacto, Lurmark and other brands. More information is provided in Annex 03.

FIGURE 6.2: Different types of flat nozzles and other spraying patterns. (1) Normal or Standard Fan. (2) Even Fan.
**Photograph 6.28**

COLOR CODE FOR TEEJET NOZZLES

![Color Code for Teejet Nozzles](image1)

**Chart 6.18**

SPRAYING VOLUME FOR TEEJET FAN NOZZLES

<table>
<thead>
<tr>
<th>Nozzle Type</th>
<th>Color Code</th>
<th>Chart 6.18</th>
<th>Description</th>
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<tr>
<td>UB(1.5-4)</td>
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<td>D25143-UB8501</td>
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<td>TT(1-6)</td>
<td></td>
<td>D25149-UB85015</td>
<td></td>
</tr>
<tr>
<td>XR(1-4)</td>
<td></td>
<td>D25143-UB8502</td>
<td></td>
</tr>
<tr>
<td>TP(2-4)</td>
<td></td>
<td></td>
<td>Spray Parameters</td>
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</table>

<table>
<thead>
<tr>
<th>Pressure (bar)</th>
<th>Flow Rate (L/min)</th>
<th>Spray Width (cm)</th>
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<tbody>
<tr>
<td>1.0</td>
<td>0.02</td>
<td>18</td>
</tr>
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<td>2.0</td>
<td>0.03</td>
<td>24</td>
</tr>
<tr>
<td>3.0</td>
<td>0.04</td>
<td>30</td>
</tr>
<tr>
<td>4.0</td>
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<tr>
<td>5.0</td>
<td>0.06</td>
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CropLife • International • Representing The Plant Science Industry
d) Other hydraulic nozzles: There are several types of hydraulic nozzles for each specific use. A very interesting one is the Raindrop nozzles designed to eliminate small drops that are formed by the conventional nozzles. A particularity of the Raindrop nozzles is that between the walls is that a second chamber of drops is formed and they capture the smaller drops. The Raindrop nozzle is recommended for flat objects even though it has a cone shape.

This nozzle also produces bigger drops and with this the drifting problem is minimized. It has been used under conditions where a strict control of the drifting factor needs to be taken. Such as the application of hormonal herbicides.

A similar nozzle is the full cone that belong to the Fulljet series. These nozzles has a very open angle and are recommended to be used with a 75 to 100 cms spacing between each one. The most common nozzles are FL-8 and FL-10. The FL-08 offers a discharge of 0.8 gallons/minute at 40 psi and the FL-10 offers 1.0 gallons / minute at the same pressure. Using the FL-8 nozzles at 40psi the size of the drops is big of approximately 80 microns. Therefore the volume of application is increased (over 500 L/ha according to the speed and pressure used) and its performance is reduced, in comparison to other nozzles of a smaller flow. Because the drops are bigger, and consequently are not subjected to the wind conditions, in some regions and/or seasons of the year with intense winds, the Fulljet nozzle offers and advantage, allowing a performance without interruptions. This is a helpful aid for the organization of duties in the agricultural business and for this reason it has been preferred by the customers (Photograph 6.29).
The Twinjet flat fan nozzle is destined for the coverage of leaves. It’s a double (twin) fan nozzle, which means that from one single nozzle there are two fan spurs that have a 60 degree separation. The identification of these nozzles is done as follows: TJ60-8004, which means that the Twinjet nozzle has to separate spurs with a 60 degree separation and each spur has a 80 degree angle and a 0.4 gallon/minute discharge. The Twinjet 8004 nozzle is formed by two 8002 spurs (Photograph 6.30).

Photograph 6.30
TWINJET NOZZLES: (1) EVEN, (2) NORMAL. (TEEJET)

The Turbo-Floodjet (TP) Nozzle – is really an impact nozzle, similar to the Floodjet (TK), with a difference in the distribution pattern. The distribution curve is symmetrical with a nozzle at the of the gradual fall, soft at both extremities, which makes a superposition easier. The manufacturer recommends a 30% superposition of the spurt, with an adjacent nozzle in opposite position of the Floodjet nozzle. A 50% superposition is recommended (double overlap). The identification of the Turbo-Floodjet nozzles is marked with the letters TF. For example TF-2 discharges 0.2 gallons/minute at 10psi, while the TF-3 discharges 0.3 gallons a minute at 10psi (Photograph 6.32 A). The Turbo Turfjet (TTJ) is another variation of the Floodjet series (Photograph 6.31 B).
• EVEN COVERAGE ALONG THE BAR.
• SPECIAL HOLE THAT MAKES BIGGER DROPS TO REDUCE THE DRIFTING.
• THE ROUND HOLE REDUCES OBSTRUCTIONS.
• WORKING PRESSURE 0.7-3 BAR
• HOW TO ORDER? TF 2.0, TF 3.0

Photograph 6.31
TURBO-FLOODJET (TF) AND TURBO TURFJET (TTJ) NOZZLES

•VERY BIG DROPS
•LOW DRIFT NOZZLES, DIRECT REPLACEMENT FOR PLASTIC NOZZLES WITH A HOLLOW CONE
•MORE PRECISE DISTRIBUTION PATTERN AND FLOW.
•THE BIG HOLE REDUCES OBSTRUCTIONS.
•HOW TO ORDER? 1/4TTJ04-VS.
The DRIFT GUARD (DG) Nozzle. It is a projected fan nozzle that produces big drops, reducing the proportion of smaller drops that are exposed to drifting. Its identification is done by the letters DG. For example, DG8002, discharges 0.2 gallons / minute at 40psi with an 80 degree angle. They also come in the Even version. According to the type, the spraying pattern is similar to the conventional fan nozzle, the standard and even fan type. Photograph 6.32.

EXTENDED RANGE (XR) Nozzle – It is a fan nozzle with an angle that varies very little regarding the pressure, to the point that the angle is considered the same for a strip of 15psi to 60psi. If the pressures is increased the size of the drops is reduced and vice versa, which means the angle does not vary considerable. These nozzle are for sprayers that are equipped with discharge controls, such as the computerized Dickey – John, or the Master – Flow mechanical controls. The control of the flow during the application with the available systems is processed by the variation of pressure. The identification of these nozzles is done by the letters XR. Like XR6501, provides a 0.1 gallons / minute discharge at 40psi with a 65 degree angle of the spurt, with the certainty that these 65 degrees will not vary with the pressure. (Photograph 6.33)
Photograph 6.33
EXTENDED RANGE NOZZLE (XR)

- EVEN COVERAGE WITH A WIDE RANGE OF PRESSURES FROM 1 TO 4 BAR
- IDEAL TO BE USED WITH ELECTRONIC CONTROL SYSTEMS IN WHICH THE PRESSURE COULD VARY.
- MAKES BIGGER DROPS TO REDUCE DRIFTING IN LOW PRESSURES.

Photograph 6.34
FAN NOZZLE WITH AIR INDUCTION

- PRODUCES BIGGER DROPS FILLES WITH AIR DEPENDING ON THE CHEMICAL.
- BIGGER DROPS THAT REDUCE DRIFTING
- EVEN COVERAGE WHEN SPRAYING IS SCATTERED
- WORKING PRESSURE OF 2 TO 8 BAR
- THERE ALSO EXISTS A UNIFORM VERSION
MAKING OF A BACKPACK SPRAYER AND ITS PARTS

This type of equipment is the mostly used by agricultures. Their preference is based on their experience with them because the have lasted longer or because they have been easy to use their spare parts were available.

The main bands available in the Latin American market are the following:

- CP3, CP15. with a diaphragm.
- Matabi, Protecno, Osatu, Guarany, Jacto. Roman hass, Gloria, Uni Spray, Swiss Mex. , with internal pistons.
- Marck Royal, Royal Condor, Carpi, Bovi, Spray meck, with external pistons.

Each of these brands have specific characteristics, but in general serve the same purpose. The main parts of a sprayer are:

**Cap or Cover:** Is used to seal the tank and avoid spilling when at work. Most of them have a hole that works as an air hole.

**Filter:** It must be places at the entrance of the tank and avoids the entrance of impurities to the tank. It must always be in place when pouring the components of the mix.

Tank: It is the deposit of the mix that will be applied. It can be made of different materials but currently a high density plastic is being used, which is durable and resistant to the effect of solar radiation. The volume varies from 8 to 20 liters.

**Pump and Compressor Deposit:** It generates the final discharge pressure which is hand operated in this equipment that is 20 to 60 psi. Some use a diaphragm and other a piston. The ones with a piston a more resistant. When you buy your equipment you much know what kind of pump it has, since it generates the pressure of the flow and the movement of the handle must be even to avoid damaging the pump or its parts.

The compressor deposit maintains the pressure of the liquid when the pump is working and it can have a variable pressure valve incorporated, which will regulate the pressure the operator chooses.

**Pump Rod:** Generally to the side (right or left) depending on the ability of the operator.

**The Hose:** Connects the exit of the pump with the spraying valve and ejects it.
The Spraying Valve and Launcher: The spraying valve usually contains a filter, which must be inspected regularly with the other gaskets of the system. The launcher is used to direct the mix to the spraying site, depending on the position of the objective as well as its length. All of these sprayers have launchers of the same length. Other exits can also be adapted to obtain a wider coverage.

Nozzles, peaks or tips: It is placed at the end of the launcher and can be of two kinds; cone nozzles and fan nozzles (fixed or variable). The type of nozzle is conditioned by the type of product that will be applied and by the biology of the plague and phenology of the plant among other factors. Always use the nozzle selection guide.

Straps: These can be made of plastic or leather and covered with cotton. They must be comfortably placed on the person that is doing the spraying.

Additional Equipment:

- **Pressure Regulator:** The pressure influences directly on the discharge of the application. It is measured by a manometer, which is placed on top or after the exit valve to determine which is the real pressure you are spraying with.

- **In order to keep an even agitation of the mix you can add:**
  - An agitator or agitation stick that is connected to the pumping handle inside the tank.
  - The hydraulic agitator which is included with the pumps, allow the return of the mix into the tank in order to maintain a constant agitation.

- **Application Launchers:** The various nozzles can be adds to them and they are placed on the front horizontal part or vertical part depending on the objective that will be treated or they can be placed on the back part if you do not wish to walk on the treated parts.

In Photograph 6.35 you can see the part or components of the pump as well as the internal piston.
Photograph 6.35

PARTS OF A SPRAYING PUMP WITH AN INTERNAL PISTON

1. Resistant and easy to assembly handle.
2. Wide filter in the spray guns handle with an incorporated closing system and quay.
3. Fixative in passing handle.
5. Filling filter with content indication.
6. Mechanical agitator with device to assemble the closing valve.
7. External level indicator in liters and gallons USA.
10. Record for accessory assemble indicated in this catalog.
11. Fastening spots for the belt. (accessory).
12. Regulating conical nozzle.
13. Replaceable nozzle for herbicides. (only Mod. Super Agro 15).
14. Pump hose with nuts, without brackets.
15. Exit record in strait angle incorporated in the camera.
16. Fixative of crowbar, spray gun and arm to make easier the transportation and storing.
17. Operating crowbar with ergonomic handle.
18. Guide nut with closing and lubricating washer.
19. Transportation handle.
20. Resistant and adjustable straps.
21. Pressure camera, eccentric and monopiece of high capacity and resistance.
22. Rubber retainer.
23. Reversible model. (See instructions).
24. Inox. balls in valve and shirt.
25. Antishock and anticorrosive complete base.
REVISION AND MAINTENANCE OF THE BACKPACK SPRAYING EQUIPMENT

This is one of the actions the sprayer must do before beginning and ending the application. The person must use protection equipment and clothes.

- **Initial Evaluation:**
  
  a) Check the cap on the pump to make sure the air hole is not obstructed or has residuals of the plant protection products.
  
  b) Check and clean the filter at the entrance of the tank. Make sure it is not torn or has trash or product residuals.
  
  c) To check and clean the filter it must be placed on a clean surface and turned over.
  
  d) Check and clean the interior of the tank
  
  e) The pressure valve must be adjusted according to the herbicides (low pressure) or insecticides and fungicides (high pressure).
  
  f) The agitator in the tank must be in good shape. Some equipment do not have an agitator.
  
  g) Check all the connections; check and clean all the components that can be taken apart. Put them back in place making sure they are adjusted (gaskets, filters, nozzles, etc). The nozzle and filter must be appropriate for the type and formula of the product that is being applied.
  
  h) The launcher must be in a good state and the filter must be clean. Lubricating may be needed.
  
  i) Check the straps. They must be in good condition and if they have any residuals of the product, they must be cleaned and washed.
  
  j) After checking the equipment, add water and start the process of application to determine if there are any leaks. Adjust the sprayer so that it will lay on the shoulders of the operator and not on his back.
  
  k) Spray on a flat surface to verify the uniformity of the spraying pattern and if it is irregular you must change the nozzle.

- **After the Application:**
  
  1. First wash the sprayer on the outside.
  2. Add water to the tank, agitate and throw out the water, into a ditch (never throw the water into a current or water source. Do this two or three times. Use water with soap (natural soap, not detergent) to clean the equipment.
  3. Again add water to the tank and let the equipment function. Repeat this operation until the water comes out clean.
  4. Take the sprayer apart and clean each component. Do not blow into the nozzles with your mouth. They should be cleans with a toothpick or a piece off straw. Do not use any metal objects and remember the recommendation given previously on the matter.
  5. Dry the parts and lubricate with a light oil if any component should need it as they are in constant movement.
6. Put the sprayer together and keep it in a safe place, outside the house and far from your family and pets.

For the instructor: Use protection garments and equipment for this practice. During the demonstration you must refer to all the types of sprayers and nozzles commonly used in your area and limit your information to what is really useful for the group you are training. Give a brief demonstration on the making of the parts of the application equipment. A logical way of doing this is by following the flow of the liquid through the equipment from the cap to the nozzle. Describe and explain the function of each component. Get the equipment ready for your presentation, loosen the screws and connections (partially take apart the equipment and keep the necessary tools on hand). Teach them about the series of inspections that must be made to check and maintain the equipment. Remember the checklist we have provided and consider it could vary according to the type of spraying being used. Organize your work groups and motivate the participants to practice on their own.

When you have finished this activity, you must provide each group with a set of nozzles so they can categorize them. They must include the name of the nozzle, the application angle, the discharge volume and its possible use.

TRACTOR SPRAYER COMPONENTS AND CONSTRUCTION

As it was explained previously, a liquid can be sprayed with just a deposit, a pump and a nozzle. But in order to control all the operational conditions, many parts are needed. The complete hydraulic circuit of a tractor sprayer is presented in Figure 6.3 and it can also be seen in the mosaic of photos in Photograph 6.36.

The description of each part will be considered in their most interesting aspects for the application of plant protection products.

**Tank or Deposit:** The deposit has a filter at the entrance with the objective of keeping out any dirt that could later clog the narrow hydraulic circuit (valves and nozzles). Normally there is a mechanical agitator in the deposit that is essential when working with powders, concentrated emulsions, concentrated suspensions and any other type of formulas in suspension. The agitation is also provided by the return of excess liquid being pumped. For the formulas presented as solutions (that are diluted with water), the hydraulic agitation is provided by the return and it is sufficient.
FIGURA 6.3: Hydraulic Circuit of a Conventional Sprayer. 1 – Tank. 2 – Agitador. 3 – Feed Cock. 4 – Filter. 5 – Pump. 6 – Compresión Chamber. 7 – Pressure Regulator. 8 – Manometer. 9 – Feed Cock. 10 – Return Piping. 11 – Bar. 12 – Nozzles.

**Filter:** Before the mix enters the pump, there is a filter at the entrance of the deposit. This filter must be cleaned frequently, once a day at least. To make the frequent cleaning possible, this filter is located at an accessible location and can be done without tools. To open the filter when the tank has liquid there is a check valve before it. Consequently there is a required sequence that must be followed: tank – check valve – filter – pump.

Filtering is essential and it must be progressive, starting with the mesh that has larger holes up to a very fine mesh near the nozzle. The nozzles that have very small discharge holes require very fine filters. See Figure 6.4.

**Pump:** The purpose of the pump is to pressurize the mix. There are several types of pumps. Some have pistons, some a roll, others a diaphragm and others are centrifuge or some are geared. The most common pumps have pistons and there are only a few of the other type of pumps. The piston is able to provide very high pressures and its pumping capacity is not affected by the pressure. This means that is can pump 40 liters per minute at 40 psi or at 400 psi. This is way it is very well accepted, even though it is expensive when initially obtained and the cost of its maintenance is also expensive.
FIGURA 6.4 Filtering system of a Tractor Sprayer

**Compression Chamber:** The mix is pumped at a low pressure and goes through a compression chamber is a compartment partially full of air. Since the liquid is not flexible but the air is, the volume of air in the chamber will be compressed in order to maintain the pressure. The main function of the chamber is to eliminate the pulsations that are originated by the aspiration actions of the piston pump. The continuous actions pumps such as the centrifuge pumps do not need this chamber, but for the pumps that have several pistons, this chamber is irreplaceable.

**Pressure Regulator:** The pulsation is eliminated, the mix enters into the pressure regulator, which basically is a volume divider. For example if the capacity of the pump is of 40 liters / minute and the flow of each nozzle is of one liter /minute, the bar must have 10 nozzles. If the pump sends 40 liters/minute and the exit total is of 10 liters /minute, there is an excess of 30 liters. The pressure regulator is in charge of making the extra 30 liters return to the tank. This part must have an entrance (to receive the mix that comes from the pump) and two exits: one exit that communicates with the two nozzles and the other that returns the excess to the tank. In order to make a variation of the output (what goes to the nozzles and what to returns to the tank) just turn the screw that compresses a spring that controls the return flow. The more you compress the spring, that harder it is of the liquid to return and therefore more liquid will be sent to
the nozzles. Since the exit of the nozzles is small, the pressure will rise in that part of the circuit and vice versa.
**Manometer:** The pressure of the circuit is read by the manometer. The common manometer has a scale in psi and in kg/cm². Normally, the common manometer has durability problems because it is not strong enough to stand the tough working conditions (vibration and aggressive liquid circulation in its interior). Recently there is a new manometer being adapted that has a coat of glycerine and is a bit more resistant. Who ever want to extend the life of his manometer, the solution is to use it when you are regulating the pressure and then take it out of the circuit. Since the regulator can be kept installed, the pressure will not be altered until a new regulation is done. In the mean time and as a precaution, it should be checked 2 or 3 times a day.

**Check Valve:** After the pressure regulator and the manometer, there must be another regulator that the operator can control to open or close the flow of liquid into the nozzles. When the bar is divided into three sections: left, and right, the regulator must have seven positions so that the sections can be operated independently, by twos or the full row of the bar. There are some regulators that are electronically activated by selenium cells that accept the command form a distance. These selenium cells are useful when they are adapted to closed cabins. In closed cabins the pipes with high pressure liquids are not allowed. If these methods are not adapted, the electronically activated regulators are not very used.

**Bar or Square drainpipe:** The spraying bar carries the nozzles. The length of the bar depends on the model of the sprayer. The longer the bar the wider the band must be and therefore it will have a greater operational capacity. The longer the bar the greater its oscillation and its discharge will be more heterogeneous. There is a relation between quality and work velocity, therefore the length of the bar must be within certain limits. In recent years it has been proposed to place a bar that is independent from the spraying structure and put it in the suspension system (with the shock and springs) in order to decrease the de heterogeneous effects of the discharge that are cause by the vertical and horizontal oscillations. With this the suspension systems absorb the vibrations of the tractor instead of being transmitted directly to the bar. This solution has allowed to may long bars that are called self-stabilizing bars. See Photographic Mosaic 6.37.

**Nozzles:** They are placed on the bare with uniform distances and fastened in many ways (Photographs 6.38 and 6.39). This mounting is adequate for the most common situations which are basically the total coverage of a ground surface or a crop. Nevertheless, for each situation in particular, the best placement of each nozzles must be obtained in order to have the greatest amount of plant protection liquid being placed on the object and avoiding any waste. Is the objective is on the tope of a row of plants, the nozzles must be placed in such a way the will cover the region a lot better. Maybe the best solution is to place two nozzles in an angle towards the row. If the objective is in the lover part of the plant a hanging arm might be needed to place the nozzles in such a way that the spurt can be directed towards the lover part of the plant (See Figure 6.5) It is always good to verify the size of the sprayers when they are at the manufacturing plant, in order to attend the conditions where it will be used. Each user must have his
own imagination to adapt the conformation of the machine to attend each particular case.

Photograph 6.37
EXAMPLE OF A SELF – ADJUSTING BAR
Photograph 6.38
DIFFERENT TYPES OF NOZZLES AND THEIR ASSEMBLING TO DRY BARS. TOTAL SEPARATION BETWEEN EACH SPRAYING POSITION TO ALLOW AN ANTIDRIP CLOSING AND A MAXIMUM WORKING PRESSURE OF 300 PSI.

Photograph 6.39
DIFFERENT TYPES OF NOZZLES AND THEIR ASSEMBLING TO WET BARS. TOTAL SEPARATION BETWEEN EACH SPRAYING POSITION TO ALLOW AN ANTIDRIP CLOSING AND A MAXIMUM WORKING PRESSURE OF 300 PSI.
FIGURE 6.5 Examples of the positions of the nozzles

CALIBRATING THE LIQUID SPRAYING EQUIPMENT.

It is fundamental to calibrate the equipment before the product is sprayed in order to protect the crops and assure the application of the recommended dose, with the correct amount of water to treat the objective adequately and obtain an effective control of the plague. Basically three aspects must be considered: Speed of the job, spraying pressure and discharge of the nozzle. The calibration of a sprayer consists of establishing or regulating the discharged percentage when the machine is using a certain type of nozzles. It works with a known pressure and moves at a determined speed, offering a good coverage of the crops or field that is being treated.

The direction you spray in to protect the crops, as indicated previously, is also very important. The plague which is our target can be located in different parts of the plant our soil and the spray must be pointed in that direction.

The selection and revision of the spraying equipment, assures its good state and maintenance, as expressed in the previous paragraphs. This is essential for a successful task. Nonetheless the success of the application does not depend solely on the equipment.

The correct application of the plant protection products also depends on the capability and training of the operators. Besides calibrating the equipment, the knowledge of the personnel involved must also be considered. Each application must be supervised and monitored in order to evaluate its effectiveness and it must be done by a technician or the farmer himself. The entire calibration process must be done with clean water.
Speed of the Sprayers: The discharge volume per surface unit is proportionally the opposite of the spraying speed.

<table>
<thead>
<tr>
<th>Speed in kms/hour</th>
<th>Discharge of Liters /ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>800</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
</tr>
<tr>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>32</td>
<td>50</td>
</tr>
</tbody>
</table>

CHART 6.19
EXAMPLES OF WORKING SPEED AND THEIR CORRESPONDING DISCHARGE.

Moving Speed (on foot or walking): The movement speed of a backpack sprayer at a normal pace can range between 2.0 and 2.5 kms./hour. The sprayers on a tractor and move at 3 to 16 Kms/ hour, even though the recommended speed is of 4 to 6 kms/hour. The standard speed is adjusted according to the system being used, and the low or extra low amounts.

The Spraying Pressure: It must be between the established range in order to produce a good spray; without producing a spray that is too fine, and not so low that the spraying will not be satisfactory. With the backpack sprayers the pressure must be of 20 to 40 psi; The tractors and planes must use a pressure of 40 to 120 psi. The low pressures are used to spray herbicides and the high ones for insecticides and fungicides.

Discharge of the Nozzle: The discharge of the nozzle and be measured in gallons per minute or liters per minute. The conversion of gallons per minute to liters per minute is done by multiplying the amount by 3.785. In order to accept any nozzle for the spraying equipment its discharge must be 90% efficient.

To determine its efficiency you must follow this procedure:

- The equipment is started with the same working pressure with which the nozzle was calibrated.
- Make three readings of the discharge that last a minute each.
- Calculate an average of the three readings and the result is considered as the correct figure.

- Read the figure that appears on the tip of the nozzle.

- Calculate its efficiency with the following formula:

\[
\%E = \frac{\text{Real Reading}}{\text{Theoretical Reading}} \times 100
\]

- The nozzle with a 90% efficiency rate are accepted. The dirty nozzles are cleaned and the efficiency calculation is repeated. The broken or deteriorated nozzles are disposed.

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CHART 6.20

FACTORS THE INFLUENCE THE CALIBRATION OF THE SPRAYING EQUIPMENT.

CALIBRATION OF SPRAYING EQUIPMENT FOR PLANT PROTECTION PRODUCTS

- PRESSSURE
- SPEED
- DESCHARGE
  - Filters
  - Nozzles
  - Drainpipe

CALIBRATION OF THE BACKPACK SPRAYING EQUIPMENT.

1. Measure a definite area in the same land where the spraying will take place for example: 2 x 5 m (100 m²).

2. Place a definite amount of water in the sprayer, for example: 5 liters.

3. Move the lever till the adequate pressure is reached.

4. Spray the water to the measured area (100 m²) keeping a constant flow of the discharge and the operator.

5. Calculate the amount of water used on the 100 m².
6. Repeat this operation 3 – 4 times to obtain the average amount of water used on the 100 m².

7. Based on the amount of water used on the 100 m² of the trail, you can calculate the amount of water you will need to spray a whole hectare.

Amount of Liters used on 100 m² x 100 = liters/ha.

Example: If you use 3 liters of water on 100m² of the trail, the total amount per ha. will be 3 x 100 liters/ha. For pneumatic backpack sprayers activated by pneumatic motors, it is important to control the moving speed and the distribution of the spray (coverage). If the displacement of the machine is too fast, a good coverage will not be obtained.

**CALIBRATION AND DOSAGE OF THE SPRAYING EQUIPMENT FOR A TRACTOR (SPRAYING BAR)**

Calibration is fundamental for the correct application of the plant protection products. Once you have adjusted the amount of water for the sprayer you must try the different nozzles in order to decide which is the most appropriate to satisfy the requirement of the treatment. In other words determine which will be the best for the product and the target, without losses because of leakage or drifting.

Considering speed and economy among the requirements, we must not forget that the goal is to use the least amount of liquid per hectare. You must keep in mind that there is no predetermined amount of product per hectare. It is not written that a certain amount (50 or 500 liters) of insecticide or herbicide must be sprayed per hectare.

The important thing is to spray the product on the target, without wasting or contamination the neighboring areas. If this is done using 5 or 500 liters, it will depend directly on the equipment and technology that is available. It must be clear that the amount sprayed per hectare is the consequence and not the goal that must be obtained. Therefore the equipment is not calibrated to spray 400 liters per hectare. It is calibrated so it will work correctly and it will spray the correct amount of products on the target.

After having chosen the adequate nozzle, the following step is to adjust the distance between the nozzles and the height you will work at. These two facts must be coordinated because the variation of the distance between nozzles can affect the height at which you are spraying and vice versa.
For example if you need to calibrate the equipment to spray a herbicide in case of an emergency in which all the soil needs to be covered, then the bar must be equipped if the fan or impact nozzle. You could also use a Raindrop or Fulljet Nozzle. Lest suppose that the bar is equipped with 8003 nozzles that are 50 cm. apart.

The first step would be to verify the uniformity of the flow of all the nozzles. So you start the sprayer and gather the liquid that is sprayed by each of the nozzles for one minute (or 30 seconds). Then measure and verify the average. The nozzles that have and exceeded flow are substituted and the bar is equipped with nozzles that will provide a flow as homogenous as possible. For practical means you can establish a 10% variation from the minimum to the maximum.

Supposing that the nozzles are 50 cms. apart, you must try to obtain the best uniformity regarding the ground level (In this example our target is the soil. If your objective is any other, naturally your criterion will also be different). You must then vary the height of the bar, so that the faucets will cross each other about 30%. See Figs. 6.6 6.7 and 6.8).

One of the most useful instruments to calibrate is the channeled tray to determine the discharge (Photograph 6.40). this instrument is 2.6 x 1.4 meters and it is mounted on wheel and it has channels 5 cm apart and each channel is connected to a collecting tube.

With the bar working at an arbitrary height (approximately a 30% discharge) the tray is placed below the bar for a few seconds (depending on the flow of the nozzles for about 20 seconds) and remove it (All this must be done while the bar is working with water).

Place the tray in a vertical position so that the collected water will run toward the tubes and the group of tubes will show the discharge curve. You can make some variations in the height to obtain a satisfactory curve. To totally spray the ground with a herbicide, our target would be to form a curve that is as horizontal as possible; in other words we want to have the same amount of liquid in all the tubes. When we have determined this, we have obtained the correct working height. Is still the determined height is not convenient, we have the following alternatives:

a) Vary the distance between nozzles.

b) Change the nozzles to a smaller angle (to increase the height) or to a greater angle (to bring the bar closer to the ground).

c) Change the nozzles and the distance between nozzles simultaneously.

In all the cases, the correct height must be determined each time. The checking with the use of a spraying inspector must be done to the entire length of the bar. The calibration consists in determining the volume of the mix that must be dried per unite (also known as application volume and is expressed as l/ha. Different from the flow, as the flow I expressed in terms of volume/time). This can also be done by the plant. In the given example the information required is the spraying volume in liters per hectare.
There are several practical methods to figure out the application volume. One of this procedures consists of using plastic bags to measure volumes. These are distributed to the agricultures by the companies that sell plant protection products. Nevertheless these measuring procedures can present unacceptable mistakes, so caution is required in its use. To verify if the calibration with these bags is correct, you can eliminate 250 milliliters of water so that the water level will match the 100 l/ha. At the distance of 50 cm. between nozzles. If 250 ml more of water are eliminated the level must mach the 200 l/ha mark, and so on. If everything is correct the measuring proceeding is reliable.
As a last choice you can use containers, or jars that are appropriately marked for such procedures.

The calibrating procedure consists of recollecting the sprayed liquid through one nozzle throughout 50 meters. Therefore the sprayer must be moved within the area that will be sprayed at a 50 meter distance and the time must be taken.

This can be done within the farm limits for convenience. Yet the ideal is to perform the procedure at the exact site because of the variations that may modify the working speed. When the time is being taken, the sprayer must be working as if it were really doing the job (Remember this trail procedure is done with water for economy and security reasons). Before spraying the mixture it is convenient to measure the flow of some of the nozzles in order to verify the existence of any differences with the flow determined by the water.

Photograph 6.40


The rotation during the connection to the tractor and the power check (PC) must be of 540 rpm. There is a manometer in the tractor, that indicates the rotation of the motor in that rpm mark.

Having determined the time that the tractor takes to cover the 50 meters, the collecting container must be placed on one of the nozzles to obtain the volume that has been sprayed during that exact time. This procedure can be done comfortably while the tractor is parked as long as the sprayer is working.

The level of water in the calibrating container will directly indicate the volume that has been sprayed (1/ha). Regarding the space between nozzles.
If you do not have any calibrating containers the procedure should be the same. You collect the volume of liquid in a container (jar or plastic bag, etc) Then you place all the liquid in a marked container and then do a little operation. For example: If “q” is the amount marked by the container, this amount corresponds to the amount that has been sprayed by one nozzle in 50 meters.

If we can say that “e” is the space between each nozzle, then the amount sprayed per hectare would be as follows:

“q” amount of liters were sprayed in (50 x e) m².

“Q” liters will be sprayed in 10,000 m².

Q = 10,000 q / 50e
Q = 200 q / e

Where:
q = amount marked by the container (in liters).
e = the space between nozzles (m)
Q = amount sprayed (liters / ha)

If the distance between the nozzles is of 0.5 m and the collected amount was of 1.5 liters, than you should obtain:

Q = 200 x 1.5 / 0.5 = 600 liters / ha

Suppose that during testing, the flow of all the nozzles was checked and the discharge pattern was verified by the spray checker, then the amount used in liters / ha. Can be don only in some of the nozzles. Nevertheless, if it was not previously done, then the amount sprayed must be determined in all the nozzles.

**Diluting:** Once you know the amount that must be used per hectare, you must make one more calculation to know the amount of product that you must dilute in the tank. For example, when the amount sprayed is 600 l / ha, and if you by a commercial mix with a dose of 2 kg /ha and the tank contains 400 liters, then you must make the following calculation:

You must use 2 kilograms of the commercial mix diluted in 600 liters.

In 400 liters you must dilute X kilograms.
X = 2 x 400 / 600 = 1.5 kg.

Therefore you must dilute 1.5 kgs. of the mix into the tank so that the indicated dose will be sprayed.

**Dose:** It is important to know that there are different forms of specifying the dose of the products (The Dose is the amount of product expressed in weight or volume. Dosage is any amount involved per unit of weight, volume or extension).

Basically the dosage of the product can be recommended according to its concentration (dose per hectoliter) or dose per area. In the first case, the product would say something like: 200g of the product (Mancozebe) per 100 liters of water. In the second case it would be: 6 liters of the product (Glifosato) per hectare.

The above indications are based on the concentration of the product and is only recommended for high volume applications, with a certain leakage of the mix and not regarding the amount sprayed. This is appropriate for fungicides. In many cases it is recommended for crops that will be sprayed in great amounts. The main advantage of this system is its simplicity. The variation of the surface that will be covered does not need to be considered for the concentration of the mix, which is always the same whether the plants are big or small. The amount is self-adjustable from its application to its dripping.

The amount of product indicated per hectare is preferable for herbicides and insecticides destined for great extensions. The advantage that this system offers is the distribution of the product regardless of the amount used. It can apparently seem more technical than the first system. Especially when the products are to be distributed on the surface of the ground as with herbicides, this system has no restrictions. When sprayed on the surface of the crops you must consider the relationship between the surface of the crop and the surface of the ground. With new plants in one hectare of land, you will see less than a hectare of leaf surface. Yet you must consider that the foliar surface grow rapidly and you cannot indicate one same dose for different stages. Therefore this indication is strictly conditioned by the “index of the foliar area”, a parameter that is not used very much.

The indications must be verified because they do not have any reference to the size of the plants and this can cause a variation. As a general rule when small plants are being sprayed an overdose can be observed.
CALIBRATION OF THE AREAL EQUIPMENT.

The spraying equipment for airplanes is compared to land equipment. It can be calibrated as for a tractor, only taking the following factors into consideration:

1. Water dose (liters/ha)
2. Flaying speed (km/hour)
3. Flying Altitude (meters)
4. Spraying Coverage (meters)
5. Nozzle type
6. Number of Nozzles
7. Angle of the nozzles
8. Discharge pressure
9. Double or Single Flight (overlap)

When spraying the signaling must be considered. The flag holders must have the appropriate protection equipment. Between laps you must leave a wide working strip of 100 to 115 meters (overlap). A second lap over the desired zone makes a better spraying possible. You must control the weather conditions during the treatment making sure the relative humidity is not less than 30 to 40%. The wind cannot be heading in the opposite direction of the flight not can it be greater that 3.5 m/sec. And if the wind is in a transverse direction regarding the flight it cannot be greater than 1.5 m/sec.

OTHER FACTORS THAT influyen THE EFFICIENCY OF THE SPRAYED PLANT PROTECTION PRODUCTS ON THE CROPS.

THE WATER: The water that is used to prepare the mix that will be sprayed is another factor that can affect the correct spraying of the plant protection products. The aspects that should be considered are the quality and amount of water, disregarding its disadvantages to dilute the mix which have been discussed previously. You must always check on the efficiency of the nozzles as a group.

The water used to dilute the mix of the plant protection products has used for many years. Nevertheless, in most of the situations, we have not considered the variation of the water conditions. These variations will depend on the origin of the water, where it runs, environmental conditions the increase the contents of mud, organic material and other materials. These materials affect the physical and chemical properties of the
products and they can also reduce their effect on the control of the plagues. Two conditions of the water such as a high content of minerals and the pH (degree of alkaline or acid), can directly affect the physical and chemical properties of the plant protection products.

**Water Quality:** the effectiveness of the plant protection products sprayed can be affected by using hard water, that is dirty and has a pH value that is inadequate for the product that is being used.

**Limy Water:** Calcareous or ferruginous water can affect the solubility of the products causing its sedimentation. This happens especially with those products that contain an active ingredient is acids.

**Dirty Water:** You must not use water that contains soil particles such as organic material or sands, which are colloidal and stick to the surface, and could totally nullify the effect of the active ingredients. For example paraquat is an active ingredient that will stick to the colloidal and consequently be inactivated. The use of dirty water causes greater wearing out of certain parts of the sprayer, especially the nozzles and tips.

**pH:** The pH levels determine the alkalinity and acidity of the water used to prepare the mix. Any value above 7 that’s the neutral level, represents alkalinity and any number below this is acidity.

The levels of alkalinity or high pH of the water can produce a chemical reaction of the plant protection product (alkaline hydrolysis) and consequently a chemical degrading, loss of effect over the plague or the phytologic toxicity of the crops. The reaction of the acid pH (acid hydrolysis), affects these products in very few cases or diminishes its effect.

The chemical degrading of a plant protection product, the reduction of its biological effectiveness and the phytologic toxicity problems are not only attributed to the pH of the water, but also to the pH changes of the mix when it is used with other crop protectors or fertilizers they are not compatible with.

A change in the pH of the water to alkalinity for a certain period of time will depend on certain factors such as temperature, season, and its contents of salt and minerals such as iron, magnesium and calcium. For these reason it is necessary to determine the pH of the water at different times of the day and different seasons in order to know the changes that are observed during the year and take the necessary measures to avoid the problems mentioned previously. In order to determine or measure the pH of the water out in the field, you will need manual meters or sensitive paper. Even though these methods are not exact, an approximate measure of the changes to acidity or alkalinity is given.
If the pH is above 6.5 it is convenient to use a buffer or acidifier (pH regulator) before starting the mix of plant protection products. For this you can use other chemical mixes (acidifier + minor elements or acidifier + surfactant agent). In Chart 6.21 we show several active ingredients, the time and degree of hydrolysis for a 50% degrading.

<table>
<thead>
<tr>
<th>ACTIVE INGREDIENT</th>
<th>TIME AND DEGREE OF HYDROLYSIS FOR THE 50% DEGRADATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSECTICIDES:</strong></td>
<td></td>
</tr>
<tr>
<td>Permetrinas</td>
<td>Stable in a 5 to 6 pH</td>
</tr>
<tr>
<td>Cipermetrinas</td>
<td>Acid pH is optimum</td>
</tr>
<tr>
<td>Monocrotofos</td>
<td>Not compatible with alkaline components</td>
</tr>
<tr>
<td>Propoxur</td>
<td>Not stable in alkaline conditions.</td>
</tr>
<tr>
<td>Bacillus thurigiensis</td>
<td>Not compatible with alkaline components.</td>
</tr>
<tr>
<td>Terubufós</td>
<td>Hydrolyses in alkaline conditions.</td>
</tr>
<tr>
<td>Profenofos</td>
<td>Not stable in alkaline conditions.</td>
</tr>
<tr>
<td>Dimethoato</td>
<td>Hydrolyses in alkaline conditions.</td>
</tr>
<tr>
<td>Malathión</td>
<td>Hydrolyses in alkaline conditions.</td>
</tr>
<tr>
<td>Diazinón</td>
<td>Stable in a neutral pH</td>
</tr>
<tr>
<td>Phosphamidón</td>
<td>Hydrolyses in alkaline conditions.</td>
</tr>
<tr>
<td>Trichlorfon</td>
<td>Hydrolyses in alkaline conditions.</td>
</tr>
<tr>
<td>Carbofuran</td>
<td>4 to 6 pH is optimum</td>
</tr>
<tr>
<td>Diazinón</td>
<td>Stable in a neutral pH</td>
</tr>
<tr>
<td>Methomyl</td>
<td>Stable in a 6 pH</td>
</tr>
<tr>
<td>Methiocarb</td>
<td>Stable in a neutral pH</td>
</tr>
<tr>
<td>Metil demetón</td>
<td>Hydrolyses in 7 hours in a 6 pH</td>
</tr>
<tr>
<td>Methamidophos</td>
<td>Stable in a pH of less than 6</td>
</tr>
<tr>
<td>Fenamiphos</td>
<td>Decomposition in a neutral pH</td>
</tr>
<tr>
<td>Acephate</td>
<td>Hydrolyses in a neutral pH</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>6 pH is optimum</td>
</tr>
<tr>
<td>Endosulfán</td>
<td>Affected by alkaline pH</td>
</tr>
<tr>
<td>Oxamyl</td>
<td>4.7 to 6.5 optimum pH</td>
</tr>
</tbody>
</table>

| **FUNGUICIDES:**  |                                                      |
| Benomil           | 5 optimum pH                                        |
| Tridimefón        | Stable in a 4 to 5 pH                                |
| Clorothalonil     | Optimum pH of less than 6                            |
| Captafol          | Stable under alkaline conditions                     |
| EBDC’s            | Stable in neutral or acid solutions                  |
### HERBICIDES:

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazinas</td>
<td>Decomposition in alkaline solutions.</td>
</tr>
<tr>
<td>Dicamba</td>
<td>Stable in a 5 to 6 pH.</td>
</tr>
<tr>
<td>Diuron</td>
<td>Stable in a neutral pH</td>
</tr>
<tr>
<td>Fluazifop-butil</td>
<td>Stable in a neutral pH</td>
</tr>
<tr>
<td>Oxyfluofen</td>
<td>Stable in a neutral pH</td>
</tr>
<tr>
<td>Paraquat</td>
<td>Stable in an acid pH</td>
</tr>
<tr>
<td>Alachlor</td>
<td>Stable in an acid pH</td>
</tr>
<tr>
<td>Glyfosato</td>
<td>Optimum pH of 3.5</td>
</tr>
</tbody>
</table>

**CHART 6.21**

**pH EFFECT ON THE HYDROLYSIS OF THE PLANT PROTECTION PRODUCTS**

**Water Amounts:** Greater or lesser amounts of water than needed can cause unequal applications or diminish the retention of the solution by the leaves. The amount of water that can be used depends on the season the plant protection product will be used, for example.

Soil Applications: For soil application in general, we recommend about 150 to 300 liters / ha of water.

Leaf Applications: For application to the leaves we recommend about 200 to 400 liters / ha of water in order to obtain a good coverage. The systematic products require less amounts of water than the contact ones. When it is a great amount of leaves you must use a greater amount of water.

**Mixtures:** Another factor that affect the effectiveness of the plant protection products is the mixture of products. To obtain good results in the applications of mixes it is necessary to take all the precautions because of the incompatibility problems.

The surfactants must be used with the same care, as they increase the effect of certain products and if these are added inadequately they can cause damage to the crops. An example is a herbicide called “propanil” as well as the insecticides “phosphorus” and “carbamites”. This mix can cause phytotoxicity of the crops.

On the other hand, you can also obtain some advantages by mixing the products because there is also a synergic effect. It is something eventual and it must be done by specialists.

When you mix herbicides, especially wetting powder and oils, the way you mix the suspension is very important. First you must dissolve the product very well in water, then add the oil or you will form lumps that will not dissolve.
In order to make a mixture you must be sure of the compatibilities. Generally plant protection products with the same formulation are compatible. Before mixing and spraying a product, it is necessary to make a previous sample in a small container and using the same proportions. If lumps or sedimentation is formed then you must not mix the ingredients.

ENVIRONMENTAL FACTORS:

![Chart 6.22](image)

CHART 6.22
ENVIRONMENTAL FACTORS THAT AFFECT THE APLICATION OF THE CROP PROTECTIONS PRODUCTS.

The environmental factors also affect the application of the plant protection products. These factors are not controllable by man and therefore the best moment must be found to obtained the greatest benefit and cause the least damage.

The humidity, the wind and the temperature are environmental factors that must be considered when in order to successfully spray any product.

HUMIDITY: Its effect is manifested in several aspects, such as the humidity of the soil, the mist and the rain.

Humidity of the Soil: This affects the application of herbicides and insecticides that are systematically applied to the soil. The systematically applied herbicides depend on the season they are sprayed. In the case of preemergent applications it is necessary for the soil to have its normal field humidity and after the application it need to water or rain fall so that the product will penetrate the solution. If the treatment is recommended before planting, this is preferably done to a relatively dry ground. In both cases the humidity of the soil is important, so that the weeds can grow and have contact with the herbicide that is present in the soil and manage to effectively control the weeds.
Mist: The mist can also affect the application of postemerging plant protection products but partially or totally retaining the solution of the product on the leaves of the crop instead of the weeds.

The Rain and Soil Applications: Excessive rain can cause lixiviation of the plant protection products along the profile of the soil, for example in the case of herbicides it could even reach the seed of the crop causing phytotoxicity. This risk is even greater for light and medium soils. For heavy soil the risk is not so great. This excess of water can cause such a solution of the concentration of any products that it will reduce or ever loose its treating effect.

The Rain and Foliage Applications: The rain diminishes the retention of the plant protection products, reducing its effectiveness to control a plague. In some cases you can increase the retention of the product by adding a surfactant mix.

The Wind: When you spray a product when there is a lot of wind you take a risk of producing a drift of the product to areas where it is not wanted. For example the drift of a herbicide can cause damage to the neighbor crops. It will also lose its effectiveness and the drift will alter the uniform distribution of the products.

It is best to spray a product when the speed of the wind is not greater than 10 km/hr. It is also important to consider the direction of the wind in order to avoid the contamination of other environments and intoxications among the personnel.

In order to counteract the negative effect of the wind during an application, it is recommended to do the following:

- Reduce the pressure of the drops so they will be big drops.
- Change the nozzle to one of a greater angle.
- Lower the height of the square pipe so the drops will be less exposed to drift.

Example: Winds with a great speed that 8 km/hr. can cause a lot of drift and carry the product to areas that are not within the target.

Temperature: Low and high temperatures can influence the effectiveness of the plant protection products.

High Temperatures. They can cause the following:

- Increase the toxicity of the product. If applied to the foliage it can affect the crop by producing phytological toxicity.
- The weeds wither. This affects the translocation of the systemic herbicides, reducing the effect of the product on the weeds and therefore reducing the control.
- They inactivate the plant protection products, especially those that are volatile.

- The increase the activity of some of the post-emergent herbicides, such as DNBP and 2,4-D which makes it necessary to reduce the dose.

Low Temperatures: They reduce the growth rate of the weeds which makes it necessary to increase the herbicide dose when the effect on the weeds it to slow. Such is the case of 2,4-D.

The applications of plant protection products must take place at a temperature between 15 and 35 degrees C.

Example: Temperatures greater than 28°C cause many losses especially if the size of the drop is very small.

**EDAPHIC FACTORS:** Edaphic factors such as texture and soil pH can also change the effectiveness of the plant protection products.

<table>
<thead>
<tr>
<th>Texture</th>
<th>Light soil (Sandy)</th>
<th>Heavy Soil (Limy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Acid Soils</td>
<td>Neutral Soils</td>
</tr>
</tbody>
</table>

**Texture:** The reduction of the effectiveness of the plant protection products application that have a systemic effect because of the texture of the soil, takes place mainly as follows:

- Light Soils. There is a greater loss of the product through lixiviation.

- Heavy Soils. The loss is due to the microbial degrading and the retention (adherence) of the product by the limy and organic matter particles.

**Soil pH:** We still do not have sufficient experience on the effectiveness of the plant protection products regarding the soil pH. We have found that atrazine is absorbed by the soil as the pH is reduced.

**QUALIFIED PERSONNEL:** There are specialists that are constantly studying and suggesting new technologies and methods for the application of plant protection products with out any danger. Almost all the procedures are a routine and all the
products are in a formula and container that prevents from any direct contact. Nevertheless its handling requires permanent education and updating on the innovations and frequent changes due to the technological advance that sometimes takes place very fast.

The first step for the correct use and handling of plant protection products is: train the personal that will be involved in any way with the transportation, sale, distribution, storage, mix preparations, application of the product, sampling and test results, etc. The personnel that is in charge of pest control must have knowledge on the matter, their life cycle, habits, and conditions that help its growth and development, among other aspects.

It is also necessary for them to know the products: their technical profile, especially its action mechanism for the adequate rotation of the products; its ecological toxicity profile for its handling without causing environmental or residual problems or any other aspects that are discussed in the present manual.

Nevertheless, before making a decision of using any chemical control as an alternative, the farmer and/or the technical advisor must and practice the Integrated Handling of Crops and Plagues (MIC and MIP). With the purpose of considering all the preventive measures as well as the monitoring and direct intervention measures in plague control.

**POSSIBLE CAUSES OF A DEFICIENT APPLICATION OF PLANT PROTECTION PRODUCTS.**

- Inadequate product due to an incorrect recommendation.

- A different dose than the one recommended due to a change of pressure or speed of the equipment, which was different from the results obtained when calibrated.

- Toxicity effects on the crops due to a badly washed sprayer after applying a herbicide.

- A deficient control at the beginning and phytological toxicity at the end of the application due to problems with the agitation system of the sprayer.

- Operators’ mistake due to the lack of signals or flags.

- Deficient control due to a resistant plague regarding the plant protection products.

- Deficient control of insect plagues (adults) because of the application of a larvicide or ovicide product.

**SUPERVISED PRACTICE, REVISIÓN, CALIBRATION AND DOSAGE OF THE SPRAYING EQUIPMENT**
OBJECTIVES OF THE PRACTICE:

That the participant will:

- Practice the different methods to calibrate the spraying equipment.
- Develop abilities to handle the different equipment properly.
- Select the spraying equipment according to the characteristics of the plant protection products.
- That he may measure the dose of the products according to the results of his calibration.

METHOD:

GROUP…………..PARTICIPANTS……………………………………
………………………………………………………………………………
………………………………………………………………………………
CROP AND PHENOLOGIC AGE………………………………………………
………………………………………………………………………………
PHYTOSANITARY PROBLEM………………………………………………
………………………………………………………………………………
RECOMMENDED ALTERNATIVE………………………………………………
………………………………………………………………………………

INSTRUCCIONS:

Initial Information.

1. Type of Pump being used and its specifications.
2. Toxicology, concentration, name of active ingredient, biologic action, chemical group, formula and way of action of the product being used.
3. Name, code and filter of the nozzle you will use.

ANSWER:
1. What information do you need to know before using a product and where can you find it.
2. Explain the steps you must follow in order to select a nozzle.
3. Which is the discharge volume of a nozzle and the timing, as well as the reason why this should be determined.
4. What amount of water should be used per hectare, according to the calibration.
5. What amount of active ingredient should be used for the same area.
6. What amount any commercial product should be used for two hectares of land.
7. How much will the final mix amount be. Explain.
8. How many 20, 16 and 12 liter pumps will you use per hectare.
9. How much active ingredient will you need for a 20, 16 and 12 liter pump.
10. Write all the steps you followed from the moment you selected the product up to the final spraying.

MATERIALS
- Personal Equipment and Protective Clothing.
- Spraying equipment.
- Stickers, manuals and simulation material to mix and spray.
- Hydro-sensitive Paper.
- Measuring tape.
- Buckets.
- Set of Nozzles.
- Tools (screwdriver, pliers)
- Paper for charts.
- Markers.
- Beaker and/or measuring liter.
CHAPTER 7

COMMUNICATION SKILLS
CHAPTER 07
COMMUNICATION SKILLS

SPECIFIC OBJECTIVES:

The participants will:

- Obtain the basic concepts that will allow them to plan the training sessions.
- Be able to select the most appropriate didactical materials and resources for the training sessions.
- Learn to use the resources and materials adequately
- Know and practice the methods that will help develop the best teaching process.
- Learn to make their own didactical materials for the training sessions.

METHOD:

Initially there will be a talk about the didactical concepts that are pedagogical and necessary for the practice.

Simultaneously the group of participants will share their experiences on the problems they have observed during the training sessions with other target groups. They will analyse the situations that have succeeded and failed in order to determine the causes. The groups will be divided into subgroups to then perform a supervise practice. Each subgroups should have a maximum of 8 participants.

Finally, the supervised practice will take place in three stages.

The first stage will consist of the planning of a training session regarding one specific topic.

The second stage will require the resources to make the didactical aids needed to impart the training sessions that has been planned.

The third stage will consist of the execution of several simulations of the planned class. One participant will be the instructor and the rest will act as participants. After each presentation, an evaluation will take place to improve the deficiencies found.

TIME REQUIRED:

Eight hours (4 of theory and 4 of a supervised practice).
MATERIALS NEEDED:

The following material must be available:
- Paper for the
- Markers
- Overhead Projector
- Rules and Pencils.

STUDY PAPERS:

COMMUNICATION SKILLS

It is relatively easy to obtain the technical abilities, but to learn or have the skills to communicate successfully with an audience is a bit more difficult. Undoubtedly some people have an easier time than others to give a training session. Nevertheless there are some simple guides and techniques that can be followed to assure a successful presentation.

Planning of a Training Session: Careful planning of a training session is the key to success. Several aspects must be considered.

The Target Group: The first step in planning a session is to learn the characteristics and experiences of the audience so they must answer the following questions:

- What is the main concern of the audience? Are they future trainers, or are they farmers, or farm workers that are going to practice what they will learn during the session?
- What educational level do they have?
- What level of knowledge and experience do they have on the subject of the course?
- Which is the best level of language and type of audiovisuals that will give a better understanding?
- The real time frame expected for the training course and how is the work of the participants organized?
- The age range expected in a training course? The teaching methods may need to vary if it is for a higher age group.
- What is the level of motivation to attend the course and how this will affect the possibility of using new techniques or changing the existing methods?
- Number of participants. It is not convenient to plan a course for a great number of people because its quality will be reduced drastically.
This information will be the base of the entire plan and it will affect the following:

- **Contents:** The topic must be of interest for the entire group and it must be presented with an appropriate technical level. The base must be built with the experience of the participants and it must also include important examples.

- **Time:** The duration of each session and the course, the time of day, week and semester as well as the schedule (every day, one day a week, etc) must be established according to the capability of the group.

- **Method:** There must be a balance between the theory and the practice and the use of training methods that focus on the participants or the instructors.

- **Supplies:** You must decide what kind of supplies you will use, especially drawings instead of writing, and aids instead of just materials. The participants must be able to understand all the aids used.

- **Location:** The location of the course is important, as well as transportation and accommodations.

**Attendance:** Motivation to attend the course is desired or the obligation to learn new techniques. The combination of both the desire and the obligation would be preferable.

**Training Objectives:** To plan a training course effectively it is necessary to determine from the beginning what is expected of the participants to learn. In order to reach this goal, you must define the purpose of the course and let the participants know what they will be able to do at the end of the training course.

The use of specific objectives will allow you to:

- Make a clear plan of the structure, methods and aids.
- Measure the effectiveness of the course.
- The participants will have a clear idea of what is expected of them.

Special books on this subject will give you more criteria on how to develop your objectives.

**Resources and Supplies:** The use of supplies and resources is vital for the planning, preparation and presentation of the course activities.

**Resources:** After identifying the target group, the location and the subject, you can ask yourself the following questions: Which are the necessary elements to cause a major impact during the available time? There are of resources that are necessary to maximize
the effectiveness of a course. The resources can be divided into three categories: time, assistants, and financing.

- **Time**: The course itself can consume a great deal of time, but you must consider the availability of the participants. A farmer or a small distributor of plant protection products in most cases will obtain an income from this one activity. Therefore it will be hard or impossible for them to attend a one week course. Nevertheless it could be practical for them to attend a series of short courses for several weeks but only for one day or half a day at a time. In conclusion you must consider the group in order to make their attendance easy.

The preparation for the course (series of courses) should take up more time than the actual course. For any new course you must consider the preparation time which is three times the duration of the actual course.

- **Assistants**: It is a big burden for one single person to give one whole course. An assistant will help with the burden and will help the course because there will be a second point of view and the attention of the participants will increase because they will hear two different voices and styles. If you have the chance to work with the same assistant during several courses you will find there is greater complementation and help as you can talk about the course, the fashion and contents at another time.

An invited speaker can enhance the course, especially if the person is a specialist on the subject or an important member of the community. On the other hand, the guest will also give credibility and importance to the course. Nevertheless you must keep in mind the following facts when you invite a speaker:

- Explain the subject and depth to the speaker. Make sure he goes to the point in order to avoid contradictions and controversies.
- Help the speaker with his audiovisuals if necessary so that the course will have the high quality in all the presentations.
- Advise the speaker to see to the participation of the attendance.

- **Financing**: During the first stage of the planning you must consider the availability of funds for the course. You must be aware that even the simplest course costs money. Make a list of expenses as follows:

  - Rent of the conference room (tables, chairs, etc.)
  - Equipment rental (video, projectors, etc.)
  - Food and/or beverages.
  - Supplies (pencils, notepads, markers, transparencies, etc.)
  - Transportation (instructors, speakers and participants).
  - Invitations, press advertisements.

When applying for funds you must have a detailed budget of expenses.

**Supplies**: The success of a course some times lays on the type of supplies used for the training sessions. Below you will find a list of the type of supplies you must consider
when planning and preparing for a course. The technical details on how to use these supplies are found under the section “Visual Aids”.

**Electrical Equipment:** The use of electronic equipment and sophisticated training equipment is more common each day. The following is a detailed list of the simple equipment an instructor could use and the operation of the electrical equipment. Nevertheless, before deciding on the type of equipment, you must consider the following situations:

- Is there a power source at the conference room?
- The voltage of the source? Are there any variation of the voltage?

Supposing the place has electricity, then you must think of the following:

- Extension cord
- Transformer (if the equipment uses a different voltage than the source)
- Voltage Regulator (to protect the equipment from the power fluctuations)
- Universal Adaptor
- Two hole adaptor
- Insulation tape.

a) **Multimedia Projection Equipment:** The components of this equipment are a computer, diskettes and CDs. It is very important to verify the good condition of the equipment and the compatibility of the software before the presentations. The projections may be shown on the wall or screen and do not require a totally dark room. The projections must be directed in such a way that all the participants will see them. A fused projector light must be replaced by an expert technician.

b) **Video:** A television set, a videocassette player and a remote control are all the components and they must be checked to see if they are working correctly.

c) **Slide Projector:** Its parts are the projector, the carrousel, the slides and a remote control. To use this equipment correctly you need a dark room. The instructor must know who to use it, especially how to turn it on and off and focus it manually or by using the remote control. It is also convenient to have spare bulbs and to know how to replace them when they burn out. The bulbs must never be changed when they are still hot. You must wait for them to cool down in order to avoid getting burned. You must have the same care when changing a bulb of a multimedia projector.
Before projecting on a wall or screen you must verify that all the participants can see it. You must also check the quality of the slides in order to eliminate the ones that are too dark or too light. It is also convenient to check the position of the slides in the carrousel so they will not be projected upside down or backwards.

If you have a remote control, it is convenient to connect it and become familiar with its handling. The control can help you go forward, rewind and focus. If the cord is too short you can ask someone to help you. These same instructions must be followed when using a multimedia projector or any audiovisual projection equipment.

b) **Audiovisual Equipment:** A slide projector, a carrousel, the slides, a recorder, the tapes and the control. This equipment needs to be handled by a technician. Inaudible pulsations make the carrousel work and project the slides in a synchronized manner with the slides. In general, each audiovisual (A-V) can last 20 minutes or less. There is less sophisticated equipment that has audible pulsations and the slides are projected manually. In order to use the equipment correctly you must read the instructions and check to see that the tape recorder is working correctly. Practice the presentation and verify the synchronization of the projection and the sound. Other recommendation are: Place the slide and the type at the starting point. Never change the bulb while they are hot and always have spare bulbs.

c) **Overhead Projector:** The supplies you need for an overhead projector, transparencies and acetates. An advantage provided by this projector is that you do not need a dark room for the presentation. Read the instructions on how to use the projector, which is rather simple. There is a control to start it, one to control the sharpness and the amount of light that the projection has. When you are going to use and overhead projector you should check in advance if the it is correctly placed before the wall or screen to avoid distorted images. You should also make sure that all the participants can see the projection and that it is not too dark. And remember that when you need to change a burned bulb you must first wait for it to cool down to avoid getting burned.

**Other Equipment :**

a) **Paper Easel.** The supplies needed are an easel, a board with paper holders and markers. Its use is very effective and increases the quality of any training course. In places where there is no electrical power it will become the only visual aid. You can find these easels already made, but if not, you can easily make one with a big board, big sheets of paper, the paper holders and the easel or any other type of support. The illustrations, headings etc, can be prepared before the session. You must always have clean sheets of paper for each session. Use markers with thick points (3mm) so the letters can be seen by all the participants. You can use 3 or 4 colors to highlight what is necessary. When the groups are small you can use a smaller easel that can be placed on a table.
b) **Blackboard:** You will need a support for the blackboard and chalk. They are easy to find, especially if you are using a classroom for your presentation. You can also make one with a board with a smooth surface and some paint. They can be hung on the wall, on an easel or on any other structure so that all the participants can see it. You must have a good supply of chalk in several colors, if possible, an eraser or a wet cloth is advisable.

c) **Whiteboard:** A whiteboard also needs an easel, markers and erasers. Lately the use of whiteboards has increased because they are easy to use and easier to erase. You must have different color markers and check to see if the ink can be erased easily. The permanent markers can only be erased with a solvent.

d) **Other Supplies:** There are a great number of supplies that can be used to assure the success of any training course. Below you will find a list of supplies that have not been mentioned yet:

- Note pads for the participants
- Pens and pencils
- Empty containers of plant protection products. Make sure they are new.
- Samples of stickers and pamphlets.
- Sprayers and/or atomizers
- A set of nozzles
- Tools (screwdriver, wrench, etc.)
- Protection clothing and equipment
- Biological specimen (weeds, insects, sick plants).

**PLANNING A TRAINING SESSION.**

Making a plan for a training session is a very important aspect, because the instructor has the opportunity to develop the structure of the session and it will also be of help during the session itself.

The plan can be used only during the session together with detailed notes. It is important that the plan contains a clear and brief development of the course, including the schedule of the different segments as well as the supplies that will be needed. There are several ways to develop a plan. Here we suggest a format that is adequate for most purposes.
After you have identified and the group you will train, then the objectives of the course must be defined as well as the rules you will establish to reach your goals. The place must also be considered, that is if it will take place in the field or in a room. On the other hand you must also think of how you will place the chairs, in a formal manner, or informally to make a semicircle. The disposition of the chairs will influence the relationship between the instructor and the participants.

The equipment you will use of the session must be listed at the top of the plan to serve as a guide when getting ready for the course.

The plan can also include the methods you will use during the session, in order to guide the instructor. The methods can be of a conference, a demonstration a simulation, a case study, group discussion, questions and answers, an expert panel, games. Brainstorming, dramas, etc. Depending on the method, you can determine how long the session will last, for example with questions and answers you need more time than for a conference. Nevertheless the first method of questions and answers gives a better training.

The questions and answers sessions are undoubtedly very effective if they are carefully guided. They can be developed in two different ways:

- With a direct question to the entire group, which will motivate and provide the instructor with a lot of information.

- With a question made to a specific participant.

Another method that is worth considering is that of the group discussions. You can divide the group in pairs or groups of three or more to discuss different topics and later share with the entire group. This method takes up more time than a conference, but as with the questions and answers, it is a very effective learning method. These methods are described in detail in the following section.

The structure of a course depends on if it is based on knowledge or abilities. But in general terms all sessions have three parts:

1) **Introduction**: To explain the important of the topic.

2) **Main Body or Development**: Explains the topic in logical steps.

3) **Conclusions**: Reviews the clue aspects of the session and covers the goals.
The structure of a session interested in knowledge would be as follows:

1) **Introduction**: The general view of the topic and maybe some important aspects to interest the participants, for example the importance of the topic in terms of security, or its relationship with crops. It can also be related to the topics of other sessions.
2) **Development**: This is the content of the topic, presented in brief steps and using the different methods such as conference, questions and answers, pairs or groups of more than three, etc..
3) **Conclusions**: Review the key information and define your goals through questions and answers.

A practical session or one based on skills will have a similar structure but the methods will be a bit different.

1) **Introduction**: Present a general view of the course and its importance, paying particular attention to the security aspects.
2) **Development**: A demonstration given by the instructor, followed by a practice with all the participants
3) **Conclusion**: Discuss any questions presented by the participants, review the clue information and establish your goals using questions and answers.

In any session the distribution of the time for each activity is very important. In a session with different activities for example, the time dedicated to the practice must take up more than half of the entire schedule. A possible distribution could be the following:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>5%</td>
</tr>
<tr>
<td>Development</td>
<td>15%</td>
</tr>
<tr>
<td>Practice</td>
<td>70%</td>
</tr>
<tr>
<td>Conclusion</td>
<td>10%</td>
</tr>
</tbody>
</table>

The following is a complete plan of a course for a group of participants that are farmers:
TRAINING SESSION PLAN

Subject: Protection Garments  Time required: 1 hour

Objectives: The participants will be able to select adequate protection garments by reading the label on a given product, when having to mix or spray it. They will also learn how to take care of the clothes and protection equipment.

Equipment: 4 pairs of rubber gloves, 4 face shields, 4 aprons, 4 overalls, 4 pairs of boots, plastic bags, plastic sacks, rubber bands, ropes, long sleeve shirts, pants, stickers, empty containers, 3 or 4 sprayers, Paper for the easel, markers, a table, seats for the participants, soap and water.

<table>
<thead>
<tr>
<th>METHODS</th>
<th>TIME</th>
<th>CONTENTS</th>
<th>AIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 INTRODUCCIÓN Questions and Answers to establish priorities.</td>
<td>5 minutes</td>
<td>Security – need for protection of skin eyes and face and toxicity of plant protection products</td>
<td>Paper Easel</td>
</tr>
<tr>
<td>2 DEVELOPMENT Questions and Answers</td>
<td>5 minutes</td>
<td>1. Good hygiene habits</td>
<td>Paper Easel water and soap Protective Clothing</td>
</tr>
<tr>
<td>DEMOSTRACIÓN Questions and Answers</td>
<td>10 minutes</td>
<td>2. Show the type of protection available and the degree of protection needed in handling concentrated or diluted products.</td>
<td>Protective Clothing Stickers and Protective Clothing</td>
</tr>
<tr>
<td>Guided questions and answers</td>
<td>10 minutes</td>
<td>3. Distribute stickers for the exercise so the participant will discover important information.</td>
<td>Protective clothes, plastic, scissors, etc.</td>
</tr>
<tr>
<td>Practice</td>
<td>10 minutes</td>
<td>4. Allow farmers to try on the different types of protective clothes and design or prepare alternatives.</td>
<td>Paper Easel</td>
</tr>
<tr>
<td>Questions and answers</td>
<td>20 minutes</td>
<td>5. Care and maintenance of protective clothes</td>
<td></td>
</tr>
<tr>
<td>3. CONCLUSIONS Questions and Answers, Discussion.</td>
<td>5 minutes</td>
<td>Review clue information and discuss doubts.</td>
<td>Paper Easel</td>
</tr>
</tbody>
</table>
TRAINING METHODS

The participants in these courses on plant protection products are usually small groups of adults with experience on the subject.

Considering these circumstances, the training methods must be as practical as possible in order to add on to their experience, maintain motivation, stimulate the participants to practice what they have learned and allow the instructor to follow the training process.

Questions and Answers: The most versatile method is to involve the participants by making questions. One of the most common ways of asking is the following:

- **Indirect Questions**: The instructor makes a question in general so any one is free to answer. These questions are useful to “break the ice” in a new group or to introduce a new subject. Nevertheless this method tends to favor those who like to talk and those who are more quiet might feel unmotivated.

- **Direct or Guided Questions**: The instructor makes a question to the whole group, looks around for a few seconds then calls a person. This method gives the instructor more control on the situation and can stimulate the less communicative. It can keep those who are distracted more focused and can help determine if most of the participants are understanding.

- **Group Questions**: These questions can stimulate the group at certain moments of the course. Always be aware of those who love to talk and those who ask questions that are not related to the subject to be answered at another time.

The main type of questions are:

**Open Questions**: These start with why, who, which, where, when, and how. So you must always make closed questions like: Are you… Did you... do you think…. , which will make the participants answer with a yes or a no and the instructor can also determine if the person knows what he is saying. One of the most common questions is: Is it clear? Or Do you understand? The answer will be yes, but you cannot determine if they understood the subject or not, so these must also be avoided.

The use of questions and answers requires practice and it may be difficult for the beginners. You must not lose motivation and you must remember that sometimes it is the participants who need to adjust because they are used to other training methods. This is something that needs to be determined by the instructor.
There is another method used to motivate participation in a course. It can be used as a basis for all courses though it is usually combined with methods that are focused on the instructor.

One form of group discussion is when the instructor presents the subject to groups of 4 or 5 and gives them time to reach conclusions, then the representative of each group will inform the entire group.

Even though the instructor has a very limited influence during group discussions, his role is very important in terms of preparing and guiding the exercise.

- The objectives of the course must be clearly defined.
- The questions for the discussions must be carefully picked to reach the objectives.
- The topic must be clearly presented.
- Precise instructions must be given regarding the time and way of making the report.
- The instructor must be prepared to give any other orientation that could have been missed as well summarize and help the participants reach the objectives.
- The chairs must be placed in such a way that there will be room for group circles around the tables.

For example if the instructor is talking about preventing intoxications caused by plant protection products. After the initial presentation showing the various parts of the body through which the product penetrates into the organism; you could then ask them to talk about how the farmer can prevent contamination by the plant protection products through each of the body parts studied.

After a determined discussion period, a representative of each group is asked to share their findings. This is how they will develop preventive intoxication methods by inhaling, ingesting or through the skin.

The instructor can use these conclusions (the representatives can use transparencies or charts if time allows) to further discuss their correct use, complementing or reviewing any point when necessary or further discussing the points of disagreement.

A second type of discussion is sometimes called “pair groups”. Here the topics are discussed by the participants in pairs and instead of getting a complete report from each pair, the instructor usually accept one or two interventions for a chart that he will develop later.
Let's say the instructor distributes the label of a given product to each participant and asks the couples to make a list of the different categories of information they contain and contribute with one or two points to a list that the instructor will make on the paper easel and will use further on.

The groups of pairs are similar in many aspects to larger groups. The most important points are the following:

- Write the question on a chart or transparency and keep it in sight so the group discussions will take place.

- The groups of two must be formed clearly, especially when the group of participants is uneven. You then will let the last group be formed by three people.

- If each group has a different topic, you must make sure each group knows the subject well.

- Tell the participants exactly what they have to do, for example if you tell them to “make a list”.

- Determine how much time you have. 5 – 10 minutes for the groups of pairs, which will be used only as a guide and the instructor will analyse that part of the discussion when he or she sees that most of the groups have finished. The instructor cannot interfere while the groups are discussing.

- During the discussion the instructor must not stay in any of the groups. He must sit in the back so he will not inhibit the group and also to observe with discretion and see when the majority of groups are finished to end the discussion period.

- The report of the discussion must be structured as follows:

  - Each group in the room will say one subject in an orderly manner. You must make a list on the blackboard or chart, with all the information.
  - Write all the points of their opinions without discussing with the group, so they will not be discouraged or think their contribution is not important.
  - Use different colors to make a clear list and relate the group with the points listed.
  - When all the groups have participated, go around again but ask another member of the group in order to complete the list. If there are no contributions let any group answer.
  - Check your only list to see if any important point has not been mentioned. If there is a missing point make more questions and guide the answers in order to have a participant respond.
  - Discuss the important points and mention the groups that said them, to motivate the participants and have their contributions appreciated.
  - Finally end the exercise and connect it with the following part of the course.
Guided Discovery: A very powerful training method is allowing the participants to discover principles and abilities for themselves.

This exercise must be guided because in short courses you do not have time to make spontaneous discoveries. This means the instructor will sufficiently prepare the participants to make sure they will follow the desired path.

For example when you are talking about calibrations, the instructor will present the subject giving a definition of calibration and discussion the importance of spraying an exact dose and identifying the necessary equipment for the calibration of a sprayer.

Then you must divide the participants into groups and give each group the equipment, a label from any product, a calibration manual and then you will ask them to calibrate the sprayer according to the product.

Solving the questions and summarizing the answers are vital elements of this type of method. There will be a great variety of questions and misinterpretations. These can be used constructively to reinforce certain points of the course.

Demonstrations: They are an important part of training courses on plant protection products because they connect the theory with the practice. The demonstrations can be well prepared with anticipation.

Make sure the equipment is complete and in good conditions for teaching. The instructor must have tools, protective clothing and personal protection equipment.

The procedure of a good demonstration is to practice in order to avoid possible mistakes. Make a careful analysis of the procedure, try to gradually make your presentations clearer especially if your are not familiar with the subject or it is too complicated.

You can ask an operator with experience to help you identify the stages, develop a methods and determine the key points. This can be done with the following chart:

<table>
<thead>
<tr>
<th>STAGES</th>
<th>METHOD</th>
<th>KEY POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is important that all the participants can see and hear well during the demonstration, so you must make the necessary arrangements for this.
Practical Instruction: Any practical activity must be based on the principal of “learning while doing”. This means that when possible the demonstrations must be followed by the practice of the participants.

The following format will help you reach this goal.

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Demonstration</th>
<th>Practice (70% of the time)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Present the procedure</td>
<td>• Give one demonstration at a normal speed.</td>
<td>• Distribute the participants into small groups considering the amount of equipment available.</td>
<td>• Reinforce the key points.</td>
</tr>
<tr>
<td>• Discuss its importance</td>
<td>• Give a second demonstration as a slower pace.</td>
<td>• Correct mistakes immediately but do not interfere unless absolutely necessary.</td>
<td>• Correct the mistakes found during the practice.</td>
</tr>
<tr>
<td>• Review all security aspects.</td>
<td>• Let the participants do it.</td>
<td>• Promote self-assurance and congratulate on success.</td>
<td></td>
</tr>
</tbody>
</table>

The session must be guided according to the number of participants, the amount of equipment and the time you have available.

Each small group must work with its own equipment so that each person can practice and the rest of participants can make corrections and comments. The groups must have enough space to work so they will not interfere with each other.

It is sometimes inevitable to have big groups but according to the circumstances, the instructor must try to let the majority do the work and the rest to keep focused and interested.

When practicing abilities, the participants will definitely may mistakes. The correction of these mistakes in an appropriate way is also a very important ability for the instructor. The participants will learn much better if he figures out alone that he is wrong and will make the necessary corrections. Therefore the trainer must avoid pointing out the mistakes. Nevertheless the instructor must be ready to intervene when the mistakes can put the participants in danger or the equipment is damaged.
Basically there are four ways for the instructor to intervene when he sees the participants making mistakes and these interventions are directly related to the type of mistakes, as follows:

<table>
<thead>
<tr>
<th></th>
<th>Prevention. If the mistake is dangerous for the participants or the equipment can be damaged.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Immediate Intervention: If the mistake will become a bad habit because it was not corrected on time.</td>
</tr>
<tr>
<td>3</td>
<td>Delayed: If the participant can figure out the mistake by himself.</td>
</tr>
<tr>
<td>4</td>
<td>Ignoring: If it is a minor mistake and the participant will be able to make the necessary corrections in the future.</td>
</tr>
</tbody>
</table>

After the timely intervention of the instructor, the participant is able to correct his mistakes. Disregarding the type of mistake in most cases, it is best to let the instructor guide the participant with questions such as the following:

- What is the problem?
- How will you correct it? What happened?
- Why is it important?
- Which is the right procedure?

Success of a practical session depends on the good preparation of the equipment, the materials, a good demonstration, a good schedule and good supervision and finally defining good conclusions.

**Instruction Visits:** An essential part of the courses on plant protection products are the instruction visits to farms, experimental station, a warehouses. Nevertheless the overall success involves the amount of preparation on behalf of the instructor.

The instructor must visit the site with anticipation and discuss with the key person about the date, schedule, number of people and objectives of the exercise.

The participants must be informed before the visit and receive information on the place, the schedule and the number of specific tasks they must complete during the visit. It is important to have an evaluation session (usually at the training) to discuss the essential aspects of the visit and to reinforce key points and give solution to any questions.
Conferences: In general we can say that the traditional lessons full of theory are inadequate to train agricultural technicians. Nevertheless, there are occasions when they must be used. For example when the group of participants is very large and you have a great amount of information to give them in very little time; when you have very little time to prepare or when the session will be conducted by a very important person.

The effectiveness of this method can be maximized just by making sure the topic is interesting and it is presented in a clear and logical way with the help of illustrations or audiovisuals. It is important to have a summary of the conference to hand out to the participants at the end of the session.

Combination of Methods: Most of the training sessions will consist of a combination of methods. When you change the training methods you also keep the participants interested. You do need to keep a balance on the amount of methods because too many methods can bore the participants and one single method will be boring.

COMMUNICATION WITH THE PARTICIPANTS

The participants can have different backgrounds. Some can be farmers, others salesmen, paramedics, school teachers, etc. demands for a course that is adaptable for each case.

Disregarding the type of participants, it is important to develop a correct approach. The instructor can learn form the participants about the specific problems that he has encountered and the methods that he has developed to solve those specific problems.

It is also important that you develop a double communication means, not only during the session but for the future when evaluating the course and its effectiveness. If you should notice during the subsequent visits that the information is not being used, then you must try to find the possible causes, such as the following:

- The information was not understood during the course?
- The information was understood but no emphasis was made on the benefits derived from its use.
- The recommended procedures were not practiced by the participants in a real way.
- The recommended procedures were practiced by the participants but reinforcement is needed.

It is important to consider these experiences and make the necessary changes for the session.

You must remember that the instructor must not only explain the recommended procedures but all the necessary procedures. For example when describing a warehouse or samples of plant protection products, you must explain that the powder formulas
must be stored and placed on top of the liquid formulas and not vice versa, because if
the liquid should spill, the powder packages will be ruined. If the participants
understand the reason for the recommendation, then there is a great possibility that they
will put it into practice.

LEARNING AIDS

In any learning process, a relatively small portion is learned by hearing nevertheless,
you can learn more when you see and you learn the most when you practice. A simple
way to explain this is as follows:

| To hear is to forget |
| To see is to remember |
| To do is to understand |

This section is about the visual aids that can help to learn such as the simplest visual
aids, the real equipment and blackboards, up to all the sophisticated equipment. Here
you will find the best ways of using the visual aids and how to get things ready.

The Real Equipment: Such as the following

- Species
  - Samples of weeds and plants
  - Insects and the harm caused by insects
  - Sick plants
- Sprayers or Pulverizers
- Nozzles
- Protective Garments
- Samples of Plaguicide packages
- Stickers and pamphlets

One of the best ways of illustrating a session is with the real equipment. Especially if
the participants are capable of handling them. This is very useful, especially in cases
where the audience can be confused, for example if an insect is shown on a screen it
may be unrecognizable.
**Blackboards and Chalk:** Blackboards are not practical for every situation and they cannot contain much information either. They should be used for summaries, to make lists of for diagrams of any topic, or simply to write a technical name at a given moment.

While writing on the blackboard you will not face the audience, therefore you must avoid talking while writing. Which turns out to be a beneficial pause for the participants so they and take some notes and the instructor and organize his thoughts.

Place the blackboard where everyone can clearly see it and your writing must be big enough to be read from every angle of the room. A general size would be of 30 mm for all the letters and 50 mm for the capital letters.

The one disadvantage in using a chalkboard is that the chalk residuals get on your hands and clothes. But the good thing is you do not need electricity and even though it can not be more effective than other visual aids, it can contribute as a complement to other equipment.

**Whiteboards and Markers:** There are just like the blackboards but with out the residuals of chalk and you can use a whole variety of colors. Generally your handwriting and other illustrations are clearer and can be seen easier than on a blackboard. Therefore its should be used like a blackboard, as follows:

- You must not talk while writing on the board and not facing the audience.
- Your handwriting must be big enough for the entire audience to see.
- Place the board where all the participants can see it.
- Use whiteboard markers.

The same as with the blackboards, the whiteboard will not replace other visual aids but it certainly is a very good complement.

**Paper Easel:** This is a very versatile and valuable aid in places where there is no electrical power. They are perfect for training sessions and can be used as follows:

- To make lists of topics, things, different aspects, etc.
- For drawings and diagrams.
- To write the important points of a discussion.
The sheets of paper are easily found. You must consider the following aspects when using an easel:

- Place the easel where everyone can see it.
- The handwriting must be big. (50mm for capital letters and 30 mm for all other letters).
- You thick point markers (3mm at least).
- Use different color markers to highlight the key phrases.
- Avoid writing too many words on each sheet.
- Write simple and short phrases.
- Prefer using printed handwriting.
- Avoid talking to the audience when writing on the easel.

Making illustrations on the Easel: Many people can make clear and simple drawings from illustrations. But if you do not have this gift then you must use other techniques that will also have good results.

The Squared Method:

- Select the illustration.

- Make vertical lines from the top to the bottom of the illustration at a same distance (5 to 10 lines); and from one side to the other make the horizontal lines all at the same distance (5 to 10 lines). This will form squares on the illustration which will be divided into 100 little squares.

- Reproduce the squares on a bigger sheet of paper from the easel, according to the size of drawing you need.

- Copy the drawing section by section, without worrying about unnecessary details. Use a pencil first so you can easily make corrections.
The Overhead Projector

- Select the required illustration
- Trace or Photocopy the illustration on the transparency without worrying about small details.

**FIGURE 7.2 Copy on the transparency**

- Project the illustration on a chart or whiteboard
- You can draw over the illustration that is being projected

**FIGURE 7.3 Transfer the illustration on the whiteboard**
FIGURE 7.4 Place the paper on a table and complete the drawing using markers and color the spaces as required.

You can make good reproductions (illustrations or drawings) with both methods.

**The Overhead Projector.** This is one of the most versatile audiovisual aids. It is more or less expensive and you need to use transparencies and special markers to use with the transparencies. The drawing on the transparency is projected on a white wall or screen. You do not need a dark room to use an overhead projector.

It can be used in the same manner as the paper easel, for example:

- To make lists of topics, or things, etc.
- To make drawings or diagrams
- To write down the important points of a discussion

The transparencies are much smaller and easier to use than a big chart. With special transparencies you can make photocopies of any illustration in black and white or in color.

When you use an overhead projector it is convenient to follow these recommendations:

- Place the screen where all the participants can see it. Make sure the projector nor the speakers gets in the way of the screen.
- You can face the audience when you use an overhead projector. The person and stand or sit beside the projector and use a pointer to show the important points of a discussion on the transparency and not on the screen.

When using transparencies for the overhead projector you must consider the following aspects:
- Your handwriting must be clear and make sure the size or the writing is appropriate for the projection on the screen (generally 5 mm as a minimum).

- Use illustrations and headings that are simple, and avoid putting too much information on one transparency. In other words just write the main ideas.

- Use a maximum of 70 words on each transparency.

- Use colors to highlight the key aspects of your illustration or chart.

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**GOOD ILLUSTRATION**

**BAD ILLUSTRATION**

**FIGURE 7.5 CORRECT DISTRIBUTION FOR CHARTS OR OVERHEAD PROJECTOR TRANSPARENCIES.**

Observation: There are two kinds of markers that can be used to write on transparencies. Some are permanent, which should be used for specific points or illustration. Sometimes it is advisable to practice on a piece of paper. The ink in there markers does not erase easily. You have to use a solvent. If you do not have a great amount of
transparencies you can use water markers and erase the transparencies over and over. Water markers sometimes run and the transparencies must be wet with care.

There are some special techniques that can be used with overhead projector to increase the effectiveness of the message conveyed, which are the following:

- **The Revealing Technique:** In this case instead of showing the entire contents of the transparency, you use a piece of paper to cover it and only let the participants see line by line to focus their attention on a specific point.

- **The Overlaying Technique:** This technique uses two or more transparencies that have a different part of the illustration. The transparencies are placed in order on the projector one by one until the illustration is complete. The transparencies can be numbered and stored conveniently. This technique is excellent for describing the parts of a sprayer for example.

  Transparency No. 1: The Body of a sprayer, the tank and the nozzle

  Transparency No. 2: The pump, the gear and pressure chamber

  Transparency No. 3: The location of the valves

  Transparency No. 4: The location of the filters.

  You can have the audience participate by placing the transparencies in the correct order in response to your questions.

- **Using Three Dimensional Objects:** They can be placed on the overhead projector to show a silhouette on the screen. For example to show the different shapes of leaves or to identify the different types of openings on the nozzles.

Finally, when you finish using the overhead projector you must turn it off and put the transparencies away. If you leave the overhead projector on, the illustration may distract the participants and the fan will interrupt with its unnecessary noise.

**Slides:** Slides are projected on a screen and offer a high quality image. They can be used for graphics, stories, pictures and you need the advise of an expert. You need a power source in order to use the slide projector. The images are of a very high quality and sometimes slides are the only from a illustration you have to show pictures of plants, insects and their diseases. You can also show a species with in its environment, for example the weeds that grow with crops or the different stages of a plant or insect.

You will probably need another visual aid for your training, but is clear that slides do offer you great realism.

When you are using slides you must consider the following issues:
- Select the slides with the best quality and the ones that best illustrate the subject. Discard those that are blurry or dark.

- Put the slides in order so that they are in a logical sequence and agree with the plan of the presentation.

- Mark the slides on the upper left hand corner to control their correct placement on the carrousel.

**Audiovisual Programs:** The programs of audiovisual professionally prepared are a useful tool for training. This technique consists of a set of slides, an audio cassette with synchronized explanations and a special projector.

These programs can be used to introduce or finalize a course, in which case you must show all the topics revised during the session. This can last no more that 20 minutes and preferably less that 10. Therefore this is a system that must be complemented.

**Videos:** Usually videos must be prepared by professional as they are almost a live presentation during a training session. Nevertheless a video cannot substitute other visual aids. The equipment is expensive and needs a power source. The monitor must be big enough for everyone to see it and give the training session more realism. The instructor can rest while the participants hear a different voice.

**Multimedia Presentations.** The use of multimedia is growing rapidly because it has all the characteristics of the visual aids described. There are several types of software that can be used for your presentations and you can buy them in software stores or find them through the internet. If you do not know how to use the software, it might be wise to find the help of a profession in the making of your audiovisual material.
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ANNEX 1

FAO INTERNATIONAL CODE OF CONDUCT ON THE DISTRIBUTION AND USE OF PESTICIDES
PREFACE

The action taken by FAO to develop, in consultation with appropriate United Nations agencies and other organisations, an International Code of Conduct on the Distribution and Use of Pesticides follows and accompanies many other events, some going back 25 years. All these events were designed to benefit the international community and to serve to increase international confidence in the availability, regulation, marketing and use of pesticides for the improvement of agriculture, public health and personal comfort.

On the basic functions of the Code, which is voluntary in nature, is to serve as a point of reference, particularly until such time as countries have established adequate regulatory infrastructures for pesticides.

The Director-General of FAO suggested in 1981 that such a Code could help to overcome a number of difficulties associated with pesticides. The FAO Panel of Experts on Pesticide Specifications, Registration Requirements and Application Standards, at its meeting in 1982, agreed that activities involving the export and import of pesticides, and thereby their safe use, might be best dealt with through the adoption of a Code of Conduct. To that end, a working document was prepared for the FAO Second Government Consultation on International Harmonisation of Pesticide Registration Requirements, Rome, 1-5 October 1982. The formal decision to develop the Code was taken at that Consultation, which recommended that FAO, in consultation with the appropriate United Nations organisations and bodies and international organisations outside the United Nations system, should draft a project of that document.

The Code itself was adopted by the FAO Conference at its Twenty-third Session in 1985 by way of Resolution 10/85, which appears as an Annex to the present publication.

A number of governments and organisations have expressed concern about the propriety of supplying pesticides to countries which do not have infrastructures to register pesticides and thereby to ensure their safe and effective use. It should be noted that the development of national regulatory programmes is the first priority of FAO’s activities in this field. There has also been concern over the possibility that residues of certain pesticides, not needed or not permitted in particular countries, are present in imported agricultural commodities produced in other countries where the use of such pesticides is not restricted. While recognising that it is impossible to eliminate all such occurrences, because of diverging pest control needs, it is nonetheless essential that every effort be made to apply pesticides only in accordance with good and recognised practices. It is, at the same time, important for industrially developed countries to recognise, in their regulatory activities concerning residues, the pest control needs of developing countries, particularly the needs of countries in tropical regions.

In the absence of an effective pesticide registration process and a governmental infrastructure to control the availability of pesticides, some countries importing pesticides must rely greatly on the pesticide industry to promote the safe and proper distribution and use of pesticides. Under these circumstances, foreign manufacturers,
exporters and importers, as well as local formulators, distributors repackers, advisers and users, must accept a share of the responsibility for safety and efficiency in distribution and use.

The role of the exporting country needs to be considered. Much emphasis has been given recently to the desirability of regulating the export of pesticides from producing countries. It is generally accepted that no company should trade in pesticides without a proper and thorough evaluation of the pesticide, including any risks. However, the fact that a product is not used or registered in a particular exporting country is not necessarily a valid reason for prohibiting the export of that pesticide. Developing countries are mostly situated in tropical and semitropical regions. Their climatic, ecological, agronomic, social, economic and environmental conditions and, therefore, their pest problems, are usually quite different from those prevailing in countries in which pesticides are manufactured and exported. The government of the exporting country, therefore, is in no position to judge the suitability, efficacy, safety or fate of the pesticide under the conditions in the country where it may ultimately be used. Such a judgement must, therefore, be made by the responsible authority in the importing country, in consultation with industry and other government authorities, in the light of the scientific evaluation that has been made and a detailed knowledge of the conditions prevailing in the country of proposed use.

The export to developing countries of pesticides that have been banned in one or more countries or whose use has been severely restricted in some industrialised countries has been a subject of public concern, which has led to intensive discussions. In addressing this issue, the FAO Conference, at its Twenty-fifth Session in 1989, agreed to introduce provision for Prior Informed Consent (PIC) procedures. These procedures are described in the revised Article 9 on Information Exchange and Prior Informed Consent.

While the Code of Conduct may not solve all problems, nevertheless, it should go a long way toward defining and clarifying the responsibilities of the various parties involved in the development, distribution and use of pesticides, and it should be of particular value in countries which do not have yet control procedures. When there is a pesticide regulatory process in a country, obviously, there will be less need for a Code of Conduct than in a country where there is no such process.

The Code of Conduct is not a short or simple document, mainly because the nature, properties, uses and effects of pesticides are diverse and, therefore, require comprehensive consideration. Furthermore, the strong public pressure for banning or restricting the use of some effective and much needed pesticides often stems from a lack of understanding of the many important issues involved. This document is designed, therefore, also to provide the general public with some basic guidance on these issues.

Edouard Saouma
Director General
TEXT OF THE CODE

Article 1. Objectives of the Code

1.1 The objectives of this Code are to set forth responsibilities and establish voluntary standards of conduct for all public and private entities, engaged in or affecting the distribution and use of pesticides, particularly where there is no national law to regulate pesticides or the existing one is inadequate.

1.2 The Code describes the share responsibility of many segments of society, including governments, individually or in regional groupings, industry, trade and international institutions, to work together so that the benefits to be derived from the necessary and acceptable use of pesticides are achieved without significant adverse effects on people or the environment. To this end, all references in this Code to a government or governments shall be deemed to apply equally to regional groupings of governments for matters falling within their areas of competence.

1.3 The Code addresses the need for cooperation between governments from exporting and importing countries to promote practices which ensure efficient and safe use, while minimising health and environmental concerns due to improper handling or use.

1.4 The entities which are addressed by this Code include international organisations; industry, including manufacturers, trade associations, formulators and distributors; users and public sector organisations, such as environmental groups, consumer groups and trade unions.

1.5 The standards of conduct set forth by this Code:

1.5.1 To encourage responsible and generally accepted trade practices;

1.5.2 To assist countries which have not yet established controls designed to regulate the quality and suitability of pesticide products needed in that country and to address the safe handling and use of such products;

1.5.3 To promote practices which encourage the safe and efficient use of pesticides, including minimising adverse effects on humans and the environment and preventing accidental poisoning from improper handling;

1.5.4 To ensure that pesticides are used effectively for the improvement of agricultural production and of human, animal and plant health.

1.6 The Code is designed to be used, within the context of national law, as a basis whereby government authorities, pesticide manufacturers, those engaged in trade and any citizens concerned may judge whether their proposed actions and the actions of others constitute acceptable practices.
Article 2. Definitions

For the purpose of this Code, it is understood by:

Active ingredient is the biologically active part of the pesticide present in a formulation.

Advertising means the promotion of the sale and use of pesticides by print and electronic media, signs, displays, gifts, demonstration or word of mouth.

Banned means a pesticide for which all registered uses have been prohibited by final government regulatory action, or for which all requests for registration or equivalent action for all uses have, for health or environmental reasons, not been granted.

Common name is the name assigned to a pesticide active ingredient by the International Standards Organisation or adopted by national standards authorities to be used as a generic or non proprietary name for that particular active ingredient only.

Distinguishing name is the name under which the pesticide is labelled, registered and promoted by the manufacturer and which, if protected under national legislation, can be used exclusively by the manufacturer to distinguish the product from other pesticides containing the same active ingredient.

Distribution means the process by which pesticides are supplied through trade channels on local or international markets.

Environment means surroundings, including water, air, soil and their interrelationship as well as all relationships between them and any living organisms.

Extension service means those entities in the country concerned responsible for the transfer of information and advice to farmers, regarding the improvement of agricultural practices, including production, handling, storage and marketing.

Formulation means the combination of various ingredients designed to render the product useful and effective for the purpose claimed; the form of the pesticide as purchased by users.

Hazard means the likelihood that a pesticide will cause an adverse effect under the conditions in which it is used.

Integrated Pest Management (IPM) means a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economically unacceptable damage or loss.
Label is the written, printed or graphic matter on, or attached to the pesticide; or the immediate container thereof and the outside container or wrapper of the retail package of the pesticide.

Manufacturer means a corporation or other entity in the public or private sector or any individual engaged in the business or function (whether directly or through an agent or through an entity controlled by or under contract with it) of manufacturing a pesticide active ingredient or preparing its formulation or product.

Marketing means the overall process of product promotion, including advertising, product public relations and information service, as well as distribution and selling on local or international markets.

Maximum residue limit (MRL) is the maximum concentration of a residue that is legally permitted or recognised as acceptable in or on a food, agricultural commodity or animal feedstuff.

Packaging means the container, together with the protective wrapping used to carry pesticide products via wholesale or retain distribution to users.

Pesticide is any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport.

Pesticide industry means all those organisations and individuals engaged in manufacturing, formulating or marketing pesticides and pesticide products.

Pesticide legislation means any laws or regulations introduced to regulate the manufacture, marketing, storage, labelling, packaging and use of pesticides in their qualitative, quantitative and environmental aspects.

Poison means a substance that can cause disturbance of structure or function, leading to injury or death when absorbed in relatively small amounts by human beings, plants or animals.

Poisoning means occurrence of damage or disturbance caused by a poison, and includes intoxication.

Prior Informed Consent (PIC) - Refers to the principle that international shipment of a pesticide that is banned or severely restricted in order to protect human health or the environment should not proceed without the agreement, where such an agreement exists, or contrary to the decision of the designated national authority in the participating importing country.
**Prior Informed Consent Procedure (PIC procedure)** means the procedure for formally obtaining and disseminating the decisions of importing countries as to whether they wish to receive future shipments of pesticides that have been banned or severely restricted. A specific procedure established for selecting pesticides for initial implementation of PIC procedures. These include pesticides that have been previously banned or severely restricted, as well as certain pesticide formulations that are acutely toxic. This procedure is described in the Guidelines on the Operation of Prior Informed Consent (15).

**Product** means the pesticide in the form in which it is packaged and sold; it usually contains an active ingredient plus coadjutors and may require dilution prior to use.

**Protective clothing** means (but is not limited to) scientific associations; farmer groups; citizens’ organisations; environmental, consumer and health organisations; and labour unions.

**Registration** means the process whereby the responsible national government authority approves the sale and use of a pesticide, following the evaluation of comprehensive scientific data, demonstrating that the product is effective for the purposes intended and not unduly hazardous to human or animal health or the environment.

**Repackaging** means the transfer of pesticide from any commercial package into any other container, usually smaller, for subsequent sale.

**Residue** means any specified substances in food, agricultural commodities, or animal feed, resulting from the use of a pesticide. The term includes any derivatives of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance. The term “pesticide residue” includes residues from unknown or unavoidable sources (e.g. environmental) as well as known uses of the chemical.

**Responsible authority** means the government agency or agencies responsible for regulating the manufacture, distribution or use of pesticides and more generally for implementing pesticide legislation.

**Risk** means the expected frequency of undesirable effects of exposure to the pesticide.

**Severely restricted (a limited ban)** means a pesticide for which virtually all registered uses have been prohibited by final government regulatory action but certain specific registered use or uses remain authorised.

**Toxicity** means a physiological or biological property which determines the capacity of a chemical substance to do harm or produce injury to a living organism by other than mechanical means.
Trader means anyone engaged in trade, including export, import, formulation and domestic distribution.

Use pattern embodies the combination of all factors involved in the use of a pesticide, including the concentration of an active ingredient in the preparation being applied, rate of application, time of treatment, number of treatments, use of coadjutors and methods and sites of application, which determine the quantity applied, timing of treatment and interval before harvest, etc.

Article 3 – Pesticide management

3.1 Governments have the overall responsibility and should take the specific powers to regulate the distribution and use of pesticides in their countries.

3.2 The pesticide industry should adhere to the provisions of this Code as a standard for the manufacture, distribution and advertising of pesticides, particularly in countries lacking appropriate legislation and advisory service.

3.3 Governments of exporting countries should help to the extent possible, directly or through their pesticide industries, to:

3.3.1 Provide technical assistance to other countries, especially those with shortages of technical expertise, in the assessment of the relevant data on pesticides, including those provided by industry (see also Article 4);

3.3.2 Ensure that good trading practices are followed in the export of pesticides, especially to those countries with no or limited regulatory schemes (see also Articles 8 and 9)

3.4 Manufacturers and traders should observe the following practices in pesticide management, especially in countries without legislation or means of implementing regulations:

3.4.1 Supply only pesticides of adequate quality, packaged and labelled as appropriate for each specific market;

3.4.2 pay special attention to formulation, presentation, packaging and labelling in order to reduce hazard to users, to the maximum extent possible, consistent with the effective functioning of the pesticide in the particular circumstances in which it is to be used;

3.4.3 provide, with each package of pesticide, information and instructions in a form and language adequate to ensure safe and effective use;

3.4.4 retain an active interest in following their products to the ultimate consumer,
keeping track of major uses and the occurrence of any problems arising in the actual use of their products as a basis for determining the need for changes in labelling, directions for use, packaging, formulation or product availability.

3.5 Pesticides which handling and application require the use of uncomfortable and expensive protective clothing and equipment should be avoided, especially in the case of small scale users in tropical climates.

3.6 National and international organisations, governments, and pesticide industries should take action in coordinated efforts to disseminate educational materials of all types to pesticide users, farmers, farmers’ organisations, agricultural workers, unions and other interested parties. Likewise, affected parties should seek and understand educational materials before using pesticides and should follow proper procedures.

3.7 Governments should allocate high priority and adequate resources to the task of effectively managing the availability, distribution and use of pesticides in their countries.

3.8 Concerted efforts should be made by governments and pesticide industries to develop and promote integrated pest management systems and the use of safe, efficient, cost-effective application methods. Public sector groups and international organisations should actively support such activities.

3.9 International organisations should provide information on specific pesticides and give guidance on methods of analysis through the provision of criteria documents, fact sheets, training sessions, etc.

3.10 It is recognised that the development of resistance of pests to pesticides can be a major problem. Therefore, governments, industry, national institutions, international organisations and public sector groups should collaborate in developing strategies which will prolong the useful life of valuable pesticides and reduce the adverse effects of the development of resistant species.
4.1 Pesticide manufacturers are expected to:

4.1.1 Ensure that each pesticide is adequately and effectively tested by well recognised scientific procedures and test methods, so as to fully evaluate its safety, effectiveness (2) and fate (3), with regards to the various anticipated conditions in regions or countries of use;

4.1.2 Ensure that such tests are conducted in accordance with sound scientific procedures and good lab practice (4) – the data produced by such tests, when evaluated by competent experts, should show whether the product can be handled and used safely, without unacceptable hazard to human health, plants, animals, wildlife and the environment (3);

4.1.3 Supply copies or summaries of the original reports of such tests for assessment by responsible government authorities in all countries where the pesticide is to be offered for sale. Evaluation of the data should be referred to qualified experts;

4.1.4 Make sure that the proposed use pattern, label claims and instructions, packages, technical literature and advertising truly reflect the outcome of these scientific tests and assessments;

4.1.5 If requested by a country, provide advice on analysis methods of any active ingredient or formulation that they manufacture, as well as the necessary analytical standards.

4.1.6 Provide advice and assistance to train technical staff in relevant analytical work. Formulators should actively support this effort.

4.1.7 Conduct residue trials prior to marketing, in accordance with FAO guidelines on good analytical practice (5) and on crop residue data (6, 7) in order to provide a basis to establish appropriate maximum residue limits (MRLs).

4.2 Each country should possess or have access to facilities to verify and exercise control over the quality of pesticides offered for sale, to establish the quantity of the active ingredient or ingredients and the suitability of their formulation (8).

4.3 International organisations and other interested bodies should, within available resources, consider assisting in the establishment of analytical laboratories in pesticide importing countries, either on a country or on a multilateral regional basis. These laboratories should be capable of carrying out product and residue analysis and should have adequate supplies of analytical standards, solvents and re-agents.
4.4 Exporting governments and international organisations must play an active role in assisting developing countries to train personnel in the interpretation and evaluation of test data.

4.5 Industry and governments should collaborate in conducting post-registration surveillance or monitoring studies to determine the fate and environmental effect of pesticides under field conditions.

Article 5. Reducing health hazards

5.1 Governments which have not already done so, should:

5.1.1 Implement a pesticide registration and control scheme, along the lines set out in Article 6;

5.1.2 Decide, and from time to time review, the pesticides to be marketed in their country, their acceptable uses and their availability to each segment of the public;

5.1.3 Provide guidance and instructions for the treatment of suspected pesticide poisoning for their basic health workers, physicians and hospital staff;

5.1.4 Establish national or regional toxicological information and control centres at strategic locations to provide immediate guidance on first aid and medical treatment, accessible at all times by telephone or radio. Governments should collect reliable information about health aspects of pesticides. Suitably trained people, with adequate resources must be made available to ensure that accurate information is collected.

5.1.5 Keep an extension and advisory service, as well as farmers’ organisations, adequately informed about the range of pesticide products available for use in each area;

5.1.6 Ensure, with the cooperation of industry, that where pesticides are available through outlets which also deal in food, medicines, other products for internal consumption, for topical application or clothing, they should be physically separated from other merchandise, so as to avoid any possibility of contamination or of mistaken identity. Where appropriate, they should be clearly marked as hazardous materials. Every effort should be made to publicise the dangers of storing foodstuffs and pesticides together.
5.2 Even where a control scheme is in operation, industry should:

5.2.1 Cooperate in the periodic reassessment of the marketed pesticides and in providing health centres and medical staff in charge of toxicological centres with information about existing hazards.

5.2.2 Make every reasonable effort to reduce hazards by:

5.2.2.1 Making less toxic formulations available;

5.2.2.2 Introducing products in ready-to-use packages and other wise developing safer and more efficient application methods;

5.2.2.3 Using containers that are not attractive for subsequent reuse and promoting Programmes to discourage their reuse;

5.2.2.4 Using containers that are safe (eg not attractive to or easily opened by children), particularly for the more toxic home use products;

5.2.2.5 Using clear and concise labelling;

5.2.3 Halt sale and recall products, when safe use does not seem feasible under any use instructions or limitations.

5.3 Government and industry should further reduce hazards by making provision for safe storage and disposal of pesticides and containers at both warehouse and farm level; determining the sites where waste from formulating plants should be eliminated and controlling elimination operations.

5.4 To avoid unjustified confusion and alarm among the general public, public sector groups should consider all available facts and try to distinguish major differences in risk levels of the various pesticides and their uses.

5.5 In establishing production facilities in developing countries, manufacturers and governments should cooperate to:

5.5.1 Adopt technical standards and follow safe operating practices, appropriate to the nature of manufacturing operations and hazards involved;

5.5.2 Take all necessary precautions to protect the health and safety of workers, bystanders and the environment;

5.5.3 Maintain quality assurance procedures to ensure that products manufactured comply with relevant purity, performance, stability and safety standards.
Article 6 – Regulatory and Technical Requirements

6.1 Governments should:

6.1.1. Take action to introduce the necessary legislation for the regulation, including registration of pesticides and make provisions for its effective enforcement, including the establishment of appropriate educational, advisory, extension and health-care service; the FAO guidelines for the registration and control of pesticides (9) should followed, as far as possible, taking full account of local needs, social and economic conditions, levels of literacy, climatic conditions and availability of pesticide application equipment;

6.1.2 Strive to establish pesticide registration schemes and infrastructures under which products can be registered prior to domestic use and, accordingly, ensure that each pesticide product is registered under the laws or regulations of the country of use before it can be made available there;

6.1.3 Protect the proprietary rights to use of data;

6.1.4 Collect and record data on the actual import, formulation and use of pesticides in each country, in order to assess the extent of any possible effects on human health or the environment, and to follow trends in use levels for economic and other purposes.

6.2 The pesticides industry should:

6.2.1 Provide and objective appraisal, together with the necessary supporting data on each product.

6.2.2 Ensure that the active ingredient and other ingredients of pesticide preparations marketed correspond in identity, quality, purity and composition to the substances tested, evaluated and cleared for toxicological and environmental acceptability;

6.2.3 Ensure that active ingredients and formulated products for pesticides for which international specifications have been developed conform with the specifications of FAO (8), where intended for use in agriculture; and with WHO pesticide specifications (10), where intended for use in public health;

6.2.4 Verify the quality and purity of the pesticides offered for sale;

6.2.5 When problems occur, voluntarily take corrective action, and when requested by governments, help find solutions to difficulties.
**Article 7 – Availability and use**

7.1 Responsible authorities should give special attention to drafting rules and regulations on the availability of pesticides. These should be compatible with existing levels of training and expertise in handling pesticides on the part of the intended users. The parameters on which such decisions are based vary widely and must be left to the discretion of each government, bearing in mind the situation prevailing in the country.

7.2 In addition, governments should take note of and, where appropriate, follow WHO’s classifications of pesticides by hazard (11) and associate the hazard class with well-recognised hazard symbols, as the basis for their own regulatory measures. In any event, the type of formulation and method of application should be taken into account in determining the risk and degree of restriction appropriate to the product.

7.3 Two methods of restricting availability can be exercised by the responsible authority: not registering a product or, as a condition of registration, restricting the availability to certain groups of users, in accordance with national assessments of hazards involved in the use of the product in the particular country.

7.4 All pesticides made available to the general public should be packaged and labelled in a manner which is consistent with FAO’s guidelines on packaging (12) and labelling (13) and with appropriate national regulations.

7.5 Prohibition of the importation, sale and purchase of an extremely toxic product may be desirable, if control measures or good marketing practices are insufficient to ensure that the product can be used safely. However, this is a matter for decision in the light of national circumstances.

**Article 8 – Distribution and Trade**

8.1 Industry should:

8.1.1 Test all pesticide products to evaluate safety with regards to human health and the environment prior to marketing, as provided for in Article 4, and ensure that all pesticide products are likewise adequately tested for efficacy and stability and crop tolerance, under procedures that will predict performance under the conditions prevailing in the region where the product is to be used, before they are offered there for sale.

8.1.2 Submit the results of all tests to the local responsible authority for independent evaluation and approval, before the products enter trade channels in that country.

8.1.3 Take all necessary steps to ensure that pesticides entering international trade conform to relevant FAO (8), WHO (10) or equivalent specifications for composition and quality (where such specifications have been developed) and to the principles embodied in pertinent FAO guidelines, and in rules and regulations on classification and packaging, marketing, labelling and documentation laid down by international organisations concerned with modes of transport (ICAO, IMO, RID and IATA in particular).¹
8.1.4 Make a commitment to see that pesticides manufactured for export are subject to the same quality requirements and standards as those applied by the manufacturer to similar domestic products.

8.1.5 Ensure that pesticides manufactured or formulated by a subsidiary company meet appropriate quality requirements and standards, which should be consistent with the requirements of the host country and parent company.

8.1.6 Encourage importing agencies, national or regional formulators and their respective trade organisations to cooperate in order to achieve fair practices and safe marketing and distribution practices and to collaborate with authorities in stamping out any malpractice within the industry.

8.1.7 Recognise that the recall of a pesticide by a manufacturer and distributor may be desirable when faced with a pesticide that represents an unacceptable hazard to human and animal health and the environment, when used as recommended and cooperate accordingly.

8.1.8 Endeavour to ensure that pesticides are traded by and purchased from reputable traders, who should preferably be members of a recognised trade organisation.

8.1.9 See that persons involved in the sale of any pesticides are trained adequately to ensure that they are capable of providing the buyer with advice on safe and efficient use.

8.1.10 Provide a range of pack sizes and types, which are appropriate for the needs of small-scale farmers and other local users to avoid handling hazards and the risk that resellers will repackage products into unlabelled or inappropriate containers.

8.2 Governments and responsible authorities should take the necessary regulatory measures to prohibit the repackaging, decanting or dispensing of any pesticide in food or beverage containers and should rigidly enforce punitive measures that effectively stop such practices.

8.3 Governments of countries importing food and agricultural commodities should recognise good agricultural practices in countries with which they trade and, in accordance with recommendations from the Codex Alimentarius Commission, should establish a legal basis for the acceptance of pesticide residues, resulting from such good agricultural practices.

ICAO: International Civil Aviation Organisation
IMO: International Maritime Organisation
RID: International regulations concerning the carriage of dangerous goods by rail
IATA: International Air Transport Association
Article 9 – Information Exchange and Prior Informed Consent

9.1 The government of any country that takes action to ban or severely restrict the use of handling of a pesticide, in order to protect health or the environment, should notify FAO as soon as possible of the action taken. FAO will notify the designated national authorities in other countries of the action of the notifying government (15).

9.2 The purpose of the notification regarding control action is to give competent authorities in other countries the opportunity to assess the risks associated with the pesticides, and to make timely and informed decisions as to the importation and use of the pesticides concerned, after taking into account local, public health, economic, environmental and administrative conditions. The minimum information to be provided for this purpose should be:

9.2.1 The identity (common name, distinguishing name and chemical name);

9.2.2 A summary of the control action taken and of the reasons for it. If the control action bans or restricts certain uses but allows other uses, such information should be included.

9.2.3 An indication of the additional information that is available, and the name and address of the contact point in the country to which a request for further information should be addressed.

Information exchange among countries

9.3 If export of a pesticide banned or severely restricted in the country of export occurs, the country of export should ensure that necessary steps are taken to provide the designated national authority of the country of import with relevant information.

9.4 The purpose of information regarding exports is to remind the country of import of the original notification regarding control action and to alert it to the fact that an export is expected or is about to occur. The minimum information to be provided for this purpose should be:

9.4.1 A copy of or reference to the information provided at the time of the notification of control action.

9.4.2 Indication that an export of the chemical concerned is expected or is about to occur.

9.5 Provision of information regarding exports should take place at the time of the first export following the control action, and should recur in the case of any significant development of new information or conditions surrounding the control action. It is the intention that the information should be provided prior to export.
9.6 The provision to individual countries of any additional information on the reasons for control actions taken by any country must take into account the protection of any proprietary data from unauthorised use.

Prior Informed Consent (PIC)

9.7 Pesticides that are banned or severely restricted for reasons of health or the environment are subject to the Prior Informed Consent Procedure. No pesticide in these categories should be exported to an importing country participating in the PIC procedure, contrary to that country’s decision made in accordance with FAO operational procedures for PIC.

9.8 FAO will:

9.8.1 Review notifications of control actions to ensure conformity with definitions in Article 2 of the Code, and will develop the relevant guidance documents;

9.8.2 In collaboration with UNEP, develop and maintain a data base of control actions and decisions taken by all Member Governments;

9.8.3 Inform all designated national authorities and relevant international organisations about notifications received under Article 9.1 and decisions that have been taken regarding the use and importation of a pesticide that has been included in the PIC procedure and publicise it in an appropriate way.

9.8.4 FAO will seek advice at regular intervals and review the criteria for inclusion of pesticides in the Prior Informed Consent procedure and the operation of the Prior Informed Consent scheme and will report to Member Governments on its findings.

9.9 Governments of importing countries should establish internal procedures and designate the appropriate authority for the receipt and handling of information.

9.10 Governments of importing countries participating in the PIC procedure, when advised by FAO of control action within this procedure, should:

9.10.1 Decide on future acceptability of that pesticide in their country and advise FAO as soon as that decision has been made;

9.10.2 Ensure that governmental measures or actions taken regarding an imported pesticide for which information has been received are not more restrictive than those applied to the same pesticide produced domestically or imported from a country, other than the one that supplied the information;
9.10.3 Ensure that such a decision is not used inconsistently with the provisions of the General Agreement on Tariffs and Trade (GATT).

9.11 Governments from pesticide exporting countries should:

9.11.1 Advise their pesticide exporters and industry of the decisions of participating importing countries;

9.11.2 Take appropriate measures within their authority and legislative competence, designed to ensure that exports do not occur contrary to the decision of participating importing countries.

Article 10 – Labelling, packaging, storage and disposal

10.1 All pesticide containers should be clearly labelled, in accordance with applicable international guidelines, such as the FAO guidelines on good labelling practice (13).

10.2 Industry should use labels that:

10.2.1 Include recommendations consistent with those of the recognised research and advisory agencies in the country of sale;

10.2.2 Include appropriate symbols and pictograms whenever possible, in addition to written instructions, warnings and precautions;

10.2.3 In international trade, clearly show appropriate WHO hazard classification of the contents (11) or, if this is inappropriate or inconsistent with national regulations, use the relevant classification;

10.2.4 Include, in the appropriate language or languages, a warning against the reuse of containers, and instructions for the safe disposal or decontamination of empty containers;

10.2.5 Identify each lot or batch of the product in numbers or letters that can be read, transcribed and communicated by anyone without the need for codes or other means of deciphering;

10.2.6 They are marked with the date (month and year) of formulation of the lot or batch and with relevant information on the storage stability of the product.
10.3 Industry should ensure that:

10.3.1 Packaging, storage and disposal of pesticides conform in principles to FAO guidelines for packaging and storage (12), FAO guidelines for the disposal of waste pesticides and containers (16), and WHO specifications for pesticides used in public health (10);

10.3.2 In cooperation with governments, packaging or repackaging is carried out only on licensed premises where the responsible authority is convinced that the staff is adequately protected against toxic hazards, that the resulting product will be properly packaged and labelled, and that the content will conform to the relevant quality standards.

10.4 Governments should take the necessary regulatory measures to prohibit the repacking, decanting or dispensing of any pesticide into food or beverage containers in trade channels and rigidly enforce punitive measures that effectively deter such practices.

Article 11 – Advertising

11.1 Industry should ensure that:

11.1.1 All statements used in advertising are capable of technical substantiation.

11.1.2 Advertisements do not contain any statement or visual presentation which, directly or by implication, omission, ambiguity or exaggerated claim, is likely to mislead the buyer, in particular with regard to the safety of the product, its nature, composition, or suitability for use, or official recognition or approval;

11.1.3 Pesticides which are legally restricted to use by trained or registered operators are not publicly advertised through journals other than those catering for such operations, unless the restricted availability is clearly and prominently shown;

11.1.4 No firm or individual in any country simultaneously markets different pesticide active ingredients or combinations of ingredients under a single distinguishing name;

11.1.5 Advertising does not encourage uses other than those specified on the approved label;

11.1.6 Promotional material does not include use recommendations different from the ones of the recognised research and advisory agencies;

11.1.7 Advertisements do not misuse research results or quotations from technical and scientific literature; and scientific jargon and irrelevances are not used to make claims appear to have a scientific basis they do not possess;
11.1.8 Claims as to safety, including statements such as “safe”, “non-poisonous”, “harmless”, “non-toxic”, are not made, with or without a qualifying phrase such as “when used as directed”;

11.1.9 Statements comparing the safety of different products are not made;

11.1.10 Misleading statements are not made concerning the effectiveness of the product;

11.1.11 No guarantees or implied guarantees – e.g. “more profits with...”, “guarantees high yields” – are given unless definite evidence to substantiate such claims is available;

11.1.12 Advertisements do not contain any visual representation of potentially dangerous practices, such as mixing or application without sufficient protective clothing, use near food, or use by or near children;

11.1.13 Advertising or promotional material draws attention to the appropriate warning phrases and symbols as laid down in the labelling guidelines (13);

11.1.14 Technical literature provides adequate information on correct practices, including the observance of recommended rates, frequency of applications, and safe pre-harvest intervals;

11.1.15 False or misleading comparisons with other pesticides are not made;

11.1.16 All staff involved in sales promotion are adequately trained and possess sufficient technical knowledge to present complete, accurate and valid information on the product sold;

11.1.17 Advertisements encourage purchasers and users to read the label carefully, or have the label read to them if they cannot read.

11.2 International organisations and public-sector groups should call attention to departures from this article.

11.3 Governments are encouraged to work with manufacturers to take advantage of their marketing skills and infrastructure, in order to provide public-service advertising regarding the safe and effective use of pesticides. This advertising could focus on such factors as proper maintenance and use of equipment, special precautions for children and pregnant women, the danger of reusing containers, and the importance of following label directions.
Article 12 – Monitoring the observance of the Code

12.1 The Code should be published and should be observed through collaborative action on the part of governments, individually or in regional groupings, appropriate organisations and bodies of the United Nations system, international governmental organisations and the pesticide industry.

12.2 The Code should be brought to the attention of all concerned in the manufacture, marketing and use of pesticides and in the control of such activities, so that governments, individually or in regional groupings, industry and international institutions understand their shared responsibilities in working together to ensure that the objectives of the Code are achieved.

12.3 All parties addressed by this Code should observe it and promote the principles and ethics expressed by the Code, regardless of other parties’ ability to observe the code. The pesticide industry should cooperate fully in the observance of the Code and promote the principles and ethics expressed thereby, irrespective of a government’s ability to observe the Code.

12.4 Independently of any measures taken with respect to the observance of this Code, all relevant legal rules should be strictly applied, whether legislative, administrative, judicial, or customary, dealing with liability, consumer protection, conservation, pollution control and other related subjects.

12.5 FAO and other competent international organisations should give full support to the observance of the Code, as adopted.

12.6 Governments should monitor the observance of the Code and report on progress made to the Director-General of FAO.

12.7 Governing Bodies should periodically review the relevance and effectiveness of the Code. The Code should be considered a dynamic text which must be brought up to date as required, taking into account technical, economic and social progress.
FAO Conference Resolution 10/85
International Code of Conduct
on the Distribution and Use of Pesticides

THE CONFERENCE

Recognising that increased food production is a high priority need in many parts of the world and that this need cannot be met without the use of indispensable agricultural inputs, such as pesticides.

Noting that FAO’s study entitled Agriculture: toward 2000 foresees a steady increase in the worldwide use of pesticides.

Convinced that such growth in pesticide use is likely to take place in spite of necessary intensive parallel efforts, to introduce biological and integrated pest control systems.

Acknowledging that pesticides can be hazardous to humans and the environment and that immediate action must be taken by all concerned, including governments, manufacturers, traders and users, to eliminate, as much as possible and within the scope of their responsibility, unreasonable risks, not only in the country of origin but also in the countries to which pesticides may be exported.

Being aware that the requirements for the safe and proper use of pesticides in some developed countries have led to the adoption of complex systems of regulations and of enforcement mechanisms, but that many other countries have neither such mechanisms nor the necessary legislation, regulations or infrastructures to control the import, availability, sale or use of pesticides.

Convinced that additional efforts are needed to enable such countries to control pesticides more effectively and to assess the hazards which could result from their use or misuse.

Recognising that a voluntary Code of Conduct, based on internationally agreed technical guidelines, would provide a practical framework for the control of pesticides, especially in countries that do not have adequate pesticide registration and control schemes.

Noting that such a draft Code was reviewed by the Committee on Agriculture at its Eighth Session, and endorsed by the Council at its Eighty-eight Session.
Having further noted the conclusions and recommendations of these bodies,

1. Hereby adopts a voluntary International Code of Conduct on the Distribution and Use of Pesticides, as given in the annex to this Resolution;

2. Recommends that all FAO Member Nations promote the use of this Code in the interests of safer and more efficient use of pesticides and of increased food production;

3. Requests governments to monitor the observance of the Code in collaboration with the Director-General who will report periodically to the committee on Agriculture;

4. Invites other United Nations agencies and other international organisations to collaborate in this endeavour within their respective spheres of competence.

(Adopted 28 November 1985)
References


ANNEX 2
FIRST AID
FIRST AID IN CASE OF INTOXICATION WITH PESTICIDES.

Shoes, C. & Collier, C. Adapted C. Palacios.

SYNTHESIS.

The first aid are the initial effort to assist a patient while the medical help is on its way. If these procedures are administered immediately when intoxication with pesticides is suspected, can constitute the difference between to save or loose a patient.

PREPARATIONS:

Before describing the management procedures of first aid in connection with the use of modern pesticides, it is important to emphasise that wherever the pesticides are stored, managed or employed, the following elements for first aid should be on hand.

(1) Water supply

(2) A soft soap and cloth to wash the skin, and

(3) Domestic remedies and antidotes that could be employed before transporting the patient to a medical installation.

Of the various antidotes that have been recommended for treatment of first aid in an intoxication, one of the most useful is the charcoal. Charcoal is essential for the treatment of intoxications by plaguicides first aid due to ingestion and should be available for its immediate use. When it is administered in an adequate dosage, this absorbent inhibits the gastrointestinal absorption of an ample spectrum of chemical compounds. The activated charcoal, a fine black powder, odorless, insipid, is the destroyer of distillation residuals of different organic materials, for example: wood pulp, treated adequately to increase its absorption power. (Hayes, 1970)

There is a pharmochemical quality of activated charcoal that usually can be bought in any drugstore. Nevertheless, when there is no drugstore available, at home you can obtain an acceptable quality of common charcoal that can be employed to treat intoxication cases. A common practice is to burn breadcrumbs heating them in a semi-closed container until it is completely carbonized. A good quality, perhaps better, of common charcoal can be done by heating wood splinters in a closed container to exclude air in the burnt process.

The wood should be brushed or cut in small splinters and heat them until they carbonize completely. A particle can be proven breaking it sporadically to determine if it has blackened complete. The heating should continue, excluding the larger quantity of air as possible, until there is no domestic charcoal smoke. This can then be sprinkle with powder or destroyed in pieces with the hands and stored in a bottle for use in case of intoxication (Freed, 1981)
The activated charcoal is only superior to the universal antidote (2 parts of activated charcoal, 1 part of oxide of magnesium and 1 part of tannic acid) or the domestic equivalent (2 parts of burnt toast, 1 part of magnesium milk and 1 part of tea) and should always be employed.

Another preparation that should be on hand is the ipecac syrup, to induce the vomit in case of ingesting a toxic substance. The dosage is of 2 spoons for adults and 1 teaspoon for children. NOTE: Ipecac syrup, NO fluidextract.

**PROCEDURES IN CASE OF INTOXICATION WITH PESTICIDES.**

The first step in an intoxication emergency, except if you are alone with the patient, is to call a doctor and/or the ambulance or any vehicle that can transport him or her to the closest clinic. If you are alone with the patient, watch that the breathing is regular, the pulse adequate and that it does not occur any additional exposition.

While you wait for the doctor or vehicle, or even while the patient is been transported to the hospital, these first aid procedures should be followed:

**INGESTED PESTICIDES**

Procedure:

1. If the pesticide is unknown, administer any of the following adsorbent agents through the mouth.
   - Activated charcoal: preferred for all toxic substances except cyanide and bypiridiles.
     - Dosage – 30 grams in 100 millilitres of water (3 tablespoons in half glass of water) as a thick suspension, or if the activated charcoal is not obtained, administer beaten egg whites. Dosage – 8 egg whites for adults; 4 egg whites for children.
     - In the case of paraquat, an adsorbent clay as the Füller land is preferable to the activated charcoal. If clay is not obtained, then no contaminated land should be administered, then take the patient to the hospital.

2. If the pesticide is known, induce to vomit if it is recommended in the pesticides label and there are no contraindications. After vomiting, administer the activated charcoal in 100 millilitres of water (3 tablespoons in half glass of water) or beaten egg white, if there is no charcoal. Take the patient to the hospital.

**VOMIT INDUCTION**

If the identity of the pesticide is known, induce to vomit if it is recommended in the label. The ipecac syrup or the vomit by mechanic stimulus are two methods employed to induce vomiting. The ipecac syrup, administered through the mouth can eliminate the 90% to the 100% of the stomach content. The dosage is 2 tablespoons for adults and 1 teaspoon for children. Note ipecac syrup, NO fluidextract.
Vomit by mechanic stimulus: Mechanic stimulation of the throat is where the index finger is used to induce the vomit. It is advised to use the first two fingers of the other hand to push the patient’s cheek between the teeth to assure that he does not bite the index finger. See figure # 1.

This procedure can extract a 50% of the stomach content and can be done immediately. As soon as the vomit occurs within a few minutes, provide the patient activated charcoal.

Procedures to avoid in cases of pesticide ingestion

1. Contraindications to the vomit induction. **Do not induce the vomit if the patient:**

- is sleepy, unconscious or with convulsions, the patient could choke and die if the vomit is induced.
- has swallowed a corrosive poison, because the product will burn the throat severely going back as it did when was ingested. Examples are the strong acids and alkalis as phenols and alkaline salts. The patient would complain of sever pain and would have signs and symptoms of mouth and throat burns.
- has ingested a pesticide on petroleum base. Most pesticides that come with liquid formulations are dissolved in petroleum derived products (xylene, kerosene, etcetera.)
- The words emulsionable concentrate or EC in the labels are signs of not inducing vomit, if the patient has ingested a concentrate. If the patient has swallowed a diluted form of these products, nevertheless should force to vomit immediately.
- If the patient is in the last three last months of pregnancy
2. The use of salt (NaCl) to induce vomit should be avoided because a severe intoxication may occur with salt in fruitless attempts to induce vomiting (Gleason et al., 1976)

3. More than two dosages of ipecac syrup should not be administered because this drug is harmful to the heart. The ipecac fluidextract should never be used to induce vomit because it is fourteen times more concentrated than the syrup. (Arena, 1978).

3. Do not administer baking powder, sodium bicarbonate and other carbonates in case of ingesting acid pesticides, because this can induce to the intestines perforation through the sudden emission of carbon dioxide.

Inhaled pesticides

Procedure:
1. If the patient is in a closed space, do not go for him or her without a breather mask.
2. Carry the patient (do not let the patient walk) to take fresh air immediately.
3. Open all doors and windows
4. Loosen adjusted cloth.

Pesticide in the skin

The more rapid the pesticide is washed from the victim, the smaller the lesion would result.

Procedure:
1. Take off contaminated clothes
2. Submerge the skin in water (shower, hose, faucet, pool, irrigation channel, etc.)
3. Clean the skin, hair and nails slowly with pure soap and water. The detergents and commercial cleaners can increase the absorption of the pesticide (Maramba, 1980)
4. If water and soap are not immediately obtained, employ a clean and dry cloth to take off as many pesticide as possible from the skin and wash as soon as possible.
5. For chemical burns, cover immediately, without tighten, with a clean and soft cloth after washing with large quantities of current water.
6. Avoid the uses of ointments, greases, oils, powders and other drugs in the treatment of first aid of burns.

Pesticides in the eye

Procedure:
1. Maintain the eyelids open and wash the eye with a soft spout of current water immediately. Do not press.
2. Be careful not to contaminate the other eye, if only one eye is affected.
3. Continue the washing during 15 minutes.
4. Do not employ chemical products or drugs in the washing water because this may increase the grade of ocular lesion.
5. Turn down first to the upper eyelid and then the inferior and clean them with a wet cotton to extract any strange body.
6. Irrigate the eye once again.
7. Do not exceed more than one hour washing the eyes because dryness may provoked or inhibit the production of tears.
8. Cover the eye with a little piece of clean cloth and send the victim to the doctor, preferable an ophthalmologist.

Other first aid procedures:
1. Cleaning of the respiratory via and posture – is always imperative to assure a clean respiratory via extracting any strange body, as teeth, foods and secretions of the mouth and the nose, put the patient in left lateral position of Trendeleburg with the head extended and 15 to 30 degrees lower than the trunk level.

Figure # 2 KEEP THIS POSITION WHILE YOU WAIT FOR THE DOCTOR OR THE VEHICLE AND WHILE THE PATIENT IS BEING TRANSPORTED TO THE HOSPITAL

This position:
- Prevent obstruction of the respiratory tract due to the relaxation of the tongue and other soft tissues. If the tongue has already slipped to the throat, it should be thrown outside.
- Prevent the aspiration of the vomited material in the respiratory tract.
- Increase the drainage by gravity of the secretions of the respiratory tract.
- Prevent the additional transit of the stomach content in the thin intestine.
2. Bring the patient to the clinic or hospital. DO NOT WASTE TIME, MAKE IT QUICKLY.
3. Breathing maintenance – if the respiratory movements are inadequate or non-existent, apply artificial respiration employing a bag "ambu" or respiration mouth to mouth. See figure # 3
4. Circulation maintenance – when the pulse disappears all of a sudden and there are no detectable heart bits, apply external massage. See figure # 4.
5. Unconsciousness – never administer anything by the mouth and assure that the tongue is suspended towards in front when inserting a small blunt and hard object as a spoon or a tongue depressor, between the tongue and the palate.

6. Convulsions – insert a quilted gag between the jaws to prevent that the patient bites his tongue. Prevent additional injury by placing a pillow or a cushion under the head and not letting it fall. See figure # 5.

7. Prophylaxis and antidote medication of first aid – the atropine sulphate and the oxys should not be ingested by the pesticide users as a prophylactic measure because they do not prevent the intoxication. Indeed, they can create a false security sense and retard the first aid administration procedures and definitely medical treatment. The sulphate of atropine pills can disguise or retard the first intoxication symptoms and that can be prejudicial at least in two manners. The workers can go back to their work and receive more exposition or, the worker is carried to a doctor, to whom he doesn’t inform that he has already taken atropine, the intoxication diagnosis can loose or retard. In an emergency of acute intoxication, if the victim is stunned or vomiting, do not employ oral atropine as
first aid measure because the dosage is too small and the victim cannot swallow. 
(Anón, 1974)

8. Pesticide identification – If it is possible, take the pesticide container, label or 
pamphlet with the doctor, in a safe way. If it is impossible, make sure he knows 
what type of pesticide the patient has been using. See figure # 6
ANNEX 3

APPLICATION EQUIPMENT

KIND OF FILTERS

NOZZLE DISCHARGE AND BRAND

ACCESSORIES
APPLICATION EQUIPMENT
BACKPACK DUSTERS
Funnel wide mouth for easy filling

Polypropylene pump resistance to corrosion detachable for its maintenance

Security valve to avoid excessive pressure

High density Polyethylene tank

COMPRESSED AIR SPRAYER
1. INTERNAL PISTON BACKPACK SPRAYER

2. EXTERNAL PISTON BACKPACK SPRAYER

3. DIFFERENT KINDS OF INTERNAL PISTON SPRAYER
INTERNAL PISTON SPRAYER AND SOME ACCESSORIES: 1. Vertical bar and 2. Universal bar
PARTS OF AN ENGINE BACKPACK SPRAYER
(1) FLIT PUMP;
(2) DETAIL OF THE GASEOUS ENERGY NOZZLE (LIQUID AIR), ATOMIZER;
(3) “ATOMIZER” OF A BACKPACK ENGINE.
CENTRIFUGE NOZZLE OF REVOLVING CRATE: to be used in airplanes. Changing the angle of the helix changes the rotation.

FOG MACHINE (EQUIPMENT WITH THERMO ENERGIE NOZZLE)
FILTERS

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NOZZLE FILTERS

STANDARD FILTER
50 mesh (medium) blue
100 mesh (fine) green

SHORT FILTER (nylon small wing)
30 mesh (thick)
50 mesh (medium)

SHORT FILTER (copper small wing)
30 mesh (thick)
50 mesh (medium)
100 mesh (fine)

GROOVE FILTER (polypropylene)
30 mesh (thick) white
50 mesh (medium) blue

ANTIDRIPPING FILTER
30 mesh (thick) white
50 mesh (medium) blue
100 mesh (fine) green
NOZZLES

TEEJET

JACTO

LURMARCK

OTHERS
### SELECTION GUIDE FOR TEEJET NOZZLES

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**NOTICE:** Read the label of the chemical product for the specific recommendations of dosage and applying volumes.
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**CropLife • International • Representing The Plant Science Industry**
### DISCHARGE OF ROW AND DIRECTED APPLICATIONS

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CropLife • International • Representing The Plant Science Industry
## APPLICATION DISCHARGE OF THE FLOOJET NOZZLES

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<th>[mm]</th>
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**APPLICATION DISCHARGE OF THE CONEJET NOZZLES**
Useful advise for band application

Proceed with caution when calculating the relation between parcel land surface and the treated surface.

Parcel land surface = Planted crop land total in hectare

Treated surface = parcel land surface \( \times \) \( \frac{\text{band angle}}{\text{Distance between rows}} \)

Blanket Application  Band Application
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<th>HERBICIDES</th>
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SELECTION GUIDE OF JACTO NOZZLES USED WITH HERBICIDES
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**SELECTION GUIDE OF JACTO NOZZLES TO BE USED WITH INSECTICIDES AND FUNGICIDES**
### MAIN CHARACTERISTICS OF THE JACTO NOZZLES

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<th>Series 110 LD y ADI</th>
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<td>flat spout of wide use</td>
<td>flat spout of low drift</td>
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- Recommended working pressure: 15 to 60 lb/ft²
- 110° angle to 15 lb/ft²
- Recommended use at low pressure (15 lb/ft²) for low volume applications and drifting reduction (large drops).
- Can be used in higher pressures (over 35 lb/ft²) to optimize the cover of the target (small drops).
- The size of the drops changes depending on the working pressure.
- Minimum height of the spraying bar: 35 cm for nozzles located at 50 cm of distance.

<table>
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<th>Series DEF</th>
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- Recommended working pressure: 15 to 60 lb/ft²
- 110° angle to 45 lb/ft²
- Good penetration and uniforme cover along the spraying bar.
- Minimum height of the spraying bar: 35 cm for nozzles located at 50 cm of distance.

<table>
<thead>
<tr>
<th>Series 80 EF</th>
<th>Series HC y JA</th>
</tr>
</thead>
<tbody>
<tr>
<td>uniform flat spout</td>
<td>hollow conical spout</td>
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</tbody>
</table>
- Recommended working pressure: 20 to 60 lb/ft²
- 80° angle to 45 lb/ft²
- Recommended for streak applications, in between bands or in the cultivated band.
- Uniform distribution along the application streak.
- Excellent for streak applications of herbicides pre and post emergence.

<table>
<thead>
<tr>
<th>Series BJ y AVI</th>
<th>Drops with air bubbles</th>
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</table>
- 76 to 93% of drift reduction to 45 lb/ft² when it is compared to conventional nozzles.
- Recommended working pressure: 30 to 75 lb/ft² (BJ nozzle) and 30 to 150 lb/ft² (AVI nozzle).
- Excellent for systemic products application.
- Recommended to be used with manual backpack sprayers and bar sprayers.
<table>
<thead>
<tr>
<th>Nozzles</th>
<th>Pressure (psi)</th>
<th>Caudal (L/min)</th>
<th>Working velocity, in (km/h)</th>
<th>Spraying volume, in (L/ha)</th>
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SPRAYING VOLUME (L/ha) - Series AVI – (Distance between nozzles: 0.50m)
### SPRAYING VOLUME FOR BAR SPRAYERS
(Distance between nozzles: 0.50m)

<table>
<thead>
<tr>
<th>Nozzles</th>
<th>Pressure (lb/1000 gal)</th>
<th>Caudal (L/min)</th>
<th>Working velocity, in (km/h)</th>
<th>Spraying volume, in (L/ha)</th>
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### SPRAYING VOLUME FOR BAR SPRAYERS - (Distance between nozzles: 0.50m)

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<th>Working velocity, in (km/h)</th>
<th>Spraying volume, in (L/ha)</th>
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SPRAYING VOLUME – (Distance between nozzles: 0.50m)
### Spraying Volume for Manual or Bar Backpack Sprayers

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<thead>
<tr>
<th>Nozzles</th>
<th>Spraying Angle (degrees)</th>
<th>Caudal (L/min) to (15 lb/psi²)</th>
<th>Nozzle Height (m)</th>
<th>Application Strip (m)</th>
<th>Working Velocity (km/h)</th>
<th>Spraying Volume (L/ha)</th>
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**Note:**
- To convert in Kgm², divide by 14.22

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**Nozzle Caudal – Series 110 LD**

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<td>110-LD-04 F110/1.6/3</td>
<td>Green Nozzle: Mesh 80</td>
<td>1.15</td>
</tr>
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* To convert in Kgm², divide by 14.22
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<tr>
<th>NOZZLE</th>
<th>PRESSURE</th>
<th>Code/ l/m</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<td>110-LD-02</td>
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<td>118</td>
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<td>110-LD-04</td>
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<td>86</td>
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**SPRAYING VOLUME– SERIES 100-LD**  
(Distance between nozzles: 0.50m)

**JACTO NOZZLES – SERIES BJ**
### DROPS DIAMETER IN MICRAS—SERIES BJ

<table>
<thead>
<tr>
<th>Cor</th>
<th>Nozzle</th>
<th>Drop diameter, in micras</th>
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<tbody>
<tr>
<td>BJ - 01</td>
<td>700.5</td>
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<td>BJ - 02</td>
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<td>BJ - 03</td>
<td>606.6</td>
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<td>BJ - 04</td>
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1 kgf/cm² = 14.22 lbf/pol²
Referência Silsoe: Research Institute, Inglaterra.

### SPRAYING VOLUME OF SERIES BJ NOZZLES

(Distance between nozzles: 0.50m)
- Produces a spraying of small drops that are distributed in a conical oval way.
- Appropriate to apply herbicides subsequent emerging, insecticides and fungicides.
- Ideal to apply by row.
- Shaped with great precision and coded by color in a material that is three times more resistant to erosion than stainless steel.
- Adaptable to standard bodies and caps.
- The only one, that its pieces can be taken apart to be easily cleaned.
<table>
<thead>
<tr>
<th>NOZZLE COLOR</th>
<th>NOZZLE CODE</th>
<th>COARSE FILTER MESH</th>
<th>PRESSURE (IN BAR)</th>
<th>CAUSTIC IN L/MIN</th>
<th>LITERS PER ACRE - VOLUME INDICATED IN LABEL</th>
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<tbody>
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<td>0.88</td>
<td>37.0</td>
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</table>

**APPLICATION VOLUMES**

CropLife • International • Representing The Plant Science Industry
QUALITY AND PRECISION NOZZLES
FAN MIRROR KIND

CHARACTERISTICS AND USES
- Produces a wide spraying angle up to 145°.
- The spraying distribution is similar to the band nozzles.
- Produces a large drop of gentle impact.
- The medium work pressure is of 1 bar (15 PSI).
- Generally used with backpack sprayers, because they require a lower pump effort.
- Produces drifting low levels.
- Used specially in herbicides application.

NOTE
To obtain the desired spraying angle is necessary to regulate the spraying height. In a dry surface mark the desired width and supporting the nozzle on the ground start the spraying. Slowly lift up until the spraying covers the mark.

Hang near the nozzle a light chain (as the ones used with the bath sink cap) with the needed length, to touch the ground.
QUALITY AND PRECISION NOZZLES
FLAT FAN KIND

KINDS, CHARACTERISTICS AND USES

NOZZLE SUPERIMPOSE
Produces a regular and total cover application when nozzles are superimposed in the middle of each nozzle.

STANDARD PRESSURE:
- Expandate in 50 cm in the bar.
- Average pressure 3 bar (45 PSI).
- Minimum height of the bar: 110° - 35 cm, 80° - 60 cm.
- A good all purpose nozzle.

LOW PRESSURE:
- Similar use as the standard pressure, but in average works at a pressure of 1 bar (15 PSI).
- Produces a thicker spraying.
- Specially for backpack sprayers.

LO-DRIFT:
- Expandate in 50 cm in the bar.
- Average pressure 3 bar (45 PSI).
- Minimum height of the bar: 110° - 35 cm.
- Best for herbicide application.

2
BAND SPRAYING NOZZLE KIND
EVEN SPRAY: (in row)

- Produces a regular spraying in the cultivated band treatment.
- Average pressure 3 bar (45 PSI).
- Height of the bar according to the desired spray width.
<table>
<thead>
<tr>
<th>NOZZLE</th>
<th>PRESSURE (PSI)</th>
<th>PRESSURE (Bar)</th>
<th>Caudal (l/min)</th>
<th>APPLIED VOLUME (l/ha km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01F80R or 01F1100R</td>
<td>30</td>
<td>2.0</td>
<td>0.326</td>
<td>65</td>
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<td>ORANGE</td>
<td>37</td>
<td>2.5</td>
<td>0.365</td>
<td>73</td>
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<td>01F80R or 01F1100R</td>
<td>45</td>
<td>3.0</td>
<td>0.400</td>
<td>80</td>
</tr>
<tr>
<td>60 litres/ha 100 mesh</td>
<td>52</td>
<td>3.5</td>
<td>0.432</td>
<td>86</td>
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<td>01F80R or 01F1100R</td>
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<td>109</td>
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<td>0.600</td>
<td>120</td>
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<td>90 litres/ha 100 mesh</td>
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<td>0.648</td>
<td>130</td>
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<td>02F80YE or 02F1100YE</td>
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<td>0.653</td>
<td>131</td>
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<tr>
<td>YELLOW</td>
<td>37</td>
<td>2.5</td>
<td>0.730</td>
<td>146</td>
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<td>45</td>
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<td>0.800</td>
<td>160</td>
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<tr>
<td>120 litres/ha 80 mesh</td>
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<td>0.864</td>
<td>173</td>
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<td>1.200</td>
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<td>180 litres/ha 80 mesh</td>
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<td>1.296</td>
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<td>RED</td>
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<td>240 litres/ha 50 mesh</td>
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<td>1.728</td>
<td>346</td>
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<td>1.832</td>
<td>326</td>
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<td>PALE BROWN</td>
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<td>2.300</td>
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<td>2.160</td>
<td>432</td>
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<td>2.400</td>
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<td>2.592</td>
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<td>691</td>
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<td>730</td>
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<td>3.0</td>
<td>4.000</td>
<td>800</td>
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<td>600 litres/ha 30 mesh</td>
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<td>3.5</td>
<td>4.260</td>
<td>864</td>
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SPRAYING VOLUME WITH STANDARD PRESSURE LURMARCK NOZZLES
# Spraying Volume with Low Pressure Lurmarck Nozzles

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<thead>
<tr>
<th>Color, Code</th>
<th>Pressure (PSI)</th>
<th>Pressure (Bar)</th>
<th>Caudal (l/min)</th>
<th>Volume at 6 km/h</th>
<th>Volume at 8 km/h</th>
<th>Volume at 10 km/h</th>
<th>Volume at 12 km/h</th>
<th>Volume at 16 km/h</th>
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<td>56 litres/ha</td>
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**BCPC Nozzle Code**
- F80/0.39/3
- F80/0.59/3
- F80/0.75/3
- F80/1.18/3
- F80/1.58/3
- F80/1.97/3
- F80/2.37/3
- F80/3.16/3

**NOTES:** This information has been prepared by the British Crop Protection Council (BCPC) and should not be changed without reference to BCPC. Fine, Medium or Coarse spray categories will be indicated on product labels. If not consult product suppliers.

### 110° Flat Fan Plastic/Nylon (NY)

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**BCPC Nozzle Code**
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- F100/0.59/3
- F110/0.79/3
- F110/1.18/3
- F110/1.58/3
- F110/1.97/3
- F110/2.37/3
- F110/3.16/3

**Sprayer Makes Using Delavan Nozzles:** L & K (ECON), BERTHOUD, TECNOMA, ALLAEYS, LELY, TEAM
### 80° Flat Fan Plastic

**Hardi Limited**
Bermuda Industrial Estate
Hunstanton, Warks
Tel: 0203 372 054

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### 110° Flat Fan Plastic

**Hardi Limited**
Bermuda Industrial Estate
Hunstanton, Warks
Tel: 0203 372 054

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### Tecnomac Nozzle Chart

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ACCESSORIES

MULTIPLE BODY FOR NOZZLES
NOZZLE ADJUSTABLE ARMS
1. Vertical
2. Horizontal

SPRAYING BAR FOR BACKPACK SPRAYERS: 1. Vertical, 2. Horizontal
GLOSSARY
ABIOTIC: Not living environmental factor. For example; The climate.
ABSORPTION: Process by which a plant protection product is absorbed by the plants tissue.
ACARUS: Invertebrate small animal (almost microscopic) with a oral system ended in tweezers.
ACARICIDE: Product for the plant protection use to kill mite.
ACTION MODE: It is the way how a plant protection product penetrates or acts in an organism that wants to be controlled.
ACTION SPECTRE: Concept that refers to the number of organisms that a plant protection product can control, for example: a monotoxic of aphicide action only kills aphids.
ACTIVE INGREDIENT: The biologically active part of a plant protection product present in a formulation.
ADHERENCE: Process by which a substance is adhered to the surface of a solid or a liquid.
ADHERENT: An additive that helps the pulverization dew (aspiration) adheres (to glue) for example adhering to the surface of an object.
ADDITIVE EFFECT: The complementary action of two or more chemical products that produces an effect similar to the addition of the individual effects.
ADULTERATED: Any product for the plant protection that has been illegally manipulated and whose purity and efficacy are inferior to the quality specified in the label.
AEROSOL: A fine cloud of solid and liquid particles suspended in the air.
AGROECOSYSTEM: Agricultural production system where the humans hand participation is necessary, for example: a crop.
AGUILON: Bar where the nozzles of an agricultural sprayer are mounted and goes parallel to the floor during the application.
ALIMENTARY CHAIN: a series of live organisms, which each of them eats the one that precedes it. For example: the rabbit eats grass, and the coyote eats the rabbit.
ANTAGONISM: An organism or substance that affects life negatively or to the effect of other organism or substance.
ANTHRACNOSE: Illness that shows depressed injuries of dark color in leaves, stem and fruits.
ANTIBIOSIS: Inhibition or destruction of an organism by means of a metabolic product of another.
ANTIBIOTIC: A substance that is used to destroy pathogen.
ANTIDOTE: Against poison. For example a treatment that is given to oppose to the effects of a toxic substance.
ANUAL: Plant that germinates, blooms, produces seeds and dies in one year.
APHICIDE: Product for the plant protection use to kill aphids.
APPLICATION RATE: quantity of any applied material per unit of length, surface or volume.
ARTHROPOD: Invertebrate animal with appendixes (feet, wings, antennas) provided of articulated pieces.
AUTOCIDA CONTROL: Alternative pest control where the same specie is used for its control previous sterilization; for example: the Mediterranean fly.

BACILLUS: a cane form bacteria.
BACTERIA: Microscopic microorganism that can provoke plant illness.
BACTERIOSIS: Disease provoked by bacterium.
BACULOVIRUS: Agent of natural biologic control of grain moth larvae.
BAIT: Any material used to attract a plague towards a trap, to obtain samples or to eliminate it.
BAND APPLICATIONS: Application of the plant protection product in only one area of the crop; for example: in row treatment, to the treetops or in between rows.
BIENNIAL: Plant that completes its life cycle in two years. It generally germinates, grows and stores nutrients in the first year, blooms and fructifies the next year.
BIODEGRADATION: Process by which the microorganisms use a substance as an energy fountain destroying it, it is generally applied to biological processes in the soil, water and to residual water.
BIOTIC: Natural factor related to living creatures, for example: the depredation, the parasitism, etcetera.
BIOLOGICAL DIVERSITY: Variety of organisms.

CALCAREOUS: Calcareous water, water that contains lime.
CALIBRATION: Determination of the application quantity of an equipment.
CANKER: Necrotic injury, frequently deep produced in stem and branches.
CATHARTIC: mechanical or chemical drug action, that when it is ingested speeds up the expulsion of the intestinal contents.
CHLOROSIS: When the green tissue of a plant becomes yellow.
COADJUTOR: Any substance that is included in the formulation of a plant protection product to improve its efficiency; for example: moisturizers, adherents, emulsions, etcetera.
COLINESTERASA: Enzyme that is necessary in the insects and human beings for the normal nervous function, it is inhibited or damaged by organophosphorus insecticides and carbamates.
COLLOID: Dispersed particles in a fluid, in sizes between 0,1 y 0,2 upbringing a suspension called colloidal.
COMMERCIAL BRAND: Name under which the manufacturer sells its plant protection products, it is not always the same as the common chemical name, but sometimes it is similar.
COMPATIBLES: Plant protection products that have the characteristic or predisposition to mix one with the other.
COMPETITION: An organism ability to use or metabolise a substratum more efficient than other.
CONCENTRATE: The quantity of an active ingredient in a determined volume or weight of a formulation or mixture.

CONTROLLED DROP APPLICATION: The application of plant protection products with a machine, that often, has a revolving disc and with which little drops of uniform size are obtained.

CROP: A cultivated variety.

CORROSIVE POISON: Poison that would provoke heat (burns) in the skin, mouth and stomach.

COTYLEDON: The first leaves that appear when a seed germinates.

COVERAGE: The objective area covered by a pesticide, expressed in percentage.

COVER CROPS: Crops that are planted to oppose the effects of an eolic and hydric erosion, keeping the soils humidity and fertility, and the biodiversity.

CULTURAL CONTROL: Alternative of pest control through an expert combination of agronomic practices, such as tillage, sowing, irrigation, healthiness crop rotation and the selection of healthy and resistant varieties.

CUTICULE: External film that recovers a plant or animal. CURLY: Symptom that makes reference to the curling leaves, for example in the case of sickness produced by virus.

CYST: Excessive growth produced in plants as a result of a pathogenic infection. Tumor or growth in leaves, stem and roots.

DANGER: In relation to plant protection products it is the combination of the product toxicity and its exposition. Without toxicity or exposition there cannot be danger.

DEFOLIANT: Pesticide used to eliminate the plants leaves.

DEGRADATION: Process by which a plant protection product is reduced to a less complex form.

DEPOSIT: Quantity of a plant protection product that reaches the objective.

DEPREDATOR: animal that in order to survive hunts another called victim.

DESICCANT: Pesticide used to dry and destroy the foliage of a plant, generally with the purpose to accelerate the dryness or the ripening planning the recollection.

DETERGENT: Liquid normally used as a substance to clean. Some of these products can also be used as moisturizers to improve the adherence covering capacity of a plant protection product.

DIAGNOSIS: Conjunction of signs and symptoms used to fix the characteristics of a phitosanitary problem.

DICOTYLEDON: It is said of plants that produces two cotyledons (embryos leaves) for example: a wide leave weed.

DILUTOR: Not live material used to dilute a concentrated material.

DL 50: Is the lethal dosage necessary to destroy the 50% of the essay population when it is administered as a unique dosage through the mouth (oral via). The dosage is generally expressed as the weight of a chemical substance, in milligrams related with the weight unit of the rehearsed species (kilograms).
DIRECT PLANTING: Planting of a crop in the soil without tillage or preparation from the previous harvest.

DISINFECT: To destroy microorganisms that are over or in a tissue.

DISINFECTANT: A substance that kills microorganisms that are over or in a tissue.

DISPERSANT: An additive that helps the dew little drops to cover the surface of a vegetable more uniformly.

DISSEMINATION: The inoculation motion form one place to another.

DIVIDED OR FRACTIONED APPLICATION: Treatment in which the total dosage of plant protection products is divided and applied in different opportunities.

DOSAGE: Any relation with dose, expressed in material quantity per weight unit, length, area or volume.

DOSE: Quantity, expressed in weight or volume of any material.

DRAIN: Refers to a liquid or mixture that free flow in a surface.

DRIFTING: Dew deviation of a spraying towards an undesired place.

ECLOTION: It is said of the birth of an animal through an egg.

ECONOMIC DAMAGE: Damage that results from the harvest loss.

ECONOMIC THRESHOLD: Occurs when the density of a plague population gets closer to the economic damage level and the control measures should initiate.

ECTOPARASITE: Parasite that lives in the exterior of a guest.

EFFECTIVE BAND APPLICATION: Length of area reached by the sprayed particles.

EFFICIENCY: The capacity to produce a desired effect.

EMETIC: Substance that provokes vomits and that can be use in first aid for certain kinds of intoxication with plant protection products.

EMULSIFICANT: Chemical substance that helps a liquid to form small drops, which remain suspended in other liquids; for example one used to make a stable mixture of two liquids, such as the oil and the water, which normally would not mix.

EMULSION: A mix in which one liquid disperses in small drops in another fluid.

EMULSIONABLE CONCENTRATE: Liquid formulation of a plant protection product, compound by an active ingredient, a solvent and an emulsifier, that is mixed with water to make an emulsion.

ENVIRONMENTALLY ACCEPTABLE: When the undesired effects of the use of any technology presents minimum risks for the environment.

ENVIRONMENTAL DYNAMIC: It makes reference to the way how chemical, physical and biologic processes degrade or makes powerful a chemical compound when being free in the environment.

EPA: Government organisation of the United States of Americas that makes that the rules over plant protection products are executed.
ERRADICATION: Remove, eliminate or total destruction of a pest organism of an area or of an individual plant.

EXOTIC: Not native, from another country.

EXTERNAL DRIFT: Particle movement out of the intentional treated area.

EXTERNAL PARASITE: Parasite that lives in the outside of an innkeeper.

EXTERNAL SKELETON: Anthropods external skeleton.

FIRST AID: Emergency treatment given to a patient before being assisted by a doctor.

FLOATING PARTICLE: Particle suspended in the air that does not deposit because of insufficient energy.

FLUIDITY: Denotes that a plant protection product can slip and displace freely.

FLOW: The material quantity that displaces per unit of time.

FOOD CHAIN OR TROPHIC CHAIN: A series of living organisms, one feeds another, at least partially, of whom precedes, for example: the rabbit eats herbs, and the rabbit is consumed by a wolf, etcetera.

FORMULATION: Preparation of the active ingredient in such a way that the user can store and apply it.

FROG LEG: Symptom that presents ill plants that is characterized by the proliferation of branches and roots.

FUMIGATION: Application of a plant protection product in a gaseous way into a crop or for an environmental treatment.

FUNGICIDE: A substance that kills fungus.

FUNGISTATIC: A substance or a fungicide concentration, that inhibits the growth of a fungus but does not kill it.

FUNGUS: A thallophyte plant without chlorophyll and its body structure is filiform and branched. The fungus have cell walls and nucleus. Its reproduction can be sexual or asexual.

HABITAT: Conjunction of environmental factors where lives, in a natural way, a determined animal or vegetable specie.

HYDROPHOBIC: Rejects the water.

HYDROSCOPIC: Absorbs humidity easily.

HOMOGENEITY: Action or effect of homogenize, transform in homogeneous a compound or compound mixture.

ILLNESS: A dynamic interaction between an organism, an innkeeper and the environment, that causes in the organism abnormal physical changes, often morphological or neurological.

IMMUNE: No susceptible to a disease or poison.

INCOMPATIBLE: That cannot be mixed.

INERT INGREDIENT: Any formulation substance that has no pesticide action.

INFLAMMABLE: easy to set on fire.
INGEST: Eat or swallow.
INHALE: Aspire deeply.
INOCULATION: Pathogenic transportation process to the plant and to its organs.
INOCULUM: Structures, generally spores, mycelium, sclerotia, bacterial cells, viral particles, etcetera, used to inoculate.
INSPECTION: Exam and recognition of a thing, for example: a crop to identify the present problems.
INTERCELL: Between cells.
INTERNAL DRIFT: Particle movement distributed in the objective area.
INTERNAL PARASITE: Parasite that lives in the interior of a guest.
INTERSOWING: Sowing crop in an intercalated way.
INTOXICATION: State produced by the introduction or by the accumulation of toxic substances in the organism.
INVITRO: Culture outside of the innkeeper.
INVIVO: Culture inside of the innkeeper.

LARVA: The second step in the life cycle of an insect that later would convert in pupa or chrysalis.
LEACHING or LIXIVIATION: Dragging process by water rain of soluble materials or colloidal of soil superior horizons or deeper horizons.
LIQUEFIABLE: That it has fluidity.
LOSS: Quantity of applied material that is not retained by the objective, generally expressed in percentage.
LYSIS: Dissolution of a cell

MAXIMUM RESIDUAL LIMIT: The maximum concentration (in milligrams by kilogram or in parts by million) of residuals from plant protection products that is legally permitted in or over a nourishment, agricultural product or animal food.
METABOLISM: Collection of chemical reactions that the swallowed or absorbed substances are submitted to, by the living creatures until they provide energy or until they become part of their own structural architecture.
METAMORPHOSIS: Change in the form or structure of an insect during its life cycle, as: egg, larva, pupa and adult; or egg, pupa and adult.
MILDEW: Illness in which the pathogenic can be seen as a growing on the innkeepers’ surface.
MICOPLASMA: Microorganism that can provoke plant diseases.
MICROENCAPSULATED: Formulation of a product for plant protection that is presented in micro-capsules for the security of the user and the environment.
MIST: Application of a spray that occupies an air volume that reduces the visibility.
MITIGATION: Soften, diminish or moderate the effects of a thing, for example the mitigation areas in an agricultural system pretend to reduce the environment contamination risks.
MIXTURE: a liquid, in the exact concentration to be applied, is the result of the dilution or a concentrated formulation.

MOISTURIZING: Helps wetting in a better way the surface of the treated vegetables with the spraying dew.

MOLLUSKICIDE: Product for the plant protection that is used for the control of snails and slugs.

MOLTING: Process through which an insect changes the skin and the form.

MUMMIFY: A dried and wrinkled organism as a result of a fungus illness.

MUTATION: Spontaneous appearance of a new characteristic in an individual as a result of an accidental change in its genes or chromosomes.

MONOCOTYLEDON: It is said of plants that only produce one cotyledon.

MOSSAIC: Symptom of a disease provoked in the plants by a virus.

MYCELLIUM: Mass of hyphas that are the fungus body.

NECROSIS: The death of the vegetal tissue.

NEMATODE: Organism of round body that lives in the soil and could parasite the plants.

NUTGALL: Excrescence, tumour or swelling of plant leaves, stem and roots.

OBJETIVE: Surface or plant intended to be applied with a plant protection product.

OBJECTIVE PLAGUE: The plague that is the specific objective of plant protection products or other control method.

OVICIDAL: Product of plant protection used to destroy the insect eggs and mite.

PARASITE: Any organism that lives and feeds of a plant, animal or insect causing damage or death.

PARASITOID: Organism that lives and feeds of a guest until the life cycle completes causing death.

PART PER MILLION (ppm): Expressed as weight or volume. Term frequently used when refers to residuals pf plant protection products and its tolerance. An ppm is equal to 1 mg of a substance in a liter of water.

PATHOGENIC: An organism or biological agent capable to cause disease.

PERENNIAL: A plant that normally lives more than two years.

PERSISTENCE: The property of a plant protection product to be active by a determined period of time.

PEST OBJECTIVE: The pest that is the objective of a plant protection product or of another control method.

PHENOLOGY: Study of the influence of climatic changes in the vital phenomenon for example: crop development steps.

PHEROMONES: Substances that attract, stimulate or prevents certain insect activities; for example: the mate.

PHYTOSANITARY: Plants health.
PHLOEM: System of living cells enlarged interconnected, in the plants, that carries the photosynthesis products from the leaves to the growing tissues.
PHOTOLYSIS: Denotes that a plant protection product can be degraded by the light action.
PHOTOSYNTHESIS: Production of sugar in a plant, in presence of light and chlorophyll.
PLANT BREEDING: Biological science that studies the plants variability and inheritance.
PLANT PHATOGEN: Infectious agent that causes plant diseases.
PLANT TOXICITY: Denotes that a plant protection products is toxic for plants.
POLLINIZATION: Union process of the pollen and the plant ovule. The insects and the wind may favour it.
POPULATION DYNAMIC: It makes reference to the regulation of a population (growth or no growth) for the intrinsic or extrinsic environmental resistance.
PRECIPITATION: Another name for rain.
PRE-HARVEST INTERVAL: The waiting period that should be respected between the last application of plant protection product and the crop recollection, appears in the pamphlet and the label.
PROGRESSIVE DEATH: Death of branches or small branches. It starts from the small branches and goes in progress to the stem or stump.
PROPHYLACTIC: A chemical substance or treatment, used to prevent a pathogen invades an organism causing a disease, different to one curative.
PROPHYLAXIS: Group of measures used to prevent an organism illness. Measures used to avoid illness.
PUPA: The inactive life step of an insect between larva and adult, in certain insects that experiment complete metamorphosis.
PUPA: The immature step of an insect such as the locust, grasshopper, bug that do not experiment a complete metamorphosis.

RANDOM SAMPLE: The more common sample used to determine the number and the pest damage and realized by random.
RECUPERATION: Quantity of material retained by the objective, generally expressed in percentages.
RE-ENTRY PERIOD: Period of time between the application of a plant protection product and the re-entry to the treated area.
RELOT: Process in which and insect changes skin and form.
RESISTANCY:
1. A characteristic that exists or is developed by natural selection, that makes a plague survive to the toxic effects of a pesticide.
2. A complex property of plants and animals that allows them to resist partially or completely the pathogenic effects of an infection.
RISK: The probability that a substance might be dangerous. It includes three components: The toxicity, the exposition and the probability of exposition.
RHIZOME: Underground trailing stem, that is used by the plants to extend or multiply.
RODENTICIDE: Plant protection product used to combat rats, mice and other rodents.

ROTATION: The practice to produce crops in the same parcel, in a regular sequence to maintain the fertility and avoids plagues such as weeds, insects, or soil diseases, reach damaging levels of population.

RUST: Illness that gives the plant a rusty appearance and is caused by fungus.

SAMPLE: Action of obtaining samples of organisms that are damaging the plants.

SAPROPHAGUS: Organisms that feed from organic materials in decomposition or putrefaction.

SATURATED: That is in its maximum capacity, for example: a soil saturated of water, permits the drainage of the same.

SATURATION POINT: Point of more liquid retention in the vegetal surface.

SCATTERED APPLICATION: Term that is used to describe the complete scattering, (distribution) of a granule, powder or mixture over a parcel, total aerial application (blanket application).

SCROTUM: A bag formed by a little skin portion and its purpose is to keep and protect the testicles.

SELECT: Elimination of undesired plants in the crop, is often hand made, and sometimes can be used a plant protection product.

SOCIALY ACCEPTABLE: Technology accepted by society through the actual knowledge.

SOIL STERILIZATION: Pesticide applied to the soil (generally injected or incorporated) to obtain a general soil plague control, whether they are insects, diseases or weeds.

SOLUTION: Mixture of a solid, liquid or gas, diluted in a liquid.

SOLVENT: Liquid, as water, paraffin or oil, that dissolves a plant protection product and forms a solution.

SPECIES: A group of plants or animals, with similar characteristics and common name that propagates according to kind.

SPORE: Small propagation unit that works as a seed, but it is different from the seed that does not have the preformed embryo.

STRATEGY: Art of coordinating all kind of actions or alternatives for the solution of a phitosanitary problem.

STYLET: Large, thin and hollow structure of the nematode and some insects that have an alimentary function.

SUSCEPTIBLE: Denotes that the plant or insect could be easily controlled by a plant protection product, strictly following the usage indications.

SUSPENTION: Solid particles finely divided, distributed integrally in a liquid or gas.

SYMBIOSIS: The living together of two or more different organisms, everyone giving or taking from the other; for example: The bacteria of the radical nodule with the legumes plants.
SYNERGISM: Complementary action of two or more plant protection products, by which the combined effect is higher than the addition of the effects of each one separately.
SYSTEMIC: It refers to plant protection products that can translocate through the plants.
SYSTEMIA: Denotes the Systemic action.

THERMO MIST: Mist by thermo energy.
TO CULL: Elimination of undesired plants in a crop, it is often handmade, but sometimes a plant protection product can be used.
TO INHALE: To aspire deeply.
TOLERANCE: The ability of a plant to bear an illness, the inherent ability to be sever attacked by an illness without significant reduce of its yield.
TO WRING OUT: It refers to the liquid or liquid mixture that runs free over a surface.
TOTAL APPLICATION BAND: Length of the reached area treated by the sprayed particles.
TOXICITY: The capacity of a substance to produce damages in human beings and environment.
TOXIN: Poison elaborated by an organism.
TRAP CROP: Crop area that is planted before the commercial plantation with the purpose of controlling the pest in a reduced and localized area.
TRANSLOCATION: Denotes that a plant protection product can move inside the plant.

ULTRA LOW VOLUME: The application of plant protection products not diluted, in dosages of less than 5 liters per hectare.

VASCULAR SYSTEM: The phloem system of tubular form and the xylem cells in a plant, from their entrances or synthesis sites, to their usage and storage sites.
VARIETY: Taxonomical group inferior to a specie. More precisely cultivated variety.
VECTOR: A porter as an insect, that transmits a pathogen from a sick plant or animal towards a healthy one.
VEHICLE: Inert ingredient in a formulation of a plant protection product, over or in which, the active ingredient is absorbed; for example: kaolin for powders.
VESSEL SYSTEM: The phloem tubular form and the xylem cells in a plant, from the entrance or syntesis, and the use and storage places.
VIRULENCE: Degree of an infectious power of a pathogen.
VIRUS: Microscopic obligate parasite that contains ARN o AND, never both.
VOLATILITY: The ability to vaporize rapidly.
WETABLE POWDER: Formulation of a plant protection product, compound by an active ingredient mixed with a fine powder and a moisturizing agent, that mixes easily with water and makes a spray suspension.

WHITEWASH: Mixture of a liquid and a wet powder, with creamy consistency.

XYLEM: In the vegetables, the channel systems more or less continuous, formed by inert joined cells, that transport water and insoluble minerals from the roots to the leaves.