TRAINING NOTEBOOK

- AGRICULTURAL PRODUCTION AND PROCESSING -

FOUNDATION OF CROP PROTECTION

COLEACP

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- AGRICULTURAL PRODUCTION AND PROCESSING -

FOUNDATION OF CROP PROTECTION

LEAFLET 1

Extent of crop enemies and need to protect them

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Describe the role of crop protection in relation to the increase in food requirements.
- List the parameters that define the type of treatment (plant health control).
- List the reasons why the conventional means of crop protection are now under question.
- Explain the role of Risk Analysis in an integrated approach to protection methods.

KEY MESSAGES

1) Food safety and the impact of crop enemies

- The increase in food requirements, due largely to the population explosion, can only be met by increasing the cultivated surface area, and improving productivity per hectare.
- Since the possibilities of expanding arable lands are limited, the medium and long-term strategies will rely mainly on increasing yield per hectare and reducing post-harvest losses. This is why it is so vital to protect crops.
- It is estimated that almost 50% of world agricultural production is lost before or after harvest. In order to safeguard the production potential, more effective methods of monitoring and protection are needed.

2) Pests, diseases and weeds

- The agents responsible for crop losses are mainly plant-eating insects (nematodes, fungi, viruses, bacteria and weeds).
- A rational and effective fight against weeds, pests and diseases involves minimum knowledge of their lifestyle, biology and principal characteristics.
- The choice of treatment must take into consideration:
  - The organisms to be controlled (efficacy);
  - The sensitivity of the crops (selectivity);
  - The aim pursued (to curb pest development, prevent an infestation, etc.);
  - Regulatory requirements and specifications;
  - The skill of the operators;
  - Safe use, and means to protect personnel;
  - Competitiveness goals (profitability of control) ;
  - Impact on the environment.

3) The challenges facing crop protection

- Chemical protection of crops is no longer entirely satisfactory, since it does not ensure the sustainability of agro-ecosystems (loss of biodiversity, etc.) and its efficacy is diminished with time (resistance of the insects, etc.).
- It is through a scientific analysis of current practices and the alternatives proposed that growers will be shown the benefit of revising their practices.
- The Risk Analysis is an approach that leads to a more rational use of plant protection products, an adequate development of alternative methods and a choice of appropriate measures to prevent contamination of the environment.

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 2

Epidemiology, dynamic and identification of pest population

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Define the concepts of epidemiology and dynamic of pest populations.
- Categorise the pests.
- List the main characteristics (morphology, development, etc.) for each category of pest.

KEY MESSAGES

1) Epidemiology and the dynamics of pest populations

- Epidemiology is defined as the study of the development of a pest population within a host population.
- The development of international trade and air transport has encouraged the introduction of pests in new areas of the world, causing considerable damage to crops.
- International regulatory measures have been adopted to limit the spread of potentially dangerous pests called “quarantine organisms”.
- The danger posed by a pest is the outcome of two groups of factors: biotic factors (fecundity, etc.) and abiotic factors (climate, competition for food, etc.).

2) Biology and identification of pests

- The main characteristics of insects are:
  - A body (adult) divided into three distinct parts: head, thorax to which the three pairs of legs and the wings are fixed, and the abdomen.
  - In the course of their development cycle, insects undergo metamorphosis (egg, larva, nymph and adult). The most harmful stage for crops is generally the larval stage.
  - It is their method of feeding that causes the damage.
- The main characteristics of mites (acarids) are:
  - They generally have 4 pairs of legs, but they have neither antenna nor wings.
  - They are very small and are therefore often invisible to the naked eye.
  - Different stages of development, all stages being mobile.
- Myriapods or centipedes are made up of similar segments, each of which has one or two pairs of legs. They destroy the sown seeds before harvesting.
- The main characteristics of plant parasitic nematodes are:
  - Nematodes are microscopic worms.
  - They have 5 stages of development (4 larval and an adult).
  - Their secretions can form special nourishing structures, or even galls on roots.
  - They can be separated into two categories: root nematodes and nematodes on the aerial parts.

- Rodents and harmful birds:
  - Rodents compete directly with humans for food. It is important to be aware of their reproductive periods to make rational control possible.
  - Birds (especially seed eaters) can cause losses to cereals, fruit and vegetables. However, they also play an essential role as crop helpers.

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 3

Development and identification of plant diseases

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Differentiate between biotic and abiotic diseases.
- List the characteristics of the various pathogen micro-organisms.
- Briefly describe the epidemiological dynamics of the various pathogen micro-organisms.
- List the three conditions for the development of infectious diseases.

KEY MESSAGES

1) Groups of plant diseases

- Disease is an anomaly of the structure or function of a plant, caused by a continuous irritating factor.
- Diseases can be divided into two main groups: infectious (or biotic) and non-infectious (or abiotic).

2) Non-infectious diseases (abiotic)

- These diseases are caused by unfavourable environmental, nutritional or mechanical factors and cannot be passed to healthy plants.
- Non-infectious diseases are also caused by deficiencies in major nutritional elements.

3) Infectious diseases (due to pathogens)

- Biotic diseases are caused by micro-organisms such as:
  - Fungi: they have an asexual (rapid and repetitive) and sexual reproduction. Sexual spores are frequently able to store pathogenic fungi during periods of plant growth stoppage in the cold or dry season and constitute the sources of primary inoculum (infection) ensuring the recurrence of the epidemic.
  - Prokaryotes: this group includes bacteria and mollicutes. As for fungi, the progress of the epidemic requires the existence of an inoculum conservation phase, followed by a succession of phases of infection and phases of dispersion.
  - Viruses and viroids: they are infectious entities which carry genetic information, obligatory parasites of living cells of a host plant. Transmission of viruses can be vertical (affecting the descendants of the infected plant) or horizontal (affecting other plants of the same species or other species) by contact. The epidemiology therefore depends on various factors relating to the vector itself, its host, etc.
- Infectious diseases develop only if three conditions fulfilled:
  - the host plant must be sensitive (and/or “sensitised”),
  - the pathogen agent must be virulent and capable of attacking the plant,

- the environment must favour the development of the disease (*i.e.* favour sensitivity and virulence).

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 4

Competition and identification of weeds

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- List and briefly describe the two types of harm caused by weeds.
- Name the basis for classification of weeds.
- List the cultivation practices that foster weed development and the phenomenon of herbicide resistance.

KEY MESSAGES

1) The biology of weeds

- A weed is a ligneous plant that is undesirable at the spot where it is found.
- The close relationship between “good” and “bad” weeds makes weeding particularly difficult.
- There are many vectors for weed propagation: wind, water, animals, etc.

2) Direct harmfulness (competitive effect)

- At the beginning of their development, weeds are formidable competitors. They germinate quickly and develop faster than the crops. Weeds absorb some of the water and nutritional elements, and partially deprive cultivated plants of air and light.
- Horticultural crops are very sensitive to competition from weeds.
- Competition starts as soon as weeds begin to emerge.
- The action threshold is based on the number of weed plants/m^2 that can lead to a significant drop in yield.

3) Indirect harmfulness

- Weeds are home to numerous pests and diseases harmful to crops. They provide cover for harmful rodents.
- The presence of weeds renders harvesting work more difficult.
- The unwanted seeds and the plant debris in the crop cut the value of the harvest.

4) Classification of weeds

- The species involved must be identified in order to choose a suitable means of control.
- Classification can be based on:
  - the presence of one or two cotyledons (Monocotyledons and Dicotyledons);

- their vegetative cycle. We can distinguish between: annual plants, biannual plants and perennial plants. Amongst perennial species, we can find those that spread: with rhizomes, stolons, bulbs, and roots.

5) Agricultural factors encouraging the development of weeds

Some practices (shortened periods of rotation, spray or bed irrigation, reduced cultivation, the absence of effective herbicide, etc.) will favour the development of population of weeds in plots and can lead to the phenomenon of resistance to herbicides.

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 5

Techniques of observation and sampling methods

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- List the methods for observing pests, fungi and bacteria.
- Differentiate and describe the notions of action threshold and economic injury level.
- Define the concept of quarantine organism.
- Describe the bases for batch sampling during phytosanitary inspections.

KEY MESSAGES

1) Methods of observing and sampling pest populations in the field

- The harmful action of a population depends largely on its density (*i.e.* the number of individuals per unit of surface area or volume).
- Methods to evaluate the density of populations may be grouped under two main headings:
  - Direct observation and counting,
  - Trapping and capturing techniques (ground cover, sweep net, pheromone traps, light traps, etc.).
- The choice of each of these methods depends on several factors, such as the type of pest, the stage of vegetative development, climate conditions, etc.
- There are also absolute sampling methods based on isolating a population over a known surface area (cage fumigation, sampling cage...).

2) Methods of observing fungi and bacteria

- Methods to observe symptoms.
- Methods for diagnosis in the laboratory:
  - biological methods (detection of infectious parts of the pathogenic agent);
  - immunological or serological methods (detection of molecules synthesised by the pathogenic agent);
  - molecular methods (detection of the sequences of nucleic acids that are specific to the genome of the pathogenic agent).

3) The thresholds of risk

- We speak about “economic injury level” which is the pest population density at which the cost to control the pest equals the amount of damage it inflicts. The action threshold is the value at which the abundance of pests justifies recourse to control measures.
- These levels can vary when other parameters are taken into account, such as agronomic

data, climatological elements, data relating to the control methods available, economic data, etc.

4) Quarantine organisms

- A quarantine organism is a pest of potential economic harm to an area in question. This organism is either not yet present in this area or is present but not widespread. It is the object of official control measures.
- Consignment inspection is the plant health procedure most frequently used to establish whether or not harmful organisms are present. This inspection relies on samples based on batch. Sampling, especially when it involves more than one batch, must comply with a series of rules (isolation, identification, calculation of the number of samples...).

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 6

Developing a crop protection strategy

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Briefly describe the various strategies of plant health control and its development over the past few decades.
- Describe the four steps to be followed for the implementation of an effective plant health control programme.

KEY MESSAGES

1) Foundations of plant health control

Plant health control has significantly developed in the past 50 years:

- Starting with “blind” chemical control established by estimating a recurrent risk.
- Followed by “rational” chemical control which called on the notion of “economic injury level” and selectivity of pesticides towards the auxiliaries.
- Culminating currently with the concept of “integrated” control based on managing populations of harmful organisations through integration, instead of a juxtaposition of all the preventive and control techniques (agricultural, biological, genetic, etc.).

2) The four stages of action in plant health control

- Identification: this stage not only consists in identifying and making an inventory of pests, it also entails an evaluation of the growing system (system of rotation, genotypes, economic value, etc.) as well as identification of the relations between pests and the natural enemies present.
- Definition of the level of infestation compared with threshold of intervention: in order to intervene at the right time, particularly, to rationalise the use of insecticides, the notion of threshold of intervention, adapted to actual pest pressure, is recommended.
- Decision on intervention methods: the choice of the intervention method is very complex because it depends on several factors such as:
  - Estimation of observed and potential losses,
  - Difficulty in accessing information,
  - The actual choice of control methods, etc.
- The evaluation of the impacts: it is important to balance the costs and the benefits of the intervention(s) in order to be able to measure:
  1. The efficacy and profitability for the grower,
  2. The selectivity for the crop and the non-targeted organisms,
  3. The respect of Maximum Residue Levels (MRL),
  4. The side effects for the operator, and domestic and wild animals,

5. The effects on the environment, on growing techniques, etc.

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 7

Chemical treatments of crops and harvested products

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Define the concept of plant protection products.
- List the methods of action of insecticides, fungicides and herbicides.
- Differentiate and briefly describe selectivity and specificity.
- List the factors that cause resistance to plant protection products.

KEY MESSAGES

1) Definition and classification of plant protection products

- A pesticide can be defined as a “substance or combination of substances” that is intended to repel, destroy or combat pests causing damage to crops or that prove to be directly or indirectly harmful to humans.
- The term “active substance” (or molecules) is used to designate the biologically active compound.
- The term “formulation” refers to the ready-to-use commercial product. It contains one or several active materials at well-defined concentrations, with co-formulations such as solvents, wetting agents, etc.
- There are 4 types of plant protection products:
  - Mineral products,
  - Biological products,
  - Plant products or extracts,
  - Products of synthesis.
- Products are classified on the basis of their biological activity (insecticides, fungicides, etc.).

2) Properties and methods of action of plant protection products

- Most insecticides on the market have neurotoxic effects. Outside the nervous system, several targets can be envisaged such as disruption of endocrine functions and change in behaviour. The insecticide may penetrate via three approaches: by contact, ingestion, or by inhalation.
- Depending on the time of application in the basic parasite cycle, a fungicide is said to have a preventive, curative, eradicating or antisporulant activity.
- Herbicides can have numerous effects on physiology, especially on photosynthesis, growth, inhibition of lipid synthesis, etc. A herbicide uses selectivity to kill weeds and leave cultivated plants intact. Selectivity in its various forms (anatomical, physiological,

- agronomic, etc.) is crucial because it means that a herbicide will respect crops and fight the weeds that are harmful to these crops. Specificity and persistence are two other factors to be taken into account.

3) Managing resistance to pesticides

- The phenomenon of resistance is the ability of individuals in a population to survive a plant protection product treatment that would normally give effective control.
- If the same insecticide compound is frequently used (selection pressure), the insects resistant to it become dominant in the population.
- Prevention and management of the resistance is based on four recommendations:
  - Recourse to the methods of integrated management (IPM) and Good Plant Protection Practices (GPPP),
  - Combinations or mixture of insecticides,
  - Alternating insecticides,
  - Reducing the number of applications.

PERSONAL NOTES AND REFERENCE MATERIAL

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TRAINING LEAFLET 8

Good practice for pesticide application

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Define the concept of plant health treatment.
- List the measures to be taken to ensure the respect of Good Plant Protection Practices during treatment.
- Calculate the various parameters to be taken into consideration for the treatment (surface covered with one tank, speed of work, output of a nozzle, etc.) based on known data (dose/ha, volume of spray mixture/ha, surface to be treated, volume of the tank, etc.).
- Name the various types of nozzles and the related treatments.

KEY MESSAGES

1) Plant health treatment

- Plant health treatments are usually applied by spraying the crop. The major aim of spraying is to apply a very accurate volume/ha of mixture whose distribution is as even as possible and with the height, number and uniformity of spray droplets appropriate to the crop and type of treatment.
- The efficacy of a treatment (from an agronomic and economic point of view) depends on its timeliness (evaluation of the situation and need to intervene), its selectivity (choice of active material, formulation and dose) and its accuracy (identification of targets, choice of apparatus and user training).

2) Good Plant Protection Practice (GPPP)

- GPPP complies with the methods of application, the instructions for safe use, storage, and disposal of unused products or those past their expiry date.
- Implementation of Good Plant Protection Practice during treatment requires:
  - organisation of the site with an accurate marking out of plots, compliance with the product's method of use, monitoring of procedures to be followed when preparing and filling the mixture, etc.
  - a careful check of the equipment with calibration, cleaning and maintenance (daily maintenance, end of season maintenance, etc.);
  - the prevention of pollution and poisoning by wearing personal protective equipment (PPE), protecting water sources and residential areas, etc.

3) Calculating and measuring the volume applied/ha and doses

- The labelling on each product indicates the authorized dose per unit of surface area and, depending on the volume of mixture/ha, the concentration to be carried out depending on

the purpose of the treatment.

- To effectively organise the “spraying site”, the farmer must take into consideration:
  - the surface to be treated;
  - the quantity of product to be measured per tank;
  - the surface covered with one tank;
  - the volume of spray mixture required.

4) The operation of adjustment and calibration

- The volume spread/ha depends on:
  - the nozzle output. The choice of the nozzle makes it possible to adjust the pressure and therefore the size of the droplets;
  - the working speed (progress speed);
  - the working width.
- Other factors that influence the volume of the spray mixture/ha must be taken into account, such as pressure (directly related to the flow rate of a nozzle) or the working height (regularity of distribution).

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 9

Spraying equipment

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- Classify and briefly describe the various types of sprayers.
- Relate the types of sprayers with the types of work to be done.
- List the parameters of the equipment to be calibrated.

KEY MESSAGES

1) Definition and types of sprayers

A sprayer is a device used to apply either a pest control mixture, or a liquid nutrient formulation intended as fertilizer.

- Back-pack sprayers:
  - pre-pressurised sprayers: the pressure must be continually maintained during treatment by activating the pumping lever;
  - motorised mist blower sprayers are characterised by the use of high-speed air current to reduce the liquid mixture into fine droplets.
- Hydraulic nozzle sprayer:
  - mounted sprayer: the spray is created by nozzles mounted on a spray boom;
  - mounted air assisted radial sprayer: the mixture is fragmented by the pressure of the liquid in the nozzles. The transport of drops is ensured by an air current.

2) Adjustment and calibration of apparatus

An apparatus must be calibrated to certify that it will be able to apply the desired volume of mixture on a given area unit, under normal conditions of use. This operation must be carried out regularly, at least once per season. Several elements must be taken into consideration when calibrating:

- The pressure:
  - for back-pack sprayer, no adjustment is necessary as the maximum pressure depends on the construction of the apparatus; on the other hand, as the parts become worn, pressure may decrease;
  - in the case of nozzle boom sprayers, the working pressure will be determined using output tables supplied by vendors and constructors. Pressure also depends on the density of the liquid sprayed.
- The output (L/min):
  - the output depends on the calibration of the nozzle and on the pressure;
  - since the pressure and the nature of the mixture are imposed by the treatment applied, the choice of nozzle depends on the volume spread and the working speed.
- The working width: the height of the nozzle in comparison with the target determines the

working width. It is important to maintain a normal height of the nozzle during treatment.

- The speed of progress: the only way of carrying out calibration consists of the operator being timed and being sure to respect a regular rhythm of progress, by the operator adjusting his steps in time to his pumping movements.

PERSONAL NOTES AND REFERENCE MATERIAL

LEAFLET 10

The management and disposal of effluents and waste

EDUCATIONAL OBJECTIVES

On completion of this training sequence, the participant must be able to:

- List the effluent treatment techniques.
- Name the rules to be respected for the construction of the various areas required for appropriate effluent management.
- List the techniques for the disposal of waste plant protection products.
- Briefly describe the short and long terms actions for the management of NUPP.

KEY MESSAGES

1) Management of effluents

“Effluents” is the name given to dregs in tanks, cleaning water from spraying equipment, unusable pesticide mixtures. If poorly managed, effluents are one of the major sources of pollution. Ideally, the grower should have on his farm an area for:

- Measuring, mixing and filling: the layout depends on the type of equipment used. A grassy area is sufficient to neutralise “minor losses” from back –pack sprayers. With regards to large sprayers, a waterproof area must be used. This area must:
  - be located away from water take-off points;
  - be a waterproof concrete area;
  - be arranged in order to avoid flowback of mixture.
- Washing the equipment used and a system for collecting and treating effluents.
  - the dregs at the bottom of the tank can be spread over the plot which has just been treated;
  - the effluents can generally be treated by the operator in installations approved for this purpose. These treatments are mainly based on the purifying power of the soil and the bacteria.
- Storing used PPE and non-usable pesticide products (NUPP). After having properly rinsed the equipment, operator can store it in an area ready for collection, set aside for this purpose.

2) Disposal of plant protection product wastes product waste

Disposal can be through:

- A controlled incineration in an approved centre, one that is equipped to treat the fumes, gaseous effluents and cinders.
- Burial in an approved dump for toxic products.

3) Management of non-usable plant protection products

These products, which are out-of-date, prohibited for health, regulatory or environmental reasons are often the source of serious pollutions and constitute a danger for health and the environment.

- The short-term actions rely mainly on the shipping of these products to countries equipped with adequate facilities for incinerating them at a high temperature.
- The long term actions rely on prevention, i.e. ensuring that these products do not accumulate any further. This can occur following a lasting change in the way pesticides are purchased and used. An action plan must be implemented by promoting rational and integrated use of PPP, developing alternative methods of control, improving and popularising updated crop protocols, promoting quality procedures, etc.

PERSONAL NOTES AND REFERENCE MATERIAL

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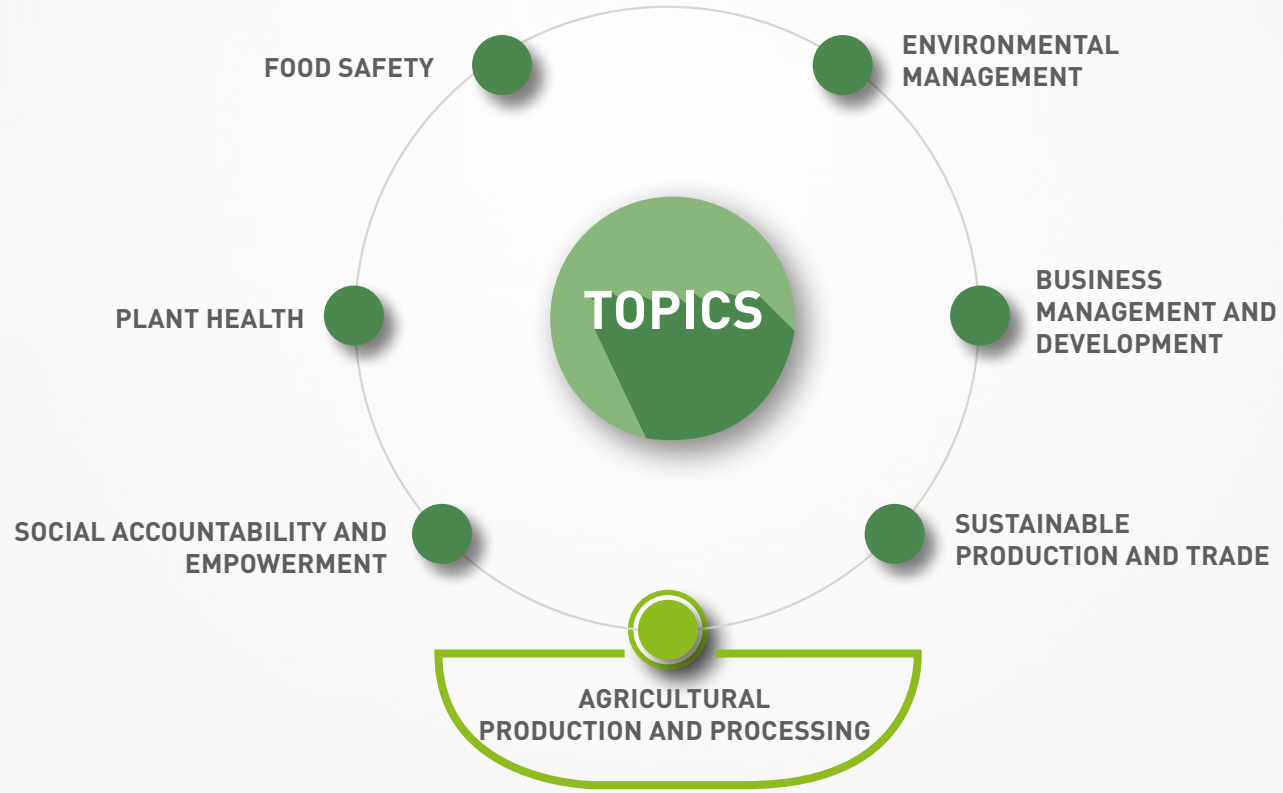

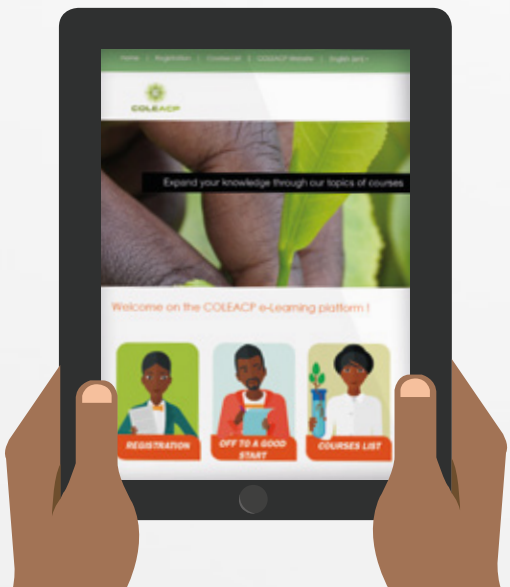

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