Pest control: protect the harvest

A pest is an organism that causes an unwanted effect, such as crop damage, disease or competition with crops. Control can reduce losses and protect yield and quality; the goal is not necessarily to eliminate every organism.

1. PESTICIDE IS THE UMBRELLA TERM

Type	Target	Agricultural example
Insecticide	Insects	Crop-feeding caterpillars
Herbicide	Unwanted plants	Weeds competing for water
Fungicide	Fungi	Fungal leaf disease
Rodenticide	Rodents	Rats damaging stored grain

Pesticides include substances that kill, repel or otherwise control pests. Herbicides are pesticides, not a separate category outside them. Names identify the intended target, not a guarantee that other organisms are unaffected.

2. BENEFIT: LESS DAMAGE, MORE USABLE CROP

Insects may eat plant tissues; weeds compete for light, nutrients and water; fungi can cause disease; rodents consume or contaminate stored food. Effective control reduces these losses. Choose a method that matches the actual pest: an insecticide will not solve every disease or weed problem. Benefits depend on pest pressure and correct identification.

3. COST: EFFECTS CAN REACH NON-TARGET ORGANISMS

Some pesticides can harm organisms other than the pest, including beneficial insects or aquatic animals. Spray drift moves droplets away during application; runoff can later carry residues into waterways. Risk depends on toxicity, exposure, persistence and application conditions. A product that controls a pest is not automatically harmless to the surrounding ecosystem.

Pesticide categories and targets: EPA, Types of Pesticide Ingredients.
Transport and non-target aquatic effects: EPA CADDIS, Insecticides.

Scope: College Board AP Environmental Science CED, Topic 5.6, p. 101.

Resistance evolves in populations

Repeated exposure to the same pesticide can favor pests with heritable resistance. Susceptible individuals are more likely to die; resistant survivors leave more offspring. Humans create the selection pressure through pesticide use.

1. VARIATION + SELECTION + REPRODUCTION



Filled circles: resistant pests. Open circles: susceptible pests. Crosses: killed pests. This simplified diagram illustrates a change in frequency, not measured survival rates; resistance need not reach 100%.

Individuals do not decide to become resistant. Over generations, inherited resistance becomes more common in the surviving and reproducing population.

2. THE PESTICIDE TREADMILL

As resistance spreads, control may weaken and farmers may rely on additional applications or different products. Continued dependence can increase costs and maintain selection pressure. Switching brand names is not enough if the products act through the same mode of action. Resistance can evolve to herbicides, fungicides and other pesticides, not just insecticides.

3. EXTENSION: REDUCE RELIANCE ON ONE CONTROL

Integrated pest management combines monitoring and action thresholds with prevention and appropriate controls. Crop rotation can interrupt some pest life cycles; natural enemies or targeted treatments may help. Different modes of action can support resistance management. IPM means neither zero pesticides nor automatic spraying whenever one pest appears.

Resistance and mode-of-action management: EPA, Slowing and Combating Pest Resistance.
Monitoring, thresholds and prevention: EPA, Integrated Pest Management Principles.

Scope: College Board AP Environmental Science CED, Topic 5.6, p. 101.

Engineered crops: benefits and limits

Genetic engineering can give a crop traits that reduce losses from certain insects or diseases. Evaluate the specific trait and farming system: the label "GMO" alone does not tell you every benefit, risk or management requirement.

1. TWO TRAITS THAT WORK DIFFERENTLY

INSECT RESISTANCE

Some Bt crops produce a protein that harms particular insect pests when eaten. This can reduce crop damage and the need for some sprayed insecticides.

HERBICIDE TOLERANCE

The crop tolerates a particular herbicide so susceptible weeds can be controlled. The crop does not itself kill the weeds; herbicide use remains part of the system.

Bt refers to Bacillus thuringiensis, the bacterium from which these insecticidal traits originate. Pest-resistant means the crop resists damage; pesticide-resistant means a pest survives a control that previously worked.

2. PROTECTION IS SPECIFIC, NOT PERMANENT IMMUNITY

An insect-resistant crop may still suffer from other insects, weeds or diseases. Target pests can also evolve resistance to a crop's protective trait. Likewise, repeated use of one herbicide with a tolerant crop can select for resistant weeds. Protecting a yield is not the same as guaranteeing a higher yield in every environment.

3. CROP DIVERSITY DEPENDS ON WHAT IS PLANTED

Replacing many local varieties with a few widely used varieties can narrow genetic diversity. Uniform susceptibility to a new pest or disease can then cause widespread losses. This risk can accompany adoption of engineered crops, but it is not unique to them or an inevitable result of inserting a gene. Maintaining diverse crop varieties and genetic resources preserves options for future breeding and adaptation.

Insect resistance and herbicide tolerance: FDA, Why Do Farmers Grow GMO Crops?
Resistance to crop protection: EPA, Insect Resistance Management for Bt Crops.
Variety replacement and genetic vulnerability: FAO, Harvesting Nature's Diversity.

Scope: College Board AP Environmental Science CED, Topic 5.6, p. 101.