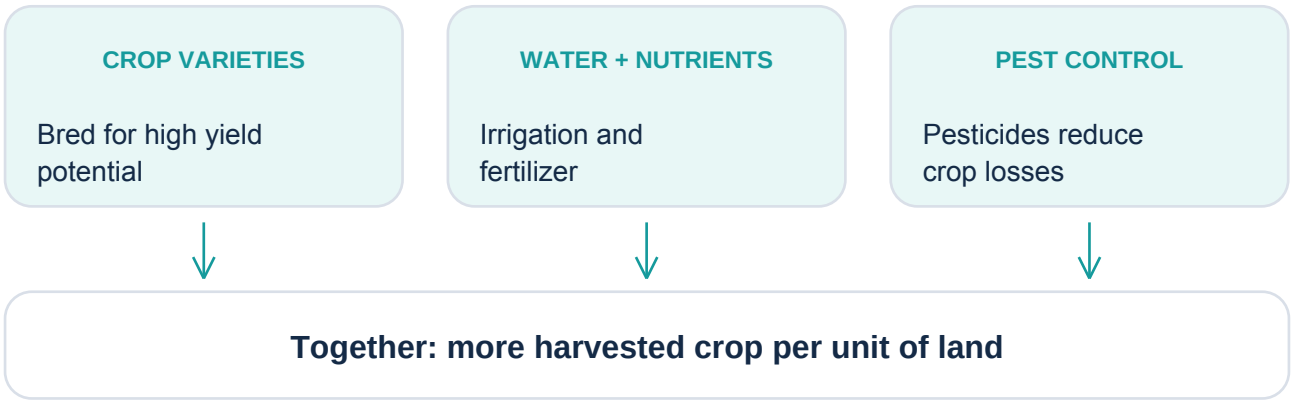
The Green Revolution

The Green Revolution increased food production through improved crop varieties and intensive farming methods. Its input package raised yields in many regions, but brought environmental and economic trade-offs.

1. A PACKAGE OF INPUTS, NOT JUST A NEW SEED



High-yield potential is not a guarantee. Water, nutrient supply, local conditions and management determine the harvest. Machinery helps farmers carry out operations at scale.

2. HISTORICAL EXAMPLE: IR8 RICE

IRRI released IR8 in 1966. This semi-dwarf rice was developed through crossing and selection. Its short, strong stems were less likely to lodge (fall over), even with substantial fertilizer. In well-managed irrigated fields, the variety could produce much more grain. Similar high-yielding varieties helped expand food supply.

3. SELECTIVE BREEDING IS NOT GENETIC ENGINEERING

Selective breeding crosses plants and selects offspring with useful traits. Genetic engineering makes targeted changes to DNA using biotechnology. APES includes GMOs among modern agricultural strategies, but the original Green Revolution varieties were conventionally bred. A high-yield variety is not automatically a GMO, and a GMO trait does not automatically increase yield.

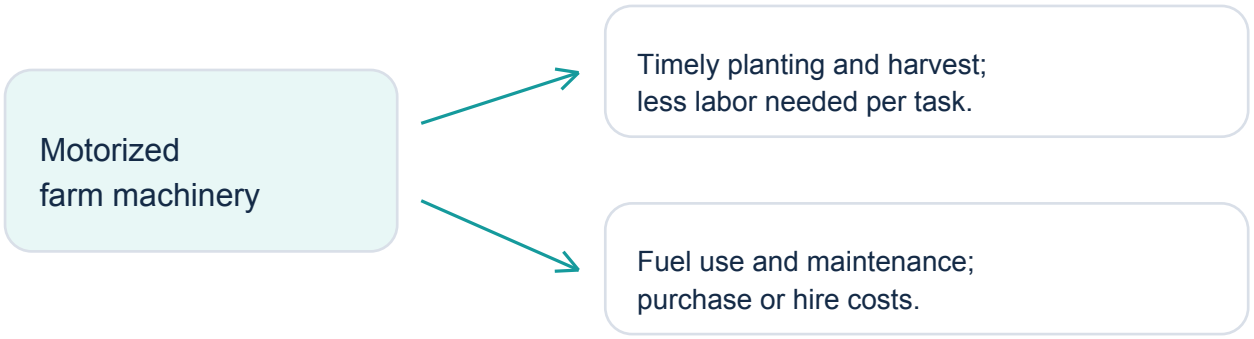
Historical example and fertilizer response: IRRI, IR8 - a rice variety for the ages.
Breeding versus genetic engineering: FDA, Science and History of GMOs.

Scope: College Board AP Environmental Science CED, Topic 5.3, p. 97.

Mechanization: speed has a cost

Mechanization replaces or assists human and animal labor with equipment. Tractors, seed drills and harvesters can complete farm operations faster and improve output per worker; yield per hectare is a different measure.

1. FOLLOW BOTH SIDES OF THE CHANGE



Efficiency and profit can rise if additional revenue and labor savings exceed the added costs. Fossil-fuel-powered equipment also increases dependence on fuel supplies and releases CO_2 when fuel burns.

2. KEEP YIELD, TOTAL OUTPUT AND PROFIT SEPARATE

Yield is harvest per unit area; total production also depends on area planted. An illustrative farm growing 3 tonnes per hectare on 20 hectares produces 60 tonnes. At 5 tonnes per hectare on the same land, it produces 100 tonnes. The extra 40 tonnes is additional output, not profit: seed, fertilizer, water, machinery and other costs must still be paid.

3. EXTENSION: WHO CAN USE THE TECHNOLOGY?

Access to suitable equipment, finance, repair services and training affects adoption. A large machine may be a poor investment for a small farm, while appropriately sized equipment or shared hire services may be useful. More food at the regional level does not by itself guarantee that every household can afford or access it. Evaluate both production gains and who receives those gains.

Efficiency, timeliness and appropriate equipment: FAO, Why mechanization is important.
Core mechanization trade-off: College Board, EIN-2.C.2.

Scope: College Board AP Environmental Science CED, Topic 5.3, p. 97.

Trace the environmental trade-offs

An agricultural input can solve one problem while creating another. Connect each method to its intended benefit, then to the mechanism of a possible cost. Outcomes depend on the input, dose, site and management.

1. FERTILIZER: MORE GROWTH, BUT POSSIBLE RUNOFF

Fertilizer supplies nutrients that can limit crop growth. Nutrients not taken up by crops can leave fields in runoff or drainage and enter waterways.

Excess nitrogen and phosphorus → Algal growth; algae later die → Decomposers use dissolved oxygen

Oxygen depletion can harm aquatic life. Extension: match nutrient application to crop needs, timing and placement to reduce losses while supporting production.

2. IRRIGATION: WATER SUPPLY AND SALT BUILDUP

Irrigation supplies water when rainfall is insufficient. In dry regions, evaporation removes water but leaves dissolved salts behind. Without adequate drainage and leaching, salts can accumulate in the root zone: salinization makes water uptake harder and can reduce growth. Applying more water without considering drainage can worsen waterlogging rather than solve the problem.

3. PESTICIDES: PROTECTING CROPS, SELECTING RESISTANCE

Pesticides suppress organisms that damage crops or compete with them. Repeated use of the same mode of action can favor resistant survivors, whose offspring make resistance more common. The pesticide then becomes less effective; individual pests do not simply choose to adapt. Extension: integrated pest management combines monitoring, prevention and appropriate controls to reduce overreliance on a single pesticide.

Fertilizer runoff and nutrient management: EPA, Sources and Solutions: Agriculture.
Irrigation and salinization: FAO, Chapter 7 - Salty Soils.
Pesticide selection pressure: EPA, Slowing and Combating Pest Resistance.

Scope: College Board AP Environmental Science CED, Topic 5.3, p. 97.