



CHAPTER 12: FOOD, SOIL, AND PEST MANAGEMENT

APES 2013

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FOOD SECURITY

- EVERY PERSON IN A GIVEN AREA HAS ENOUGH NUTRITIOUS FOOD TO LIVE AN ACTIVE AND HEALTHY LIFE
- AS HUMANS WE PRODUCE MORE THAN ENOUGH FOOD FOR EVERYONE TO HAVE BASIC FOOD SECURITY, BUT STILL IN DEVELOPING COUNTRIES ABOUT 1 IN 6 DOES NOT HAVE ENOUGH FOOD.

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BASIC FOOD NEEDS

- MACRONUTRIENTS (PROTEINS, LIPIDS, CARBOHYDRATES)

Table 12-1

Key Nutrients for a Healthy Human Life

Nutrient	Food source	Function
Proteins	Animals and some plants	Help to build and repair body tissues
Carbohydrates	Wheat, corn and rice	Provide short-term energy
Lipids (oils and fats)	Animal fats, nuts, oils	Help to build membrane tissues and create hormones

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- MICRONUTRIENTS (VITAMINS AND MINERALS)

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NUTRITION

- **UNDERNUTRITION - NOT CONSUMING ENOUGH FOOD**
- **MALNUTRITION - NOT GETTING ENOUGH OF NECESSARY MACRO AND MICRO NUTRIENTS**
- **BOTH OF THESE CAN BE CONSIDERED “CHRONIC” IF IT IS A CONTINUOUS PROBLEM**
- **WHAT PROBLEMS CAN RESULT FROM THESE CONDITIONS?**

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IRON DEFICIENCY

- **CAUSES ANEMIA (FATIGUE, INCREASED POSSIBILITY OF INFECTION, HEMORRHAGING)**
- **ESTIMATED 1 IN 5 PEOPLE SUFFER FROM THIS (USUALLY WOMEN AND CHILDREN)**
- **GOLDEN RICE - RICE GENETICALLY ENGINEERED TO CONTAIN MORE IRON AND VITAMIN A**
 - **SOME SAY THIS IS JUST A PLOY TO STOP OPPOSITION TO GENETICALLY ENGINEERED CROPS**
 - **STILL MORE RESEARCH HAS TO BE PERFORMED TO SUBSTANTIATE CLAIMS**

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IODINE DEFICIENCY



- **IODINE NECESSARY FOR PROPER THYROID FUNCTION**
 - **THYROID PRODUCED HORMONES THAT REGULATE FUNCTIONS OF METABOLISM**
- **IODINE IS FOUND IN SEAFOOD AND CROPS FROM IRON RICH SOILS**
- **CHRONIC LACK OF IODINE CAUSES: STUNTED GROWTH, MENTAL RETARDATION, AND GOITER (SWOLLEN THYROID GLAND WHICH CAN LEAD TO DEAFNESS)**
- **ESTIMATED 600 MILLION PEOPLE SUFFER FROM GOITER AND 26 MILLION CHILDREN SUFFER BRAIN DAMAGE EACH YEAR FROM LACK OF IODINE**
- **ADDING TRACE AMOUNTS OF IODINE TO SALT HAS REDUCED THIS PROBLEM**

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FAMINE

- OCCURS WHEN A SEVERE SHORTAGE OF FOOD IN AN AREA LEADS TO MASS STARVATION, MANY DEATHS, ECONOMIC CHAOS, AND SOCIAL DISRUPTION

- CAN RESULT IN MASS MIGRATIONS OF PEOPLE

- MAIN CAUSES:

- CROP FAILURES

- DROUGHT

- FLOODING

- WAR



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OVERNUTRITION

- OCCURS WHEN FOOD ENERGY INTAKE EXCEEDS ENERGY USE AND CAUSES STORAGE AS FAT

- FACE SIMILAR PROBLEMS TO THOSE UNDERNOURISHED

- LOWER LIFE EXPECTANCY

- GREATER SUSCEPTIBILITY TO DISEASE AND ILLNESS

- LOWER PRODUCTIVITY AND QUALITY OF LIFE

- 1 OUT OF 4 PEOPLE WORLDWIDE ARE OVERWEIGHT

- UNITED STATES 2 OUT OF 3 ARE OVERWEIGHT AND 1 OUT OF 3 ARE OBESE

- AMERICANS SPEND AN ESTIMATED \$50 BILLION ON LOSING WEIGHT EACH YEAR. THE UN ESTIMATES THAT UNDERNUTRITION AND MALNUTRITION COULD BE ELIMINATED WITH \$24 BILLION.

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FOOD PRODUCTION

- THREE SYSTEMS

- CROPLANDS (77% OF WORLD'S FOOD)

- USES 11% OF WORLD'S LAND AREA

- RANGELANDS (16% OF WORLD'S FOOD)

- USES 29% OF WORLD'S LAND AREA

- OCEANIC FISHERIES (7% OF WORLD'S FOOD)

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FOOD CONSUMPTION

- ESTIMATED 50,000 EDIBLE PLANT SPECIES
- 90% OF WORLD'S CALORIES CONSUMED COME FROM 14 SPECIES
 - WHEAT, RICE, AND CORN PROVIDE 47% OF CALORIES
- WHAT PROBLEMS COULD THIS CAUSE?
 - OUR NUTRITION VULNERABLE TO DISEASE AND ENVIRONMENTAL DEGRADATION OF A SMALL NUMBER OF SPECIES
 - VIOLATES BIODIVERSITY PRINCIPLE OF SUSTAINABILITY

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MONOCULTURES VS. POLYCULTURES

- **INDUSTRIAL AGRICULTURE** (HIGH-INPUT AGRICULTURE)
 - PRODUCES MONOCULTURES (SINGLE CROP TYPE)
 - RELIES ON: HEAVY EQUIPMENT, FOSSIL FUELS, WATER, ARTIFICIAL FERTILIZERS, AND PESTICIDES
- **TRADITIONAL SUBSISTENCE AGRICULTURE** (PROVIDE FOOD FOR FARM FAMILY'S SURVIVAL) AND **TRADITIONAL INTENSIVE AGRICULTURE** (PROVIDE FOR FAMILY SURVIVAL WITH LIMITED AMOUNT TO SELL FOR INCOME)
 - PRODUCE POLYCULTURES (SEVERAL TYPES OF CROPS)
 - RELIES ON: HUMAN LABOR, ANIMAL LABOR, NATURAL FERTILIZERS, AND WATER

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VARIATIONS OF FOOD PRODUCTION

- PLANTATIONS (MONOCULTURES)
- HYDROPONICS AND GREENHOUSES (MONOCULTURES)
 - USES AS MUCH AS ONE-FIFTH AS MUCH WATER
- SLASH-AND-BURN (POLYCULTURES)
 - BURNING AND CLEARING AREAS (USUALLY IN TROPICAL FORESTS) TO GROW CROPS UNTIL SOIL NUTRIENTS ARE USED UP (USUALLY ONLY A FEW YEARS)
 - CAN TAKE UP TO 30 UNDISTURBED YEARS FOR SOIL TO AGAIN BE FERTILE

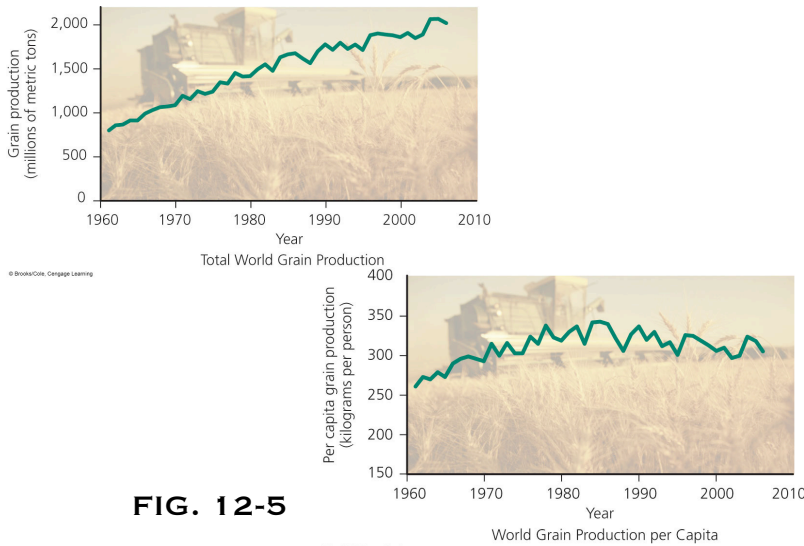
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“GREEN REVOLUTION”

- **HIGH-INPUT INDUSTRIALIZED AGRICULTURE TO INCREASE CROP YIELDS**
- **THREE STEPS:**
 - **SELECTIVELY BREED AND GENETICALLY ENGINEER VARIETIES OF KEY CROPS (RICE, WHEAT, AND CORN)**
 - **USE LARGE INPUTS OF FERTILIZERS, PESTICIDES, AND WATER**
 - **INCREASE NUMBER OF CROPS GROWN IN ONE AREA THROUGH MULTICROPPING**
- **SECOND GREEN REVOLUTION - FAST GROWING, DWARF VARIETIES BRED FOR TROPICAL AREAS**

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GRAIN PRODUCTION



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CROSSBREEDING AND GENETIC ENGINEERING

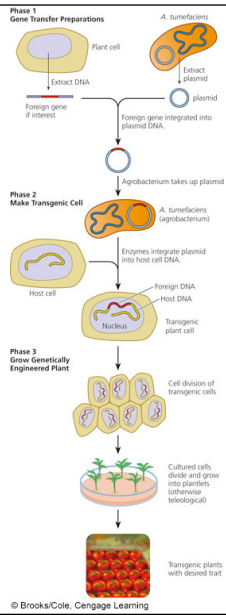
- **BOTH FORMS OF ARTIFICIAL SELECTION**
- **CROSSBREEDING - SLOW PROCESS, ACHIEVED THROUGH SELECTIVELY BREEDING ORGANISMS WITH DESIRABLE TRAITS WITH EACH OTHER**
- **GENETIC ENGINEERING - FASTER, INVOLVES THE ADDITION OR DELETION OF GENES TO CREATE ORGANISMS WITH THE MOST DESIRABLE CHARACTERISTICS**
 - **RESULTING ORGANISMS CALLED GMOs (GENETICALLY MODIFIED ORGANISMS)**

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GENETIC ENGINEERING

FIG. 12-6

- DEVELOP CROPS THAT ARE RESISTANT TO:
 - HEAT AND COLD
 - HERBICIDES
 - INSECT PESTS
 - PARASITES
 - VIRAL DISEASES
 - DROUGHT
 - SALTY OR ACIDIC SOILS



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MEAT PRODUCTION

- HALF OF THE WORLD'S MEAT COMES FROM INDUSTRIALIZED FEEDLOTS
- HUGE AREAS OF GRAZING LANDS ARE OVERTAKING CROP LANDS FORCING COUNTRIES TO IMPORT GRAINS TO SUPPORT THEIR POPULATIONS

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FISH AND SHELLFISH PRODUCTION

- FISHERY - CONCENTRATION OF PARTICULAR AQUATIC SPECIES SUITABLE FOR COMMERCIAL HARVESTING
- AQUACULTURE - RAISING MARINE AND FRESHWATER FISH IN PONDS AND UNDERWATER CAGES

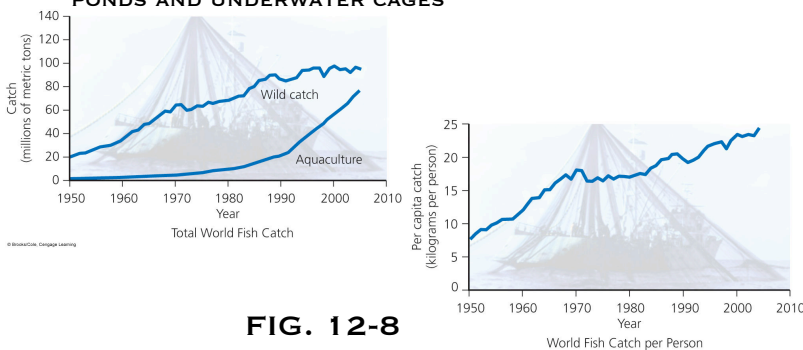


FIG. 12-8

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FISHERY STATUS

- **25% OF THE WORLD'S FISHERIES ARE VIRTUALLY DEPLETED**
- **52% HAVE BEEN FULLY EXPLOITED**
- **THIS MEANS 77% OF FISHERIES ARE OVEREXPLOITED**

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CONSEQUENCES OF FOOD PRODUCTION



FIG. 12-9

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FOOD PRODUCTION AND ENERGY USE

- **ABOUT 10 UNITS OF NONRENEWABLE ENERGY IS USED TO PRODUCE 1 UNIT OF ENERGY FOR THE CONSUMER**
- **IT TAKES 12.5 TIMES AS MUCH ENERGY TO OBTAIN FISH THAN IT PROVIDES TO THE CONSUMER**
- **TO COMPARE, USING TRADITIONAL FARMING EACH UNIT OF ENERGY PUT IN NETS 1 TO 10 UNITS OF ENERGY IN THE FORM OF FOOD**

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GENETICALLY MODIFIED FOODS

- PRODUCERS SAY IT CAN HELP SOLVE WORLD HUNGER
- CRITICS SAY WE DO NOT KNOW THE LONG TERM IMPACTS TO HUMAN HEALTH AND ECOSYSTEMS
 - EX. POLLEN FROM GM FOODS CAN SPREAD TO NATIVE SPECIES THUS LIMITING BIODIVERSITY

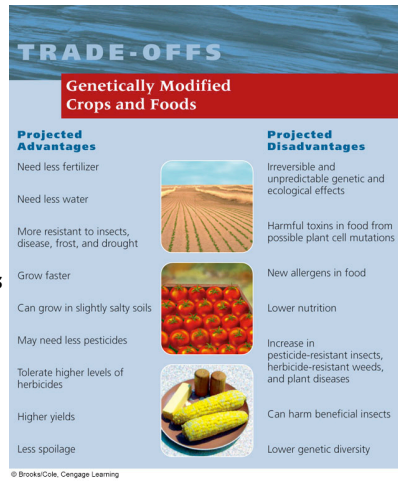


FIG. 12-16

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INDUSTRIALIZED MEAT PRODUCTION

- USE HUGE AMOUNTS OF ENERGY
- GENERATE HUGE AMOUNTS OF WASTE
 - WASTE IS THEN LEACHED THROUGH THE GROUND AND INTO WATER SYSTEMS CAUSING EUTROPHICATION
- DAIRY COW METHANE ACCOUNTS FOR 16% OF ALL GLOBAL METHANE RELEASES
- MORE SUSTAINABLY - BEEF RAISED ON GRASS EMITS 40% LESS METHANE AND USES 85% LESS ENERGY

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FIG. 12-17

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AQUACULTURE

■ PROBLEMS:

- **2003 STUDY: FARMED SALMON HAVE 7 TIMES MORE PCBs THAN WILD SALMON AND 4 TIMES MORE THAN FEEDLOT BEEF**
- **2004 STUDY: FARMED SALMON HAVE 11 TIMES MORE DIOXIN THAN WILD SALMON**

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TRADE-OFFS
Aquaculture

Advantages	Disadvantages
High efficiency	Needs large inputs of land, feed, and water
High yield in small volume of water	Large waste output
Can reduce overharvesting of fisheries	Can destroy mangrove forests and estuaries
Low fuel use	Uses grain to feed some species
High profits	Dense populations vulnerable to disease

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FIG. 12-18

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PEST CONTROL

- **ECOSYSTEM DESTRUCTION (FOR FARMING, LIVESTOCK, GOLF COURSES, ETC.) LEADS TO LOSS OF BIODIVERSITY AND THUS LOSS OF NATURAL PEST CONTROL**
- **NATURAL CONTROL - SPIDERS KILL MORE INSECTS THAN MAN-MADE PESTICIDES**
- **ARTIFICIAL CONTROL - HUMAN MADE MECHANISMS**
 - **PESTICIDES - CHEMICALS USED TO KILL OR CONTROL POPULATIONS OF ORGANISMS HUMANS CONSIDER UNDESIRABLE**
 - **COMMON TYPES: HERBICIDES (“WEED” KILLERS), FUNGICIDES (FUNGUS KILLERS), RODENTICIDES (RODENT KILLERS), INSECTICIDES (INSECT KILLERS)**

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PESTICIDE CONSEQUENCES

- NOT UTILIZING OR HARMING COEVOLUTIONARY RELATIONSHIPS (ORGANISM DEFENSES - EX. MILKWEED AND MONARCH BUTTERFLIES)
- MANY END UP ALSO BEING HAZARDOUS TO HUMANS
- BROAD-SPECTRUM AGENTS - TOXIC TO PESTS AND NONPESTS (EX. DDT)
- NARROW-SPECTRUM (SELECTIVE) AGENTS - EFFECTIVE ONLY ON A DEFINED GROUP
- PESTICIDE PERSISTENCE - LENGTH OF TIME THEY REMAIN DEADLY IN THE ENVIRONMENT

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DDT

- DICHLORODIPHENYLTRICHLOROETHANE
- USED AS AN INSECTICIDE FIRST IN 1939
- FIRST "SECOND GENERATION PESTICIDE" (PRODUCED IN A LABORATORY)
- PAUL MÜLLER RECEIVED THE NOBEL PRIZE IN 1948 FOR HIS DISCOVERY
- IN 1962, RACHEL CARSON (SILENT SPRING) ALERTED THE PUBLIC THAT DDT WAS KILLING NOT ONLY PESTS
- IN 1972, DDT WAS BANNED IN THE U.S. AND EVENTUALLY BANNED WORLDWIDE UNDER THE STOCKHOLM CONVENTION

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ENVIRONMENTAL IMPACTS OF DDT

- HIGH PERSISTENCE, STRONGLY ABSORBED BY SOIL
- CAN SURVIVE IN SOIL FOR UP TO 30 YEARS
- CAN BE FOUND EVERYWHERE ON EARTH (EVEN THE ARCTIC)
- BIOACCUMULATES IN BODY FAT
- BIOLOGICALLY MAGNIFIED THROUGH THE FOOD CHAIN
- EGGSHELL THINNING (REASON FOR BALD EAGLES NEAR EXTINCTION)
- BAN ON DDT CREDITED WITH INCREASING POPULATIONS

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HUMAN IMPACTS OF DDT

- **DISRUPTS THE ENDOCRINE SYSTEM (LINKED TO DIABETES AND PRENATAL DEFECTS)**
- **SUSPECTED TO CAUSE CANCER**
- **POSITIVE IMPACT:**
 - **DRASTICALLY REDUCED CASES OF MALARIA**
 - **UNFORTUNATELY, MOSQUITOS HAVE BUILT UP A RESISTANCE**

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BENEFITS AND DANGERS OF SYNTHETIC PESTICIDES

TRADE-OFFS

Conventional Chemical Pesticides

Advantages		Disadvantages
Save lives		Promote genetic resistance
Increase food supplies		Kill natural pest enemies
Profitable		Pollute the environment
Work fast		Can harm wildlife and people
Safe if used properly		Are expensive for farmers

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FIG. 12-20

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LEGAL REGULATIONS

- **GOVERNMENT REGULATES USE THROUGH FIFRA (FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT OF 1947 - AMMEND. 1972)**
 - **1972 AMENDING WEAKENED REGULATIONS**
 - **SUPPOSED TO EVALUATE ALL ACTIVE INGREDIENTS IN PESTICIDES BUT HAVE ONLY EXAMINED ABOUT 10%**
- **FOOD QUALITY PROTECTION ACT (1996) - ALLOWS EPA TO REDUCE ALLOWED LEVELS BY A FACTOR OF 10 IF INFORMATION IS NOT PRESENT ON HARM TO CHILDREN**
- **CIRCLE OF POISON (BOOMERANG EFFECT) - U.S. COMPANIES CAN STILL EXPORT BANNED CHEMICALS TO OTHER COUNTRIES (MANY OF THOSE COUNTRIES EXPORT FOOD TO THE U.S.)**

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ARE PESTICIDES EFFECTIVE?

- PESTICIDE USE HAS NOT REDUCED U.S. CROP LOSSES TO PESTS (BECAUSE OF GENETIC RESISTANCE AND LOSS OF NATURAL PREDATORS)
- US OF PESTICIDES HAS INCREASED 33 TIMES SINCE 1942, BUT TODAY 37% OF FOOD SUPPLY IS LOST COMPARED TO 31% IN THE 1940S (LOSSES CAUSED BY INSECTS HAVE ALMOST DOUBLED DESPITE 10 TIMES MORE INSECTICIDE USE)
- ENVIRONMENTAL, HEALTH, AND SOCIAL COSTS ARE ESTIMATED AT \$5-10 FOR EVERY \$1 SPENT ON PESTICIDES
- ALTERNATIVE PEST MANAGEMENT (EX. INTRODUCTION OF NATIVE PREDATORS) COULD CUT USE OF PESTICIDES IN HALF WITHOUT REDUCING CROP YIELDS

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PESTICIDE ALTERNATIVES

- FOOL THE PEST - CROP ROTATION, ADJUST PLANTING TIMES
- PROVIDE HOMES FOR PEST ENEMIES - POLY CULTURE, CUT GRASS LONGER (AT LEAST 3IN)
- IMPLANT GENETIC RESISTANCE - THIS IS CONTROVERSIAL
- BRING IN NATURAL ENEMIES - NATURAL PREDATORS (SAVES MONEY, BUT MUST BE CLOSELY MONITORED)
- INSECT PHEROMONES - LURE OR TRAP PESTS, ATTRACT NATURAL PREDATORS
- SCALD THEM - SPRAY WITH HOT WATER (DOES REQUIRE LARGE AMOUNTS OF WATER AND ENERGY)

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INTEGRATED PEST MANAGEMENT

- INTEGRATED PEST MANAGEMENT (IPM) - SUSTAINABLE APPROACH THAT EVALUATES EACH CROP AND PEST AS PART OF AN ECOSYSTEM
 - PROGRAMS ARE DEVELOPED THAT COMBINE CULTIVATION CONTROLS, BIOLOGICAL CONTROLS, AND CHEMICAL TOOLS APPLIED IN A COORDINATED WAY
- THESE SYSTEMS DO NOT DECREASE FOOD SAFETY OR CROP YIELDS (SOME EXAMPLES THEY INCREASE - SEE INDONESIA ON PAGE 300)

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GOVERNMENTAL INFLUENCES ON FOOD PRODUCTION

- **CONTROL PRICES** - USE PRICE CONTROLS TO KEEP CONSUMERS HAPPY, BUT IT REDUCES FARMERS' ABILITY TO MAKE A LIVING
- **PROVIDE SUBSIDIES** - GIVE FARMERS PRICE SUPPORTS, TAX BREAKS TO ENCOURAGE FOOD PRODUCTION
 - ACCORDING TO UN 31% OF FARM INCOME IS SUBSIDIES
 - GLOBALLY SUBSIDIES AVERAGE \$530,000 A MINUTE
 - SUBSIDIES OFTEN LEAD TO UNSUSTAINABLE PRACTICES
- **LET MARKETPLACE DECIDE** - ELIMINATE PRICE CONTROLS AND SUBSIDIES (BUT THIS WOULD REQUIRE ADDITIONAL AIDE TO POOR AND MIDDLE CLASS BECAUSE OF INCREASED FOOD PRICES)

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SUSTAINABLE AQUACULTURE

SOLUTIONS

More Sustainable Aquaculture

- Restrict locations of fish farms to reduce losses of mangrove forests and estuaries
- Improve management of aquaculture wastes
- Reduce escape of aquaculture species into the wild
- Raise some aquaculture species in deeply submerged cages to protect them from wave action and predators and to allow dilution of wastes into the ocean
- Certify sustainable forms of aquaculture and label products accordingly

FIG. 12-29

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MOVE DOWN FOOD CHAIN

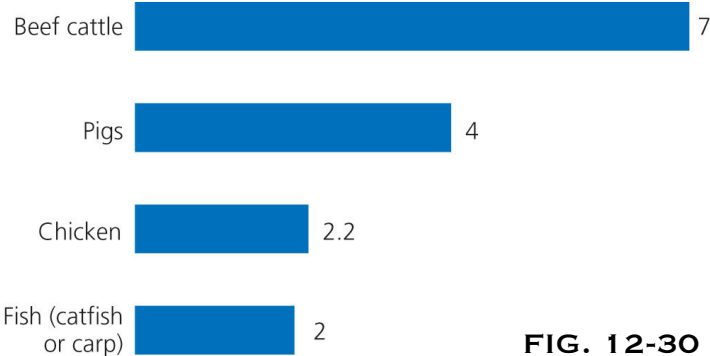


FIG. 12-30

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- **AMOUNT OF KG OF GRAIN PER KG OF ANIMAL PROTEIN PRODUCED**

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SUSTAINABLE AGRICULTURE

- **ORGANIC AGRICULTURE-CROPS GROWN WITH LITTLE OR NO USE OF SYNTHETIC PESTICIDES, SYNTHETIC FERTILIZERS, OR GENETICALLY ENGINEERED SEEDS**
- **LIVESTOCK RAISED WITHOUT GENETIC ENGINEERING, SYNTHETIC GROWTH REGULATORS, OR FEED ADDITIVES**

SOLUTIONS

Sustainable Organic Agriculture




<p>More</p> <ul style="list-style-type: none"> High-yield polyculture Organic fertilizers Biological pest control Integrated pest management Efficient irrigation Perennial crops Crop rotation Water-efficient crops Soil conservation Subsidies for sustainable farming and fishing 	  	<p>Less</p> <ul style="list-style-type: none"> Soil erosion Aquifer depletion Overgrazing Overfishing Loss of biodiversity Food waste Subsidies for unsustainable farming and fishing Soil salinization Population growth Poverty
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FIG. 12-31 © Brooks/Cole, Cengage Learning

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ORGANIC FARMING

WHAT CAN YOU DO?

Sustainable Organic Agriculture

- Waste less food.
- Eat less or no meat.
- Use organic farming to grow some of your food.
- Buy organic food.
- Eat locally grown food.
- Compost food wastes.

FIG. 12-33

SOLUTIONS

Organic Farming

- Improves soil fertility
- Reduces soil erosion
- Retains more water in soil during drought years
- Uses about 30% less energy per unit of yield
- Lowers CO₂ emissions
- Reduces water pollution by recycling livestock wastes
- Eliminates pollution from pesticides
- Increases biodiversity above and below ground
- Benefits wildlife such as birds and bats





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FIG. 12-32

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LOCALLY GROWN FOOD

- **SUPPORTS LOCAL ECONOMY**
- **REDUCES TRANSPORTATION COST**
- **REDUCES POLLUTION FROM TRANSPORTATION**
- **SUSTAINABILITY!!**

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