AGRICULTURE

- Food – one of the basic requirements of life
- Producing Food for a Hungry World
- Producing Food for a Growing Population

Food and Hunger

- When we say we are HUNGRY it typically means …
  - it has been several hours since my last meal
  - I skipped a meal
  - I am on a diet to lose weight

Food and Hunger

- Most people in MDCs have never experienced the HUNGER that is common in LDCs
- HUNGER for weeks, months, and years affects many people in LDCs – CHRONIC HUNGER

Food and Hunger

Types of CHRONIC HUNGER
- under nutrition
  failure to ingest sufficient calories
- malnutrition
  failure to ingest the proper mixture of nutrients
Food and Hunger
- What proportion of the world's population suffers from chronic hunger?
- Estimates vary due to differing criteria for hunger

Food and Hunger
- What proportion of the world's population suffers from chronic hunger?
- General agreement that more than 10% of world population suffers from hunger

Food and Hunger
More than 10% of world population suffers chronic hunger
\[ 10\% \times 7 \text{ billion} = 700 \text{ million} \]
*Often cited number is 800 million*

Food and Hunger
- Currently 800 million people are not adequately nourished
- Most of these hungry people are in LDCs
- Many of these hungry people are children

Food and Hunger
- Hungry people in LDCs are overworking the land and clearing forests in efforts to produce more food
- Land degradation results from overworking the land

Food and Hunger
- Currently we are adding 75 million people per year to world population
- Most of this population growth is in LDCs
Food and Hunger
- Continued population growth will exacerbate the problems of hunger and land degradation

Food and Hunger
- Chronic hunger has adverse effects upon the individual
- The nature of these adverse effects depends upon the age of the individual

Adverse Effects of Chronic Hunger
- Chronic Hunger during ADULTHOOD
  - Upon restoration of an adequate diet, many (but not all) of the adverse effects are reversible
  - the person will largely recover

Adverse Effects of Chronic Hunger
- Chronic Hunger during EARLY DEVELOPMENT
  - Low body mass
  - Reduced physical growth
  - Reduced mental growth
  - Physical lethargy
  - Mental dullness
  - Impaired healing
  - Impaired immune function

Adverse Effects of Chronic Hunger
- Chronic Hunger during ADULTHOOD
  - Loss of body mass
  - Physical lethargy
  - Mental dullness
  - Impaired healing
  - Impaired immune function
  - Loss of hair, teeth, menstrual cycles
  - Heart damage
Adverse Effects of Chronic Hunger
- Chronic Hunger during EARLY DEVELOPMENT
- Upon placement on an adequate diet, many of the adverse effects are not reversible
- developmental deficits are not regained after the critical period of development is over

Adverse Effects of Chronic Hunger
- Chronic Hunger during EARLY DEVELOPMENT
- The adverse effects prevent the individual from realizing their full potential
- The adverse effects result in life-long impairments of the individual

AGRICULTURE
The GREEN REVOLUTION
During the 1950’s and 60’s
Introduction of high-yield hybrid grains
Tremendous increases in productivity – bushels per acre/hectare

AGRICULTURE
The GREEN REVOLUTION
During this period – food production grew more rapidly than population
Time of great optimism that agricultural production would grow faster than population

AGRICULTURE
The GREEN REVOLUTION
Since this period – population growth has been catching up
Now – concern that agricultural production can keep up with population growth

AGRICULTURE
Currently, many nations of the world do not produce sufficient food to feed their own people
Many of these countries rely upon importation of food to feed their people
Where is this food coming from?
Much of the food needed to supply nations in need is coming from four major food exporting countries:

- United States of America
- Canada
- Australia
- Brazil

**Is importation of food a long-term solution for nations in need?**

**NO!**

It is a short-term means of preventing wide-spread starvation.

**Is importation of food a long-term solution for nations in need?**

**NO!**

It can actually harm local agricultural economies and increase food dependence.

Is importation of food a long-term solution for nations in need?

**NO!**

The long-term solution is to assist countries to become self-sufficient in agricultural production.

Is modern, mechanized agriculture the best solution for increased food production in less-developed countries?

**NO!**

Should we give every farmer in LDCs a new John Deere tractor?

A better means of assistance in development of agricultural self-sufficiency is through **Appropriate Technology**.

Agricultural technology improvements suitable for the local culture and economy.

Relatively simple and low cost ways to increase local food production.
Challenges Facing World Agriculture

Immediate Challenge
Adequately feeding the people already here
Not just a matter of food production
There is already sufficient production capacity to feed us all

Long Term Challenge
Increasing agricultural production to keep up with population growth

Immediate Challenge
Adequately feeding the people already here
There are current problems with
- Distribution
- Economics
- Politics

Long Term Challenge
Increasing agricultural production to keep up with population growth
- Population growth must be controlled
- Until population is stabilized – there will be ever more people to feed
Challenges Facing World Agriculture

- Immediate
- Long Term
- Continuing

Protect the soil

Fertile soil is the basis of agricultural production of food

As soil fertility declines, food production declines

Continuing Challenge

Protect the soil

Efforts to meet the immediate and long term challenges can NOT be accomplished at the expense of soil fertility

Degraded soil fertility and agricultural productivity would
- leave barren and useless lands for future generations
- drastically lower carrying capacity
Paradoxical dilemmas facing agriculture in MDCs and LDCs

- In MDCs - agriculture can produce **too much** food
- In LDCs - agriculture can **not** produce **enough** food

There are numerous problems facing world agriculture

- **Erosion**
  - Nutrient Depletion
  - Desertification
  - Water Mismanagement
  - Energy
  - Farmland Conversion
  - Food Diversity

Erosion

- The most serious problem facing world agriculture
- The loss of topsoil due to movement by wind or water

**Topsoil**

- Rich in humus – the organic matter of soil
- Gives soil its fertility
- The loss of topsoil by erosion robs the land of its fertility and agricultural productivity
- It is estimated that we are losing 7% of our topsoil per decade

Erosion is due to poor land management
- In LDCs, desperation for food and fuel often leads to poor land management
Erosion

- Erosion is due to poor land management
- In MDCs, poor farming practices lead to erosion

Multiple Causes

- Removal of vegetation
  - deforestation
  - vegetation use for firewood
  - over grazing

Erosion

Multiple Causes

- Removal of vegetation
  - removing windbreaks
  - removing natural vegetation along fence rows
  - farming riparian zones

Erosion

Multiple Causes

- Removing windbreaks
- Removing natural vegetation along fence rows
- Farming riparian zones

Erosion

Multiple Causes

- Farming highly erodible land
- Failure to control gullies
- Traditional plowing leaves soil bare and exposed

AGRICULTURE

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Nutrient Depletion

- Plants take essential nutrients from the soil
- Nutrient depletion results from repeated planting and harvesting of crops, without replacing soil nutrients
Nutrient Depletion

- Plants require essential nutrients from the soil
- Depletion of soil nutrients lowers soil fertility and agricultural productivity

Nutrient Depletion

- Over working the soil
  - repeated crops in effort to grow more food
  - not letting the land rest or lay fallow
  - not replacing nutrients with fertilizers or manures

AGRICULTURE

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Desertification

- Conversion of formerly fertile land into barren, desert-like condition
- Most severe form of land degradation
- A human-caused problem

Desertification

- Conversion of formerly fertile land into barren, desert-like condition
- Results from erosion and nutrient depletion
- Land becomes useless for agriculture

Desertification

- Conversion of formerly fertile land into barren, desert-like condition
- Occurring worldwide on a massive scale
Desertification
- Results in long-term destruction of ecosystems
- A historical example --
  - The “Fertile Crescent” region of the Middle East underwent desertification... thousands of years ago
  - It is still a desert today

Desertification
- Desertification is DECREASING the amount of arable, farmable land at the same time that
- Population growth is INCREASING the number of people to feed

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Water Mismanagement
- What do you need for agricultural production?
  - Fertile soil and … WATER
  - Much of the Earth’s surface is covered with water … but it is salt water
  - Our precious freshwater resources, vital for agriculture, are limited and often mismanaged

Water Mismanagement
- Limited surface water
- Competition for water
- Overdraft of aquifers
- Inefficient irrigation
- Salinization of soils
- Salt-water intrusion
- Water-logging of soils
- Water pollution

Limited surface water
- In arid areas with low rainfall, availability of surface water limits agricultural production
- Despite limited surface water, large population centers have developed in some arid areas
Water Mismanagement
- Limited surface water
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Competition for water
- In arid areas with limited water resources, there is intense competition for water
- There may be regional competition, for example:
  - in the American southwest
  - in the Middle East

Competition for water
- In arid areas with limited water resources, there is intense competition for water
- There may be competition among users of water
  - domestic
  - business & industry
  - agriculture

Water Mismanagement
- Limited surface water
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Overdraft of aquifers
- Aquifer = underground water in porous rock
- Often called “fossil water” because the water may have been underground for thousands of years

Overdraft of aquifers
- Recharge = the entry of water into the aquifer
- Overdraft = the rate of water withdrawal from the aquifer exceeds the rate of recharge
Overdraft of aquifers

- In areas with limited surface water, aquifers may be the primary water source
  - overdraft of aquifers
    - water table levels are lowered
    - wells run dry
    - the aquifer may be depleted of water

Overdraft of the Ogallala Aquifer

- The problem is occurring in the United States and around the world
- Overdraft of the Ogallala Aquifer is a looming threat to American agriculture

Ogallala Aquifer

- Also known as the “High Plains Aquifer”
- Underlies parts of eight states

Overdraft of the Ogallala Aquifer

- The primary source of water in the High Plains region
  - Region of high agricultural production, in large part, due to water from the aquifer

Ogallala Aquifer

- The aquifer contains melt water from the last ice age
- It is estimated that the aquifer took 10,000 years to fill
- Due to overdraft, the aquifer is being rapidly depleted

Ogallala Aquifer

- What will happen to agriculture (and communities) without the water?
Water Mismanagement
- Limited surface water
- Competition for water
- Overdraft of aquifers
- Inefficient irrigation
- Salinization of soils
- Salt-water intrusion
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- Water pollution

Inefficient irrigation
- Traditional methods of irrigation are wasteful of water
- Due to loss by evaporation into air and infiltration into ground
- Substantial quantities of water fail to reach the plants

Salinization of soils
- The build up of mineral salts in soils
- Due to a history of irrigation with mineral-rich ground water
- As the irrigation water evaporates, the mineral salts are left behind in the soil
- The soils may become too salty for agricultural use

Water Mismanagement
- Limited surface water
- Competition for water
- Overdraft of aquifers
- Inefficient irrigation
- Salinization of soils
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- Water pollution
Salt-water intrusion
- Can occur in aquifers adjacent to coastal areas
- Excess freshwater withdrawal from the aquifer allows saltwater to enter the aquifer
- The aquifer water becomes too salty for agricultural (or other) uses

Water Mismanagement
- Limited surface water
- Competition for water
- Overdraft of aquifers
- Inefficient irrigation
- Salinization of soils
- Salt-water intrusion
- Water-logging of soils
- Water pollution

Water-logging of soils
- May become a problem in areas with shallow water tables and poorly drained soils
- Excess irrigation or precipitation can saturate (water-log) the root zone of plants resulting in plant death

Water Mismanagement
- Limited surface water
- Competition for water
- Overdraft of aquifers
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- Salinization of soils
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Water pollution
- Many harmful materials enter our water supply
- Water pollution poses many environmental threats, including harm to agriculture

AGRICULTURE
There are numerous problems facing world agriculture
- Erosion
  - Nutrient Depletion
  - Desertification
  - Water Mismanagement
  - Energy
  - Farmland Conversion
  - Food Diversity
Energy and Agriculture

- Modern agriculture in MDCs is extraordinarily productive of food
  AND
  extraordinarily energy intensive

Energy and Agriculture

- Essentially all of the energy for agriculture in MDCs comes from fossil fuels
  Farm machines  Irrigation
  Fertilizer  Transport
  Processing  Distribution

Energy and Agriculture

- Essentially all of the energy for agriculture in MDCs comes from fossil fuels
  Fossil fuel supplies are finite and limited
  Energy costs will rise as fossil fuel supplies decrease

Energy and Agriculture

- Essentially all of the energy for agriculture in MDCs comes from fossil fuels
  Fossil fuel supplies are finite and limited
  New energy sources will be needed in the future

AGRICULTURE

- There are numerous problems facing world agriculture
  Erosion
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Farmland Conversion

- The conversion of farm lands to non-agricultural uses
  homes
  roads
  businesses and industries
<table>
<thead>
<tr>
<th>Farmland Conversion</th>
<th>Food Diversity</th>
<th>AGRICULTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The conversion of farm lands to non-agricultural uses</td>
<td>• Over dependence on a few crop species</td>
<td></td>
</tr>
<tr>
<td>In the US between 1982 and 1992 more than four million acres of farmlands were lost to urban development</td>
<td>• heavy reliance on just a few strains of each species</td>
<td>• There are numerous problems facing world agriculture</td>
</tr>
<tr>
<td></td>
<td>• low genetic diversity in our food sources</td>
<td>• Erosion</td>
</tr>
<tr>
<td></td>
<td>• affects both MDCs and LDCs</td>
<td>• Nutrient Depletion  • Desertification</td>
</tr>
<tr>
<td></td>
<td>• due to continued population growth</td>
<td>• Water Mismanagement  • Energy</td>
</tr>
<tr>
<td></td>
<td>• due to poor land use planning</td>
<td>• Farmland Conversion  • Food Diversity</td>
</tr>
<tr>
<td></td>
<td>• genetic diversity of current food sources is threatened by loss of their wild ancestors</td>
<td>• Erosion</td>
</tr>
<tr>
<td></td>
<td>• potential new food sources are lost through species extinction</td>
<td>• Nutrient Depletion  • Desertification</td>
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AGRICULTURE
There are numerous problems facing world agriculture

These problems *must* be addressed to feed the current and future human population

Controlling Soil Erosion
- Maintain vegetative cover
  - Slow deforestation
  - Reforestation
  - Energy alternatives to firewood
  - Reduce overgrazing

Controlling Soil Erosion
- Avoid farming highly erodible land
  - On sloped lands practice
    - contour plowing
    - terracing
    - gully reclamation
  - integrated soil management

Controlling Soil Erosion
- Minimum-till or no-till planting
  - soil is not exposed by plowing
  - weed control by herbicides
  - seeds planted by seed drills

Controlling Soil Erosion
- Minimum-till or no-till planting
  - reduces soil erosion
  - reduces fuel use and costs
  - increases herbicide use and costs
Restoring Soil Nutrients
- synthetic fertilizers
- fallowing
- integrated soil management
- green manures
- animal manures
- human biosolids
- compost

Increasing Agricultural Lands
- Bring reserve lands into production
- Better land use planning and management
- Reclamation of desert lands

Increasing Agricultural Productivity
Historically, the largest increases in productivity were accomplished through the green revolution

Biotechnology has the potential to bring agriculture a second green revolution

Biotechnology and Agriculture
Application of advances in molecular biology to problems of agricultural production of food

Biotechnology and Agriculture
- Increased crop yields
- Increased nutritional value
- Increased pest resistance
- Improved fertilizer utilization and nitrogen fixation

Biotechnology and Agriculture
- Freeze resistant plants
- Drought and salt tolerant plants
- Improved ripening, harvesting, and storage characteristics
<table>
<thead>
<tr>
<th>Biotechnology and Agriculture</th>
<th>Development of New Foods</th>
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</tr>
</thead>
<tbody>
<tr>
<td>❖ Development of perennial crop plants</td>
<td>❖ New foods are needed to</td>
<td>❖ Acceptance of new foods ?</td>
</tr>
<tr>
<td>❖ Improved feed efficiency and growth of livestock</td>
<td>✷ Lessen over dependence on a small number of grain species</td>
<td>✷ Food preferences are learned</td>
</tr>
<tr>
<td>❖ Development of highly productive livestock strains</td>
<td>✷ Feed an ever growing population</td>
<td>✷ Typically, part of cultural tradition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✷ Many find delight in exploration of new cultural cuisines</td>
</tr>
<tr>
<td>Development of New Foods</td>
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</tr>
<tr>
<td>❖ Develop large-scale production of select native foods</td>
<td>❖ Increased use of grazer species native to an area</td>
<td>❖ Increased use of “trash” fish and bi-catch</td>
</tr>
<tr>
<td>✷ Some locally used, native foods may be suitable for large-scale agricultural production</td>
<td>✷ Animals well adapted to local climate and forages</td>
<td>✷ Much of harvest from oceans is currently wasted</td>
</tr>
</tbody>
</table>
Development of New Foods

- Increased food production by aquaculture and mariculture
  - aquaculture – freshwater farming
  - mariculture – saltwater farming

Development of New Foods

- Utilization of algae as food
  - High nutritional value
  - Tremendous available biomass
  - Grows well in most locations

Development of New Foods

- Utilization of insects as food
  - High nutritional value
  - Tremendous available biomass
  - Our primary competitors for food

Daily Calories Per Capita

Note: Data refer to 1980.