Sustainable Food Supply

Be fruitful and multiply...

Now divide.
Key Question One: What is the global pattern of food consumption?

Content:

- Global pattern of low calorie intake
- Pattern of high food consumption

Hunger is the want or scarcity of food in a country. The related technical term is malnutrition. Malnutrition is a general term that indicates a lack of some or all nutritional elements necessary for human health. There are two basic types of malnutrition.

- The first and most important is protein-energy malnutrition - the lack of enough protein (from meat and other sources) and food that provides energy (measured in calories) which all of the basic food groups provide. This is the type of malnutrition that is referred to when world hunger is discussed.
- The second type of malnutrition, also very important, is micronutrient (vitamin and mineral) deficiency. This is not the type of malnutrition that is referred to when world hunger is discussed, though it is certainly very important.

Recently there has also been a move to include obesity as a third form of malnutrition. Considering obesity as malnutrition expands the previous usual meaning of the term which referred to poor nutrition due to lack of food inputs. It is poor nutrition, but it is not typically due to a lack of calories, but rather too many (although poor food choices, often due to poverty, are part of the problem). Undernourishment is the condition of receiving less than 90 percent of the minimum dietary intake over a long-term time period; suffers lack energy for an active, productive life and are more susceptible to infectious diseases.

http://www.wfp.org/country_brief/hunger_map/map/hungermap_popup/map_popup.html
Discuss any relationships you can see between these maps and suggest reasons why these relationships may have occurred.

Higher income, urbanisation, other demographic shifts, improved transportation, and consumer perceptions regarding quality and safety are changing global food consumption patterns. Shifts in food consumption have led to increased trade and changes in the
composition of world agricultural trade. Given different diets, food expenditure and food budget responses to income and price changes vary between developing and developed countries. In developing countries, higher income results in increased demand for meat products, often leading to increased import of live-stock feed. Diet diversification and increasing demand for better quality and labour-saving products have increased imports of high-value and processed food products in developed countries. Consumer groups in developed countries have also brought attention to organic production of food and the topic of animal welfare. One way in which the public and private sectors have responded to consumer demand for these quality attributes has been by developing and implementing mandatory and voluntary quality control, management, and assurance schemes.

Useful websites:

http://www.fao.org/es/ESS/chartroom/gfap.asp#
http://www.who.int/nutrition/topics/3_foodconsumption/en/index7.html
http://www.fao.org/WAIRDOCS/WHO/AC911E/ac911e05.htm
http://www.youtube.com/watch?v=aFklx0kFm4
http://www.wfp.org/english/

TASK: Two contrasting countries.

Research the two contrasting case studies below and produce a presentation which compares the two. Include research of the food consumption, calorie intake, level of development etc.

<table>
<thead>
<tr>
<th>Wajir, Kenya.</th>
<th>USA.</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Image]</td>
<td></td>
</tr>
<tr>
<td>ETHIOPIA</td>
<td>USA.</td>
</tr>
<tr>
<td>SOMALIA</td>
<td></td>
</tr>
<tr>
<td>KENYA</td>
<td></td>
</tr>
<tr>
<td>TANZANIA</td>
<td></td>
</tr>
</tbody>
</table>

Research famine and its consequences in the Wajir district of Kenya.

Exam Question:

Discuss the reasons for the global imbalance in the availability of food [10 Marks]

Instructions:

You are going to write this essay style exam answer in a group. Each person will have a copy of

Key Question 2: What factors promote or hinder food production?

Content:

✓ Physical
✓ Political
✓ Economic
✓ Technological

With reference to these factors

- EU Common Agricultural Policy
- Restrictions on agriculture in National Parks
- Supermarket-farmer relationships

There are many causes of food shortages....

<table>
<thead>
<tr>
<th>Physical</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil exhaustion</td>
<td>Low capital investment/poverty</td>
</tr>
<tr>
<td>Drought</td>
<td>Poor distribution</td>
</tr>
<tr>
<td>Floods</td>
<td>Transport difficulties</td>
</tr>
<tr>
<td>Tropical cyclones</td>
<td>War and civil conflict</td>
</tr>
<tr>
<td>Pests</td>
<td>Commercial farming and growth of cash crops</td>
</tr>
<tr>
<td>Disease</td>
<td></td>
</tr>
</tbody>
</table>

Use the links provided in the following table to research the causes and consequences of each of the factors which hinder food supply. You will receive a table to fill in.

Physical Causes of Food Shortages
<table>
<thead>
<tr>
<th>Cause</th>
<th>Source</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Exhaustion</td>
<td><a href="http://news.bbc.co.uk/2/hi/africa/6288445.stm">http://news.bbc.co.uk/2/hi/africa/6288445.stm</a></td>
<td>Nigerian houses swallowed by sand</td>
</tr>
<tr>
<td>Drought</td>
<td><a href="http://news.bbc.co.uk/2/hi/south_asia/6165304.stm">http://news.bbc.co.uk/2/hi/south_asia/6165304.stm</a></td>
<td>Afghanistan’s neglected drought</td>
</tr>
<tr>
<td>Flood</td>
<td><a href="http://www.alertnet.org/thenews/newsdesk/IRIN/a362483c1ae3ff0c8c7ad3684ea8088b.htm">http://www.alertnet.org/thenews/newsdesk/IRIN/a362483c1ae3ff0c8c7ad3684ea8088b.htm</a></td>
<td>Floods threaten food security in Bujumbura Rural</td>
</tr>
<tr>
<td>Tropical Cyclones</td>
<td><a href="http://news.bbc.co.uk/2/hi/americas/4426240.stm">http://news.bbc.co.uk/2/hi/americas/4426240.stm</a></td>
<td>Guatemala faces hunger 'timebomb'</td>
</tr>
<tr>
<td>Pests</td>
<td><a href="http://news.bbc.co.uk/2/hi/africa/6043276.stm">http://news.bbc.co.uk/2/hi/africa/6043276.stm</a></td>
<td>Africa warned over locust swarms</td>
</tr>
<tr>
<td>Disease</td>
<td><a href="http://news.bbc.co.uk/2/hi/science/nature/4466783.stm">http://news.bbc.co.uk/2/hi/science/nature/4466783.stm</a></td>
<td>Rice fungus genome mapped at last</td>
</tr>
</tbody>
</table>

**Human Causes of Food Shortages**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Source</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poverty</td>
<td><a href="http://news.bbc.co.uk/2/hi/africa/6302101.stm">http://news.bbc.co.uk/2/hi/africa/6302101.stm</a></td>
<td>Severe hunger looms for Zimbabwe</td>
</tr>
<tr>
<td>Transport Difficulties</td>
<td><a href="http://news.bbc.co.uk/2/hi/south_asia/1584132.stm">http://news.bbc.co.uk/2/hi/south_asia/1584132.stm</a></td>
<td>Afghan aid: The supply problems</td>
</tr>
</tbody>
</table>
### War and Civil Conflict

http://news.bbc.co.uk/2/hi/science/nature/6054938.stm

Conflicts 'feeding global hunger'

### Commerical Farming

http://news.bbc.co.uk/2/hi/business/2197702.stm

Aid workers grope for famine causes

http://www.geographyalltheway.com/igcse_geography/economic_development/agricultural_systems/igcse_food_shortages.htm

**Case study: Sahel**

Sahel: A semiarid region of north-central Africa south of the Sahara Desert

![The Sahel Map](image)

#### Issues at Stake in Sahelian Food Security

- Sahel: area of 5.4 millions km² with a population of ~ 60 million,
• Very High population growth: 3.1% on average. Sahelian countries will have to feed more than 100 millions people by 2025,
• Agriculture and Livestock account for ~ 40% of the GDP and ~ 50% of the working population,
• Mainly rainfed agriculture,
• West Africa is the most vulnerable region to the vagaries of the weather, with recurrent food crises

→ Necessity to monitor crop development conditions towards early warning and the provision of advice to farmers and economic operators.

**The need**
Almost 8 million people are currently threatened by severe food shortages in the Western Sahel region of Africa—including Niger, Mali, Mauritania and Burkina Faso. The famine, brought on by two years of low rainfalls and drought in the region, coupled with the worst locust infestation in 20 years, has led to widespread malnutrition.

For full document see: [http://www.simonbatterbury.net/pubs/geogmag.html](http://www.simonbatterbury.net/pubs/geogmag.html)

The Sahel forms the southern edge of the Saharan desert, passing at least 4,500km from Senegal through Mauritania, Mali, Burkina Faso, Niger, and Chad, and blends seamlessly into the slightly less arid Sudano-Sahel belt to its southern edge. The 50 million people of the Sahel pursue diverse livelihood strategies including agriculture, livestock herding, fishing, short and long-distance trading, and a variety of urban occupations. Farming in this region is almost entirely reliant on three months of summer rainfall, except along the banks of the major rivers, lakes, and other seasonal water courses.

**Solutions:**

Drought monitoring and early warning in the Sahel: The AGRHYMET scheme.


[http://forms.mundiconveniu.pt/docs_gmes/docs_b2/46.pdf](http://forms.mundiconveniu.pt/docs_gmes/docs_b2/46.pdf)

**Created in 1974**
1974, following the catastrophic droughts of the early 70’s. Its mission was to contribute to achieving sustainable food security and rational natural resource management by:

• Building the capacity of member States
• *(training, equipment and financial support)*
• Producing and disseminating information to various decision makers (national authorities, cooperation partners, *NGOs and farmers’ associations*)

**Achievements:**
• Reliable and operational database on climate, agriculture and natural resources
• Over 1000 officers trained (Engineers - bachelor's degree students - higher technicians)
• Infrastructures and equipped laboratories for training programs

Early Warning and Food Crisis Prevention:
• Seasonal rainfall forecast (PRESAO),
• Monitoring the progress of sowing and crop performance (DHC, ZAR Models),
• Monitoring the locust situation (Rainfall maps + NDVI),
• Monitoring crop water requirement satisfaction (DHC Model)
• Yield forecasting (DHC Model),
• Identifying risk zones (Synthesis of all the products),
• Joint preharvest assessment missions in the field,
• Annual consultative meeting in late October,
• Targeting vulnerable populations.

Decision Support to Enhance Food Availability
Provision of opinions and advice to farmers and economic operators

Case study: Niger, Africa.

Physical causes of desertification in Niger
• Physical environment not favourable to agriculture.
• Low fertility
• Low water holding capacity
• Vulnerable to erosion.
• High evapotranspiration rates
• Unreliable rains (floods one year, rains for several)
• Periods of drought becoming longer

Human causes of desertification in Niger
• Slash and burn of rainforests
• Soil fertility loss
• Annual cropping
• Large scale mechanical clearing
• Breaching of the green belt = invasion of desert onto agricultural land.

When widespread hunger began ravaging the West African nation of Niger earlier this year, the crisis was largely blamed on the drought that had struck the country a year ago.

But a closer look at the environmental factors behind the food crisis—including geography, drought, and insect infestations—reveals a more complex picture of why so many people are going hungry, and why the hunger will return.

For full article see:
http://news.bbc.co.uk/1/hi/world/africa/4699643.stm

**Niger food crisis timeline**

Up to a quarter of Niger’s 12m people need food aid and 150,000 children could die unless they get help soon, aid workers say. The food crisis was predicted after poor harvests last year, so why was the situation allowed to become so serious? This is the course of events over the past year:

See: http://news.bbc.co.uk/1/hi/world/africa/4699643.stm for timeline

### GCSE GEOGRAPHY CASE STUDY CARD

<table>
<thead>
<tr>
<th>Case Study:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Theme? (tick)</th>
<th>Theme 1: Physical Systems &amp; Environments</th>
<th>Theme 2: Natural Hazards &amp; People</th>
<th>Theme 3: Economic Systems &amp; Development</th>
<th>Theme 4: Populations &amp; Settlement</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Location:</th>
<th>Town/City/Region:</th>
<th>Country:</th>
<th>Continent:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sketch Map:</th>
<th>What is happening? OR What is changing?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‣</td>
</tr>
<tr>
<td></td>
<td>‣</td>
</tr>
<tr>
<td></td>
<td>‣</td>
</tr>
</tbody>
</table>
**Facts & Figures:**

<table>
<thead>
<tr>
<th>Why is it happening/changing?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What are the effects of the changes?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who is affected by the changes?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How can the changes be managed or solved? By whom?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What are the options for the future?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Key Words:**

**Solutions:** [http://www.eden-foundation.org/index.html](http://www.eden-foundation.org/index.html)

The Eden Foundation is a Sweden-based charitable foundation focusing on utilization of useful plant species. Since 1987, Eden has been running a project in Tanout, Zinder Department of Niger, just south of the Sahara desert, helping the farmers and their families achieve a sustainable life with the means available to them. Eden’s solution was to bring them trees and bushes that could grow naturally in this dry area and give food, even in times of need. Eden has served more than 2500 households in the area.

Their main problem is lack of food.
Niger is one of the driest countries in the world, situated south of the Sahara desert. The people are poor and have neither money nor water to spare. Our solution is to bring them trees and bushes that can grow naturally in this dry area and give food, even in times of need. Since our arrival, Eden has served more than 2500 households in the region. The trees and bushes we offer have been researched at our local field station and need neither irrigation nor chemical fertilizers to grow. The method we use is called direct seeding and is adapted to the farmers’ means. The come to us on their own accord and can order from a Eden species. The seeds are free and we show them direct seed. We also give advice on preventive health practicalities.

"Thanks to our Eden trees, we’ve had food to eat even though the millet failed. For the last three years, we haven’t had a single good rain in our village and this year’s harvest lasted less than a month. Instead, my family has lived from the Eden fruits on our field which gives us food for the day. We depend on it, for there is nothing else to eat around here."

- Musa Abari from Garin Farara

The results:

Once the trees are mature, they produce fruits that are either consumed within the household or sold at the market. This year, the Eden farmers reported to have harvested fruits, leaves and berries from their trees for an average value of €67 per household.

Since 1991, Eden has served 2500 households in 129 villages around Tanout. The farmers come to us on their own accord and can order from a list of Eden species.

Exam question:

For a region you have studied, explain the physical and human causes of food shortages and strategies that have been used to overcome them.

**Technological: The Common Agricultural Policy**

**What is it?**

The common agricultural policy, better known as the CAP, is a system of subsidies paid to EU farmers. Its main purposes are to guarantee minimum levels of production, so that Europeans have enough food to eat, and to ensure a fair standard of living for those dependent on agriculture.
What are its aims?

- Secure food supplies
- Expand output
- Increase productivity
- Stabilise prices
- Secure farm incomes
- To ensure fair living standards for the agricultural community
- To provide food at reasonable prices

The Common Agricultural Policy began operating in 1962, with the Community intervening to buy farm output when the market price fell below an agreed target level. This helped reduce Europe's reliance on imported food but led before long to over-production, and the creation of "mountains" and "lakes" of surplus food and drink.

What are the problems?

The EU cannot use all its agricultural products, so it sells them cheaply to the third world. This undercuts local farmers, who cannot compete with the heavily-subsidised imports. The CAP has also been blamed for encouraging environmentally damaging intensive farming. Its commitment to guarantee prices makes it economically worthwhile to use all available land, with the aid of chemicals, to grow more crops than are demanded by consumers. A policy of "set aside", where farmers are paid to leave land fallow, has attempted to remedy this, but overproduction persists. The policy costs around £30bn a year - or half the EU’s £60bn annual budget - and even the agreed reforms do not really reduce the cost. The CAP has been criticised for its large budget and for supporting inefficient agricultural practices.

The 1990s reforms are accused of so far having done little to reduce its cost, and of leaving agricultural prices unnecessarily high at the expense of the consumer. It is also claimed that the distribution of funds under the CAP is unfair - with some 20 per cent of farms, primarily the larger ones, receiving 70 per cent of the subsidies. There is also CAP fraud in some member states, where levels of diligence to prevent fraud reflect different levels of effectiveness from different member states’ agriculture ministries.

What has been the the impact of the CAP on the environment?

The CAP has had a significant impact on the environment

- Hedgerows have been removed to increase field sizes to accommodate larger machinery and increase yields = increased soil erosion and a reduction in wildlife habitats.
The increased use of fertilisers and pesticides has caused groundwater supplies to become contaminated. The increase in levels of nitrates in streams and rivers has caused the growth of algae and bacteria. This has reduced oxygen levels in rivers killing fish and insects.

Furthermore, by encouraging farm 'modernisation', the CAP was blamed for environmental damage caused by the increase of agricultural chemicals and intensive farming methods. Some have blamed the CAP for the practices that led to a series of food safety scares during the 1980s and 1990s, chief among them being BSE.

**What are the benefits?**

- Contributed to an improvement in European agricultural efficiency by promoting modernisation and rationalisation.

- Average agricultural incomes have risen roughly in line with other sectors, markets have been stabilised, and the EU has been rendered virtually self-sufficient in all foodstuffs that its climate permits to be cultivated.

**Intensification and diversification of agriculture in Rajasthan.**

70 per cent of the work force is employed in farming. 80 per cent of the population lives in rural areas and is dependent on farming. Rainfall is unreliable. Recent years of drought have made problems of desertification worse. More irrigation is planned in new projects.

Main crops range from wheat and millet in the drier areas to sorghum, cotton, maize, oilseeds, sugar cane, tobacco, rice and potatoes. Yields are dependent on the annual monsoon. The Rajasthan government aims to take agriculture beyond traditional crops and practices by diversifying farming practices and improving marketing strategies. Previously course cereals were grown but since 2000, diversification has occurred and now soya bean and basmati rice are grown as well as...Gowar bean, Coriander, Moth bean, Medicinal and spice crops. Government now wants to declare minimum support prices for these crops. 15 commodity-specific granaries Agricultural export zones Agro-food parks Encourage contract farming in selected areas. Objective of exploring alternative sources of diesel by promoting multi-purpose crops e.g. Karanj and Castor and other medicinal plants. Mission hopes to provide land to raise nurseries and plantations. Arranging supply of quality seeds/saplings for plantation. A new agricultural policy was introduced in 2004 The Indian Gandhi Canal or the
Rajasthan Canal irrigates the arid western districts. Construction of canals was taken into new areas. The government has increased its budget for agriculture six fold. Two new sealed laboratories are planned. Two pesticide testing facilities. Two tissue culture laboratories are on the cards. Twelve soil testing labs are also being set up. Overall, there have been significant interventions in agriculture which has led to a need for roads. Under the missing link project, nearly 826km of road has been laid. Commercial fruit farming and development of granaries for cash crops are indicative of the government's move to diversify agricultural production and develop marketing strategies.

For a region you have studied explain how attempts to modernise agriculture have affected the physical and human landscape?

Key Question 3: Can food production be sustainably increased?

Content:
- Hydroponics and aeroponics
- The Blue Revolution
- Genetic modification
- The Second Green Revolution

The Blue revolution:
http://news.bbc.co.uk/2/hi/science/nature/6255137.stm

Like the Green Revolution of the 1960s, the Blue Revolution a decade later was supposed to increase global food production miraculously and stave off widespread hunger.

Task: Research the conflicts caused by the Blue revolution in Suphanburi, Thailand.

Genetically modified (GM) foods

Genetically modified (GM) foods are foods made from genetically modified organisms (GMO) that have had their DNA altered through genetic engineering. GM foods were first put on the market in the early 1990s. The most common modified foods are derived from plants: soybean, corn, canola, and cotton seed oil. Controversies surrounding GM foods and crops commonly focus on human and environmental safety, labelling and consumer choice, intellectual property rights, ethics, food security, poverty reduction, and environmental conservation.

What are some of the advantages of GM foods?

The world population has topped 6 billion people and is predicted to double in the next 50 years. Ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. GM foods promise to meet this need in a number of ways:

- Pest resistance: Crop losses from insect pests can be staggering, resulting in devastating financial loss for farmers and starvation in developing countries. Farmers typically use many tons of chemical pesticides annually. Consumers do not wish to eat food that has been
treated with pesticides because of potential health hazards, and run-off of agricultural wastes from excessive use of pesticides and fertilizers can poison the water supply and cause harm to the environment. Growing GM foods such as B.t. corn can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market\textsuperscript{4,5}.

- **Herbicide tolerance** For some crops, it is not cost-effective to remove weeds by physical means such as tilling, so farmers will often spray large quantities of different herbicides (weed-killer) to destroy weeds, a time-consuming and expensive process, that requires care so that the herbicide doesn’t harm the crop plant or the environment. Crop plants genetically-engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed. For example, Monsanto has created a strain of soybeans genetically modified to be not affected by their herbicide product Roundup. A farmer grows these soybeans which then only require one application of weed-killer instead of multiple applications, reducing production cost and limiting the dangers of agricultural waste run-off.

- **Disease resistance** There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases.

- **Cold tolerance** Unexpected frost can destroy sensitive seedlings. An antifreeze gene from cold water fish has been introduced into plants such as tobacco and potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings. (Note: I have not been able to find any journal articles or patents that involve fish antifreeze proteins in strawberries, although I have seen such reports in newspapers. I can only conclude that nothing on this application has yet been published or patented.)

- **Drought tolerance/salinity tolerance** As the world population grows and more land is utilized for housing instead of food production, farmers will need to grow crops in locations previously unsuited for plant cultivation. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help people to grow crops in formerly inhospitable places.

- **Nutrition** Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated. For example, blindness due to vitamin A deficiency is a common problem in third world countries. Researchers at the Swiss Federal Institute of Technology Institute for Plant Sciences have created a strain of "golden" rice containing an unusually high content of beta-carotene (vitamin A). Since this rice was funded by the Rockefeller Foundation, a non-profit organization, the Institute hopes to offer the golden rice seed free to any third world country that requests it. Plans were underway to develop a golden rice that also has increased iron content. However, the grant that funded the creation of these two rice strains was not renewed, perhaps because of the vigorous anti-GM food protesting in Europe, and so this nutritionally-enhanced rice may not come to market at all.
Pharmaceuticals
Medicines and vaccines often are costly to produce and sometimes require special storage conditions not readily available in third world countries. Researchers are working to develop edible vaccines in tomatoes and potatoes. These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

Phytoremediation
Not all GM plants are grown as crops. Soil and groundwater pollution continues to be a problem in all parts of the world. Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil.

What are some of the criticisms against GM foods?
Environmental activists, religious organizations, public interest groups, professional associations and other scientists and government officials have all raised concerns about GM foods, and criticized agribusiness for pursuing profit without concern for potential hazards, and the government for failing to exercise adequate regulatory oversight. It seems that everyone has a strong opinion about GM foods. Even the Vatican and the Prince of Wales have expressed their opinions. Most concerns about GM foods fall into three categories: environmental hazards, human health risks, and economic concerns.

Environmental hazards
Unintended harm to other organisms
Last year a laboratory study was published in Nature showing that pollen from B.t. corn caused high mortality rates in monarch butterfly caterpillars. Monarch caterpillars consume milkweed plants, not corn, but the fear is that if pollen from B.t. corn is blown by the wind onto milkweed plants in neighboring fields, the caterpillars could eat the pollen and perish. Although the Nature study was not conducted under natural field conditions, the results seemed to support this viewpoint. Unfortunately, B.t. toxins kill many species of insect larvae indiscriminately; it is not possible to design a B.t. toxin that would only kill crop-damaging pests and remain harmless to all other insects. This study is being reexamined by the USDA, the U.S. Environmental Protection Agency (EPA) and other non-government research groups, and preliminary data from new studies suggests that the original study may have been flawed. This topic is the subject of acrimonious debate, and both sides of the argument are defending their data vigorously. Currently, there is no agreement about the results of these studies, and the potential risk of harm to non-target organisms will need to be evaluated further.

Reduced effectiveness of pesticides
Just as some populations of mosquitoes developed resistance to the now-banned pesticide DDT, many people are concerned that insects will become resistant to B.t. or other crops that have been genetically-modified to produce their own pesticides.

Gene transfer to non-target species
Another concern is that crop plants engineered for herbicide tolerance and weeds will cross-breed, resulting in the transfer of the herbicide resistance genes from the crops into the weeds. These "superweeds" would then be herbicide tolerant as well. Other introduced genes may cross over into non-modified crops planted next to GM crops. The possibility of interbreeding is shown by the defense of farmers against lawsuits filed by Monsanto. The company has filed patent infringement
lawsuits against farmers who may have harvested GM crops. Monsanto claims that the farmers obtained Monsanto-licensed GM seeds from an unknown source and did not pay royalties to Monsanto. The farmers claim that their unmodified crops were cross-pollinated from someone else’s GM crops planted a field or two away. More investigation is needed to resolve this issue.

There are several possible solutions to the three problems mentioned above. Genes are exchanged between plants via pollen. Two ways to ensure that non-target species will not receive introduced genes from GM plants are to create GM plants that are male sterile (do not produce pollen) or to modify the GM plant so that the pollen does not contain the introduced gene. Cross-pollination would not occur, and if harmless insects such as monarch caterpillars were to eat pollen from GM plants, the caterpillars would survive.

Another possible solution is to create buffer zones around fields of GM crops. For example, non-GM corn would be planted to surround a field of B.t. GM corn, and the non-GM corn would not be harvested. Beneficial or harmless insects would have a refuge in the non-GM corn, and insect pests could be allowed to destroy the non-GM corn and would not develop resistance to B.t. pesticides. Gene transfer to weeds and other crops would not occur because the wind-blown pollen would not travel beyond the buffer zone. Estimates of the necessary width of buffer zones range from 6 meters to 30 meters or more. This planting method may not be feasible if too much acreage is required for the buffer zones.

**Human health risks**

- **Allergenicity** Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of the fear of causing unexpected allergic reactions. Extensive testing of GM foods may be required to avoid the possibility of harm to consumers with food allergies. Labeling of GM foods and food products will acquire new importance, which I shall discuss later.

- **Unknown effects on human health** There is a growing concern that introducing foreign genes into food plants may have an unexpected and negative impact on human health. A recent article published in Lancet examined the effects of GM potatoes on the digestive tract in rats. This study claimed that there were appreciable differences in the intestines of rats fed GM potatoes and rats fed unmodified potatoes. Yet critics say that this paper, like the monarch butterfly data, is flawed and does not hold up to scientific scrutiny. Moreover, the gene introduced into the potatoes was a snowdrop flower lectin, a substance known to be toxic to mammals. The scientists who created this variety of potato chose to use the lectin gene simply to test the methodology, and these potatoes were never intended for human or animal consumption.

On the whole, with the exception of possible allergenicity, scientists believe that GM foods do not present a risk to human health.

**Economic concerns**
Bringing a GM food to market is a lengthy and costly process, and of course agri-biotech companies wish to ensure a profitable return on their investment. Many new plant genetic engineering technologies and GM plants have been patented, and patent infringement is a big concern of agribusiness. Yet consumer advocates are worried that patenting these new plant varieties will raise the price of seeds so high that small farmers and third world countries will not be able to afford seeds for GM crops, thus widening the gap between the wealthy and the poor. It is hoped that in a humanitarian gesture, more companies and non-profits will follow the lead of the Rockefeller Foundation and offer their products at reduced cost to impoverished nations.

Patent enforcement may also be difficult, as the contention of the farmers that they involuntarily grew Monsanto-engineered strains when their crops were cross-pollinated shows. One way to combat possible patent infringement is to introduce a "suicide gene" into GM plants. These plants would be viable for only one growing season and would produce sterile seeds that do not germinate. Farmers would need to buy a fresh supply of seeds each year. However, this would be financially disastrous for farmers in third world countries who cannot afford to buy seed each year and traditionally set aside a portion of their harvest to plant in the next growing season. In an open letter to the public, Monsanto has pledged to abandon all research using this suicide gene technology35.

Conclusion

Genetically-modified foods have the potential to solve many of the world’s hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution to avoid causing unintended harm to human health and the environment as a result of our enthusiasm for this powerful technology.

Task: Work in pairs, one of you write an argument for GM foods, the other write one against and present your debate to the class. Your arguments must be supported by facts, figures and views from different parties from your research.

Hydroponics:

Hydroponics is a method of growing plants using mineral nutrient solutions instead of soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel or mineral wool. Plant physiology researchers discovered in the 19th century that plants absorb essential mineral nutrients as inorganic ions in water. In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant’s water supply artificially, soil is no longer required for the plant to thrive. Almost any
terrestrial plant will grow with hydroponics, but some will do better than others. It is also very easy to do; the activity is often undertaken by very young children with such plants as watercress. Hydroponics is also a standard technique in biology research and teaching.

**Aeroponics:**

Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium. Aeroponic culture differs from both hydroponics and in-vitro (Plant tissue culture) growing. Unlike hydroponics, which uses water as a growing medium and essential minerals to sustain plant growth, aeroponics is conducted without a growing medium.

**Basic Principles of Aeroponics**

The basic principle of aeroponic growing is to grow plants in a closed or semi-closed environment by spraying the plant’s roots with a nutrient rich solution. Ideally, the environment is kept free from pests and disease so that the plants may grow healthier and quicker than plants grown in a medium. However, since most aeroponic environments are not perfectly closed off to the outside, pests and disease may still cause a threat. These conditions advance plant development, health, growth, flowering and fruiting for any given plant species and cultivars. Carbon dioxide in the air is necessary for healthy plant growth. As aeroponics is conducted in air combined with micro-droplets of water, almost any plant can grow to maturity in air with a plentiful supply of carbon dioxide, water and nutrients.

Some growers favor aeroponic systems over other methods of hydroponics because the increased aeration of nutrient solution delivers more oxygen to plant roots, stimulating growth and helping to prevent pathogen formation.

**Methods**

Aeroponics refers to the method of growing crops with their roots suspended in a misted nutrient solution. Many types of plants can be grown aeroponically.

Aeroponics is a form of hydroponic technique. Water is the sole nutrient carrier and typically the method is not hybridized with geoponic technique; although due to the sensitivity of root systems aeroponics is often combined with conventional hydroponics which is used as an emergency ‘crop saver’ -backup nutrition and water supply- if the aeroponic apparatus fails.

In an aeroponic system the plant’s rootzone is suspended into an environment where the roots protrude into an atomized nutrient solution; the leaves and crown, often called the "canopy", extending above. The roots of the plant are separated by the plant support structure. The lowest stem and root system are sprayed or misted for short durations with a hydro-atomized pure water/nutrient solution.

One of the more singular aspects of aeroponic growing is the frequent omission of media, whether organic or not, for anchoring the plant. Many times closed cell foam is compressed around the lower stem and inserted into an opening in the aeroponic chamber, which
decreases labour and expense; for larger plants, trellising is used to suspend the weight of vegetation and fruit.

**Ecological advantages**

Aeroponic growing is considered to be safe and ecologically friendly for producing natural, healthy plants and crops. The main ecological advantages of aeroponics are the conservation of water and energy. When compared to hydroponics, aeroponics offers lower water and energy inputs per sq meter of growing area.

**The Green Revolution:**

http://www.hindu.com/2006/01/04/stories/2006010414060100.htm

The Green Revolution refers to the wave of technological development that started in the 1940s to increase crop productivity in order to help developing countries face their growing populations’ needs. The technologies of the Green Revolution broadly fall into two major categories. The first is the breeding of new plant varieties; the second is the application of modern agricultural techniques such as chemical fertilizers, herbicides, irrigation, and mechanization. Beginning in Mexico in 1944, the Green Revolution continued in the 1960s to India and Pakistan, where it is credited with saving over one billion people from starvation. Dr. Norman Borlaug was the agricultural scientist who led the program. In 1970, he won the Nobel Peace Prize for his efforts.

- The original Green Revolution was the increase in food production stemming from the improved strains of wheat, rice, maize and other cereals in the 1960s created by technologists, which increased the crop yield in underdeveloped countries across the world and prevented large scale famine. Biotech created the first Green Revolution; it looks like the search for energy will fuel the second.

**The Second Green Revolution**

- To help bring food security to the 8 billion people projected in 2025, the world needs another Green Revolution as many delegates to the World Food Summit urged. The Green Revolution that began in the 1960s has helped keep food supply ahead of rising demand over the past 30 years. By doubling and tripling yields, it bought time for developing countries to start dealing with rapid population growth. But the Green Revolution represented only a "temporary success," as Norman Borlaug, the Danish-American plant geneticist who was one of its architects, noted upon receiving the 1970 Nobel Peace Prize for his contribution. Borlaug pointed out that it is not enough to boost yields on existing cropland; slowing population growth also is crucial.
- The first Green Revolution raised the productivity of the three main staple food crops—rice, wheat, and corn. Between 1950 and 1990 grain yields increased by nearly two and a half times, from 1.06 metric tons per hectare to 2.52 tons. A second revolution also must raise the productivity of other important food crops such as sorghum, millet, and cassava—foods produced and consumed mainly by the world’s poor.
Workers plant rice cuttings at an experimental rice farm near Bombay, India, in 1962. The Green Revolution that began in the 1960s has helped keep food production ahead of population growth. But it amounts to only a temporary success. Now, a second Green Revolution is needed. So far, the outlook for a second Green Revolution is uncertain. Because most increases in food supplies must come from currently cultivated land, raising productivity will require new technologies and better farming practices. Poor people, however, cannot afford the large amounts of fertilizers, pesticides, and other agricultural inputs that increased yields in the first Green Revolution. Moreover, the population of developing countries is much larger than it was in the 1960s, the amount of arable land per person is less, and natural resources are more degraded. Nevertheless, three recent developments are promising:

• **Super rice.** The International Rice Research Institute (IRRI) in the Philippines has developed a new strain of super rice capable of boosting yields by 25%, amounting to an extra 100 million metric tons a year—enough to feed an additional 450 million people. This rice does not promise to produce well on marginal land, however, and therefore its use may be limited to well-irrigated bottom land.

• **Improved corn.** The International Center for the Improvement of Maize and Wheat in Mexico has engineered several improved varieties of corn that could increase yields by up to 40%. These varieties could be grown on marginal land under difficult growing conditions and thus could be raised by poor farmers. If widely used, the new varieties could feed an additional 50 million people a year.

• **A new potato.** The International Potato Centre in Peru claims that, for an investment of US$25 million, it could produce a new potato that would be resistant to a virulent form of potato blight that has reached every continent except Australia.

• These developments, encouraging as they are, could well be offset, however, if current patterns of soil degradation and damaging agricultural practices continue.

**Key Question 4: Can a sustainable food supply be maintained in the future?**

Draw together all of the ideas you have studied in this booklet to put together a structured essay to answer this question. You must come to your own individual decision based on what you have learned and your own research. Can food supply ever be maintained sustainably? You decide!!
Sustainable Water Supply

Key Question 1: What physical factors determine the supply of water?

Freshwater is the liquid of life. Without it the planet would be a barren wasteland. The supply of water is finite, but demand is rising rapidly as population grows and as water use per capita increases. In an effort to spur action to meet the impending crisis, the UN General Assembly has proclaimed the period from 2005 to 2015 as the International Decade for Action, "Water for Life". This began on World Water Day, 22 March 2005. It is badly needed.

Where is our water?

Of all the water on the Earth, about 97% exists in the ocean as saltwater. The remaining 3% represents the amount of freshwater on the planet. Unfortunately, however, 90% of this freshwater is trapped in glaciers and ice caps, and in general humans cannot extract it for use. Ultimately, only 0.014% of the earth's total volume of water is easily available to us for agricultural, industrial, and domestic purposes. This water exists in a variety of forms, including soil moisture, groundwater, water vapor, and lakes and streams.
In theory, some 34,000 cubic kilometres of freshwater are available globally for human use every year. If evenly distributed this would provide each person with roughly 8,000 cubic metres of water per year (based on the population in 2000). This amount would be enough to meet human needs, if freshwater were evenly distributed. But available freshwater supplies are not distributed evenly around the globe, throughout the seasons from year to year.

**Causes of water scarcity**

The causes of water scarcity are varied. Some are natural and others are as a result of human activity. The current debate sites the causes as largely deterministic in that scarcity is a result of identifiable cause and effect. However, if water scarcity is the point at which water stress occurs (the point at which various conflicts arise, harvests fail and the like), then there are also less definable sociological and political causes. Many of the causes are inter-related and are not easily distinguished.

<table>
<thead>
<tr>
<th>Causes of water scarcity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Population growth</td>
<td>• Poverty and economic policy</td>
</tr>
<tr>
<td>• Food production</td>
<td>• Legislation and water resource management</td>
</tr>
<tr>
<td>• Climatic change and variability</td>
<td>• International waters</td>
</tr>
<tr>
<td>• Land use</td>
<td>• Political realities (sticking to policies)</td>
</tr>
<tr>
<td>• Water quality</td>
<td></td>
</tr>
<tr>
<td>• Water demand</td>
<td></td>
</tr>
<tr>
<td>• Sociological issues</td>
<td></td>
</tr>
</tbody>
</table>
Fresh water is a decreasing resource.

Rising world population
Increased contamination of water

Fresh water availability per person
1950 – 16,000m³
2000 – 7,000m³

More competition between users
Larger river management schemes, longer transfers of water

Environmental damage increases
International conflicts over water grow

Firstly:

- Global water consumption is increasing rapidly, well ahead of population growth.
- During the twentieth century water consumption increased seven fold.
- Two thirds of the world’s water goes to agriculture. This is higher in the LEDW. This in itself is a sign that we need to grow more food to feed more people.
- Increase in household and industrial use is also forecast.
- Although consumption per head continues to rise in industrialised countries like UK, the greater increase in water use will be in LEDCS in line with their higher rates of population growth.

Secondly:

- Fresh water supplies have an uneven spatial distribution.
- Water rich countries tend to be located in hot, wet tropics or humid temperate latitudes.
- Water poor counties tend to be located in the Middle East and North Africa.

Thirdly:

- Water pollution is increasing, which means that large volumes of surface water are no longer available for human uses.
- In MEDCs since there have been investments in infrastructure, stronger legislation, closer monitoring and improved management, water quality has steadily improved in recent years.
- In LEDCs undergoing rapid industrialisation and experiencing an urban explosion, populations are faced by accelerated contamination of surface water supplies by untreated human and industrial wastes.
Key Question 2: How do human activities influence water supply and demand?

Content:
- Demographic
- Economic
- Murray - Darling Basin case study: Consequences for amount and quantity of water

Key Question 3: How can water supply and demand be managed sustainably?

<table>
<thead>
<tr>
<th>Content:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- New storage capacity</td>
</tr>
<tr>
<td>- Water transfers</td>
</tr>
<tr>
<td>- Groundwater sources</td>
</tr>
<tr>
<td>- Desalination</td>
</tr>
<tr>
<td>- Recycling</td>
</tr>
<tr>
<td>- 'Grey' water</td>
</tr>
<tr>
<td>- Reducing consumption</td>
</tr>
</tbody>
</table>

Desalination

**UK gets first desalination plant** The UK’s first desalination plant providing drinking water for Londoners and people in the south-east has been granted government approval.

The plant in Beckton, east London, will start producing water sometime in 2009, in times of drought or low rainfall

For full article see: [http://news.bbc.co.uk/1/hi/england/london/6904722.stm](http://news.bbc.co.uk/1/hi/england/london/6904722.stm)

Water transfers:

**China plans huge water transfer**

Floodwater could help in areas hit by drought

China is reported to be close to giving the go-ahead to a controversial scheme to pump huge amounts of water from its flood-prone south to the drought-affected north.

For full article see: [http://news.bbc.co.uk/1/hi/world/asia-pacific/2143860.stm](http://news.bbc.co.uk/1/hi/world/asia-pacific/2143860.stm)

Groundwater sources:

**Groundwater overuse could cause severe water shortage**

The excessive use of groundwater for a variety of purposes has significantly depleted water tables and aquifers throughout Afghanistan and if the trend is not reversed soon the country will face a severe shortage of drinking water, the Ministry of Water and Energy said. Recurrent droughts, low precipitation and poor water management have exacerbated the country’s water crisis, ministry officials said.

Water Recycling:

Recycled water takes Singapore by storm

Singapore will now be sourcing 15% of all its water from water recycling plants, after the opening of the fourth and largest such facility this week.

For full article see: http://www.edie.net/news/news_story.asp?id=12773

Queensland to drink waste water

People in the Australian state of Queensland will soon have to start drinking water containing recycled sewage, the state premier has warned.

For full article see: http://news.bbc.co.uk/1/hi/world/asia-pacific/6308715.stm

New storage capacity:

<table>
<thead>
<tr>
<th>Three Gorges Dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Three Gorges Dam is the world's largest hydropower project and most notorious dam. The massive project sets records for number of people displaced (more than 1.2 million), number of cities and towns flooded (13 cities, 140 towns, 1,350 villages), and length of reservoir (more than 600 kilometres). The project has been plagued by corruption, spiralling costs, technological problems, human rights violations and resettlement difficulties. You need to look up the costs and benefits of the dam.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The Aswan Dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Aswan Dam was built in 1971, it was created along with a Hydroelectric Power Station and a large lake known as Lake Nasser (named after Egypt's first president) was formed behind the Dam. The Dam was built:</td>
</tr>
<tr>
<td>• to stop serious flooding in the Nile Valley and maintain a constant river level</td>
</tr>
<tr>
<td>• to provide water all year round, with ample reserve to provide water in years of drought</td>
</tr>
<tr>
<td>• to provide electricity in the form of Hydro Electric power</td>
</tr>
<tr>
<td>• to increase the area of cultivation so that two or three crops can be grown on the same piece of land each year. You need to look up the costs and benefits of the dam.</td>
</tr>
</tbody>
</table>

http://www.kented.org.uk/ngfl/subjects/geography/rivers/
RiverArticles/theaswanhighdam.htm

Grey water:

Greywater, also known as sullage, is non-industrial wastewater generated from domestic processes such as dish washing, laundry and bathing. Greywater comprises 50-80% of residential wastewater. Greywater comprises wastewater generated from all of the house's
sanitation equipment except for the septic tank (water from toilets is blackwater, or sewage). In recent years concerns over dwindling reserves of groundwater and overloaded or costly sewage treatment plants has generated much interest in the reuse or recycling of greywater, both domestically and for use in commercial irrigation. However, concerns over potential health and environmental risks means that many jurisdictions demand such intensive treatment systems for legal reuse of greywater that the commercial cost is higher than for fresh water. Despite these obstacles, greywater is often reused for irrigation, illegally or not. In droughtzones or areas hit by hose pipe bans (irrigation restrictions) greywater can be harvested informally by manual bucketing. In the third world, reuse of greywater is often unregulated and is common. At present, the recycling of greywater is poorly understood compared with elimination.

Reducing consumption:

**Anglian Water's water efficiency plan**

The Environment Act 1995 gave every water company the statutory duty to promote the efficient use of water by their customers. In October 1996, the Department of the Environment and the Welsh Office published "Water Resources and Supply: Agenda for Action". The paper highlighted broad areas of activity where efficiency of water use could be increased. These included:

- the provision and installation of more water-efficient equipment
- reduction of leakage
- promotion of efficient use by customers

We published our first Water Efficiency Plan in 1997 and have subsequently submitted annual reports to Ofwat detailing our progress with the plan. Household metering and leakage reduction were the central planks of our water efficiency strategy as detailed in the first plan. We have now delivered on these in being the leading company in meter penetration and lower leakage levels.

Anglian Water's mission statement for water efficiency is:

"to work with our customers to protect and maintain water supplies and enhance environmental quality, now and in the future." We have developed a water efficiency strategy to fit in with our company vision and values.

For full article see: http://209.85.229.132/search?q=cache:9GZACP0FHLAJ:www.anglianwater.co.uk/assets/WaterEfficiency.pdf+The+Environment+Act+1995+gave+every+water+company+the+statutory+duty+to+promote+the+efficient+use+of+water+by+their+customers.+In+October+1996,+the+Department+of+the+Environment+and+the+Welsh+Office+published&cd=1&hl=en&ct=clnk&gl=uk

Key Question 4: Can sustainable water supplies be maintained in the future?

Draw together all the ideas you have learned to critically assess attitudes towards the sustainability of water supplies