

## Why Study Plants? (TTPB1) – Teaching Guide

**Overview** – Plants provide us with oxygen, food, fuel and fiber. Among other reasons, scientists study plants to improve and secure the food supply for an increasing world population, identify new sources of bioactive compounds and medicines, improve fiber production and identify sources of biofuels and biorenewable resources. This lecture is designed for a general audience, high school students or first year university students - no prior knowledge is assumed.

### Learning Objectives

*By the end of this lecture the student should be able to:*

- Identify ways that humans depend upon plants for our survival
- Identify scientific breakthroughs derived from the study of plants
- Define the challenges brought about by a growing human population
- Identify two forms of malnutrition that affect many humans
- Describe three threats to crop production
- Identify three non-food products derived from plants

### Study / exam questions (*understanding and comprehension*)

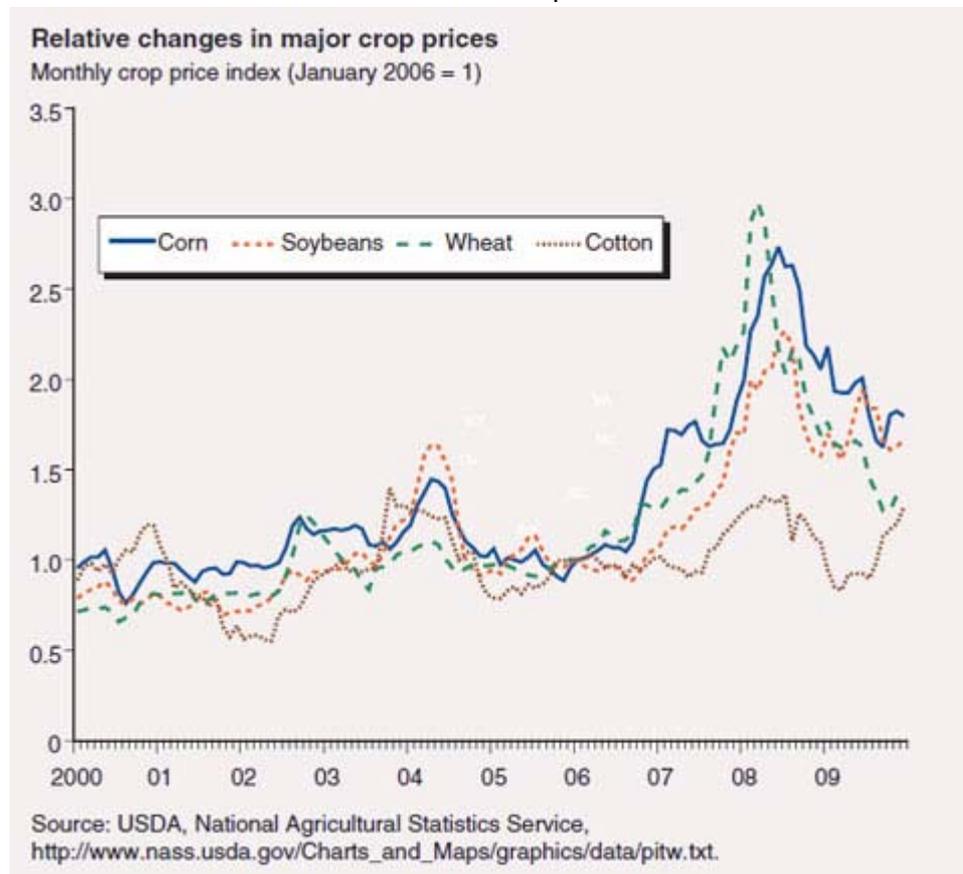
- What was the size of the human population in 1950 and what is the 2020 projected population size? What fold increase is this? Is this rate of growth sustainable?
- Most of our major crop plants are annuals, but there is considerable interest into developing perennial plants as food sources. What are the benefits of a perennial life habit?
- What are the pros and cons of nitrogenous fertilizer use? How can we mitigate the problems associated with its use?
- Plant breeders can introduce disease resistance genes into crop plants, but these solutions are normally short lived. Why will plant pathologists never be unemployed?
- What is biofortification?
- Name three non-food plant products.
- What is bioethanol and how does it differ from gasoline or petrol?

### Discussion Questions (*engagement and connections*)

- What would happen if all the plants disappeared from the earth right now? Could we engineer plant substitutes?
- What is the range of population sizes projected for 2050 and 2100 and 2300? (The UN has information about population projections). What factors will affect whether the population follows the high, medium or low projections? Which factors are under the control of individuals, policy makers, governments or scientists?
- What is the interaction between drought stress, temperature and yield? How do low crop yields affect land usage, biodiversity and atmospheric carbon dioxide?
- The UN Food and Agriculture Organization is an excellent source of data about food production and agriculture use (<http://www.fao.org/ag/aql/fertistat/>). Explore that site and this world forecast summary (<ftp://ftp.fao.org/ag/aqp/docs/cwfto14.pdf>). Select a country or region of the world and traditional and projected use of nitrogen, phosphorous and potassium fertilizer. Do all countries meet their own needs for

fertilizer? Are any of these plant nutrients limiting resources for future food production?

- Explore the history of the development of Golden Rice, from the perspective of the scientific challenges, the regulatory hurdles and the funding sources. With your classmates prepare a debate of the pros and cons of this crop.
- Watch the short video series Two Degrees Up (available on YouTube). How is climate change affecting small farmers, and what challenges to we face in the future?
- What kinds of fuels do we currently use and for what purposes? What are some of the ways that plants are used for fuels? What challenges do we face as we move from an oil economy towards a bio economy?
- This chart is from “The Ethanol Decade: An Expansion of US Corn Production 2000 – 2009” published by the USDA (<http://www.ers.usda.gov/Publications/EIB79/EIB79.pdf>). What does the report suggest are the causes for the transient price increases in 2008? What can we learn about how we should and should not use plants as sources of fuel?



## **Lecture synopsis**

### **Introduction (1 – 10)**

Plants are: interesting multicellular organisms, very diverse, and provide us with oxygen, food and chemical compounds.

### **Why study plants? (11 – 17)**

Studying plants helps us understand and preserve natural environments. Fundamental discoveries in science have come from plant studies, including the first observations of cells and viruses, and Mendel's laws of inheritance!

### **The global demand for food and nutrients is increasing (18 - 27)**

The world population is increasing at a dangerous rate and is expected to increase by nearly 50% in the next 40 years. More than a billion people are chronically hungry, and hunger and malnutrition disproportionately affect children.

### **What can scientists do to try to alleviate hunger? (28 - 55)**

Plant scientists are working to develop plants that are drought or stress tolerant, require less fertilizer or water, are more resistant to pathogens, and are more nutritious. Drought stress causes plants to produce less food, and the incidence of drought is increasing. It has been possible to breed drought-tolerant traits into many plants. Fertilizer application enhances yields, but also is very energy demanding and polluting. Learning how plants take up and use nutrients helps farmers use fertilizers more effectively and breeders enhance nutrient utilization. Plants are continually threatened by pathogens and pests. Scientists must meet the challenges of newly emerging pathogens by identifying resistant lines and improving management practices. It is also important that our crop plants resist pathogens after they are harvested so that they stay fresh and safe between the time of harvesting and the time they are used as food. Plants provide us with necessary vitamins and nutrients, but many people only have access to relatively nutrient-poor foods. Scientists are breeding plants that are better sources of vitamin A, iron and many other essential nutrients.

### **Plants provide us with more than food (56 -78)**

Plants are sources of novel therapeutic drugs, provide fibers for paper or fabric, are sources of biorenewable products and provide renewable energy sources. Aspirin, digitalis and taxol are some of the more familiar compounds initially derived from plants, but new compounds are constantly being identified. Plant cell walls provide us with wood, cotton fabric, and paper. Scientists are identifying ways to improve the production and sustainability of these products. Plants can also be sources of fuels and bioenergy, which is becoming increasingly important as petroleum reserves are not renewable. As alternatives to fossil fuels, biofuels can slow the rate at which carbon dioxide is released into the atmosphere. Plants can also produce renewable and degradable alternatives to petroleum based products like plastics.

### **Summary (79)**

Studying plants increases our knowledge about life in general and helps us to work with them to keep us fed, healthy, sheltered, clothed, and happy.

**Slide Concepts:**

Slides	Table of contents / concepts
1	Title
<b>2 – 10</b>	<b>Why Study Plants?</b>
2	Plants, like most animals, are multicellular eukaryotes
3	Plants are diverse and range from tiny mosses to huge trees
4	Plants make us happy! It's true – seeing plants improves peoples' moods and satisfaction level.
5	Plants are amazing living organisms; big flowers and trees and very old trees.
<b>6 - 10</b>	<b>We could not live without plants (they make oxygen and food)</b>
<b>11</b>	<b>Why study plants? To learn about the natural world, and provide us with food, medicines and energy</b>
12 - 13	Cells and viruses were observed in plants
18 - 20	The world population is growing and growing
21 - 27	Hunger and malnutrition affect millions, with children disproportionately affected
<b>28 - 29</b>	<b>What can scientists do about hunger and malnutrition?</b>
30 - 37	Plant growth is limited by drought stress; drought resistant crops are needed
38 - 41	Fertilizer is energy demanding and polluting; plants can be bred to take up nutrients more efficiently, as can perennial plants
<b>42</b>	<b>Food supplies are threatened by diseases</b>
43 - 44	Late blight ( <i>Phytophthora infestans</i> )
45 - 49	Wheat stem rust ( <i>Puccinia graminis tritici</i> )
50 - 51	Plants are susceptible to disease and damage even after harvesting
52 - 55	<b>Malnutrition is a problem that can be addressed through biofortification</b>
<b>56</b>	<b>Plants provide us with more than food</b>
57	Many medicines originated as plant products
58 - 64	Quinine and artemisinin are anti-malarial drugs
65	Plants can make edible vaccines
<b>66 - 70</b>	<b>Plant cell walls provide important durable materials</b>
66 - 70	Plant cell walls are rigid and give wood its strength. Plant fibers make cloth and paper.
71 - 72	Plants can replace petroleum for many products and purposes
73 - 76	Plants can be a source of biofuels
77 - 78	Plants can be sources of biorenewables and biodegradable resources
<b>79</b>	<b>Summary</b>