**Agricultural Sustainability:**

Building a Greenhouse to grow plants in a way that helps the society and the environment

SBI3U Unit**: Plants: Anatomy, Growth and Function**

**Background Information**: (words that are in italics are terms that will be defined in the following section)

**Plants are essential for sustaining life on our unique planet**. Of the many *ecosystem services* plants provide, three of the most important are:

1. serving as food for organisms

2. providing oxygen through *photosynthesis*

3. using carbon dioxide to reduce excess greenhouse gasses which increase *climate change*

Plants are producers in the intricate *food web* which describes the interdependence all consumers have on plants. Humans rely on plants for nutrition, energy for life and metabolism, health, and sustenance. Agriculture refers to farming practices that produce food from plants.

Fifty percent of the oxygen in earth’s atmosphere is produced by plants. The rest is produced by *cyanobacteria* and some *protists*. Living organisms, including plants, need oxygen for cellular respiration. The conversion of *solar energy* into *chemical energy* occurs through a process called photosynthesis, which plants have the ability to perform. It is through photosynthesis that glucose used as food and oxygen are produced.

Since the industrial revolution the balance of oxygen and carbon dioxide illustrated in the *carbon cycle* has been interruptedthrough *anthropogenic* factors such as burning fossil fuels. As a result, the atmospheric carbon dioxide levels have significantly increased, making it one of the most influential greenhouse gasses affecting climate change. For their consumption of carbon dioxide, plants are needed to restore and sustain the carbon cycle balance.

***Sustainable agriculture* is a concept that carries hope for the world to have enough food for its ever-increasing population without compromising the well-being of future generations**. The goal of sustainable agriculture is to produce enough food while integrating wise practices for the society and environment. By 2050, it is predicted that the world population may rise to 9 billion. (Dunlop et al, 2010) *Food security* is thus a crucial issue for today’s population. As an alternative to *monoculture* and other technological agricultural techniques, sustainable agricultural offers a significant food source without negative environmental and economic consequences.

Four ways this is accomplished are:

1. Crop rotation reduces depletion of important nutrients so synthetic fertilizers are not needed.

2. Using natural predators, such as ladybugs, to eliminate pests rather than using chemical pesticides that cause *biomagnification* of deadly toxins throughout the food chain.

3. Hand-pulling of weeds, rather than petroleum-based machinery which increases the negative effects of climate change.

4. Hiring local people which benefits the society and economy of the communities involved.

# *Greenhouses* may be built to grow plants in environmentally controlled areas. Solar radiation passes through the polycarbonate or glass walls and is absorbed by the plants and soil inside. *Heat sinks* such as a black barrel filled with water or a small pond may be placed inside to absorb and retain the solar heat. The transfer of heat inside the greenhouse is caused by convection from the re-radiation of the thermal energy from the plants, walls and other heat *sinks inside the building.*

# To apply the concept of sustainable agriculture, students will work on an STSE project which will give them an opportunity to plan and construct a greenhouse so they can grow a sustainable garden to benefit their home and school.

# Term Definitions:

# *1. ecosystem services –* the benefits provided by sustainable ecosystems to organisms

# *2. photosynthesis –* a series of chemical reactions that convert energy from sunlight into chemical energy stored in molecules

# *3. climate change –* long term change in climate that is measureable

# *4. food web –*graphic organizer that illustrates the interdependence of organisms for food

# *5. cyanobacteria-* a species of bacteria that can photosynthesize, blue-green algae

# *6. protists –* unicellular eukaryotic organism

# *7. solar energy – energy that is captured from the sun’s radiation*

# *8. chemical energy* – energy made available through chemical reactions

# *9. carbon cycle –* the flow of carbon through an ecosystem including the processes of photosynthesis and cellular respiration

# *10. anthropogenic –* factors affecting climate change that is from human activities

# *11. Sustainable agriculture –* an approach to agriculture production that integrates economics, the environment and society in meeting the nutritional needs of the world

# *12. Food security –* the state in which all people have access to safe and nutritious food to meet their dietary needs

# *13. biomagnification –* the process whereby toxic substances accumulate in bodies of organisms in increasing amounts toward the top of a food chain

# *14. Greenhouses –* a structure built to allow plants to grow throughout the year because the interior temperature remains stable

# 

**Objectives:**

Through this concept development of sustainable agriculture, students will gain skills in all four achievement categories through the following objectives:

1. students will gain **knowledge and understanding** of what sustainable agriculture is and how it is implemented

2. students will use **thinking and investigation** skills to develop a plan for and construct a solar-powered greenhouse to grow a garden

3. students will **communicate** the understanding they have gained by presenting to the class their research and part of the plan they designed

# 4. students will apply the concept of sustainable agriculture to the society, technology and the environment by creating a sustainable garden which contributes food to their families and the school community without using fossil fuels.

# Lesson Sequence:

The Grade 10 Climate Change unit as part of SNC2D is required before this concept is taught. In the climate change unit the carbon cycle, greenhouse gasses, and convection energy transfer will be taught**.**

The concept of Agricultural Sustainability will be integrated throughout the entire unit. It will be the thread that weaves the ministry expectations for the plant unit together. The ministry expectations are listed after the appropriate lessons where they are met.

**Grants for building a greenhouse:** The website listed below has several contacts for grants for educational institutions building a greenhouse. It is advised that the teacher investigate this prior to beginning the lesson. Also, details concerning the property location, costs, etc., will be discussed with the administration.

**Safety** lessons will be taught before any work with tools or construction materials begins.

**Lesson 1 The Necessity of Plants F2, F2.1**

This lesson will explain the ecosystem services plants provide and their role as producers. Photosynthesis will be explained. An excellent video with great diagrams, pictures and a catchy rap: <http://www.teachertube.com/viewVideo.php?video_id=62625>

Another short video good for an introduction: <http://www.youtube.com/watch?v=vgu2RzkCkJU&feature=related>

**Lesson 2 What is Agricultural Sustainability? F1, F1.1, F1.2, A1.1, A1.2**

This lesson will define sustainability and research examples to the students of working sustainable farms and greenhouses. The students will begin their STSE project: begin greenhouse plan in groups. A sample video for an example:

“Its Winter and Everything is Green. <http://www.youtube.com/watch?v=_jPVreSYS5w>

**Lesson 3 Factors that Affect Plant Growth F1, F2, F1.2, F2.1, F2.2, F3.4**

This lesson will discuss nutrients, soil, water, CO2, O2 and practical requirements for a successfulorganic garden. The students will plan their garden in groups. For an interactive lesson online teaching factors that affect plant growth: <http://www.ngfl-cymru.org.uk/vtc/factors_plant_growth/eng/Introduction/MainSessionPart2.htm>

**Lesson 4 Constructing a Greenhouse Part One F1, A1.4, A1.5, A1.6, A1.12, A1.13**

Students will bring their designs and collaborate to finalize a class plan. For an introduction, students can watch this instruction about greenhouses: <http://www.youtube.com/watch?v=jILdnz4q2Xs>

**Lesson 5 Constructing a Greenhouse Part Two F1, A1.4, A1.5, A1.12, A1.13**

Students will gather materials and begin construction. This construction will continue for a length of time necessary to finish the project.

**Lesson 6 Planting a Sustainable Garden F2, F2.2, F2.4, F3.4**

Students will begin planting their garden according to the group plans that were submitted and approved by the instructor.

**Lesson 7 Reaping the Reward F2.2, A2.1**

Students will tend their garden and share their harvest with their family and school community. Students will write a reflection on what it is like to be an organic gardener and what difference they made for the community and/or the environment.

**Ministry Expectations fulfilled:**

F1. evaluate the importance of sustainable use of plants to Canadian society and other cultures;

F2. investigate the structures and functions of plant tissues, and factors affecting plant growth;

F1.1 evaluate, on the basis of research, the importance of plants to the growth and development of Canadian society [IP, PR, AI, C]

F1.2 evaluate, on the basis of research, ways in which different societies or cultures have used plants to sustain human populations while supporting environmental sustainability (e.g., sustainable agricultural practices in developing countries such as crop rotation and seed saving; traditional Aboriginal corn production practices) [IP, PR, AI, C]

F2.1 use appropriate terminology related to plants, including, but not limited to: mesophyll, palisade, aerenchyma, epidermal tissue, stomata, root hair, pistil, stamen, venation, auxin, and gibberellin [C]

F2.2 design and conduct an inquiry to determine the factors that affect plant growth (e.g., the effects on plant growth of the quantity of nutrients, the quantity and quality of light, and factors such as temperature and water retention or percolation rate)[IP, PR, AI]

F2.4 investigate various techniques of plant propagation (e.g., leaf cutting, stem cutting, root cutting, seed germination) [PR]

F3.4 describe the various factors that affect plant growth (e.g., growth regulators, sunlight, water, nutrients, acidity, tropism)

A1.1 formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research

A1.2 select appropriate instruments and materials (e.g., dichotomous keys, computer simulations, plant cuttings), and identify appropriate methods, techniques, and procedures, for each inquiry

A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately

A1.4 apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory and biological materials (e.g., preserved specimens); and by using appropriate personal protection

Performing and Recording [PR]\*

A1.5 conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data

A1.6 compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams

A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)

A1.12 use appropriate numeric, symbolic, and graphic modes of representation (e.g., biological diagrams, Punnett squares), and appropriate units of measurement (e.g., SI and imperial units)

A1.13 express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures

A2.1 identify and describe a variety of careers related to the fields of science under study (e.g., botanist, geneticist, ecologist, farmer, horticulturalist) and the education and training necessary for these careers

**Student Difficulties:**

**1.** Some students may have difficulty grasping the concept of not using technology such as machinery and pesticides for agriculture, since we live in a technological age. I have attached a problem-solving activity which will help them see the cost/benefit analysis of sustainable agriculture.

2.Students may have trouble working cooperatively. This plan has several types of differentiated instruction activities so students can interact at their own pace.

**Considerations for Special Needs and English Language Learners Students:**

The nature of the STSE project, designing a building a greenhouse, and then planting a sustainable garden is conducive for these students. **Assessments for and as learning** activities using cooperative learning methods such as K-W-L charts, jigsaw and think-pair –share will be used . The project will be a group assignment, first in small groups to gather information, do the research and then collaborate to present to the class. This will be a tiered assignment where the instructor will decide which parts of the research, and later, which physical tasks each special needs student will benefit the most from.

ELL students will benefit from the hands-on aspect of the concept, which is conducive to natural English conversation and problem solving. Word boards will be used to develop vocabulary.

**Considerations for Advanced students**:

There are many tasks that will engage the expertise and research skill of an advanced student. The teacher will reinforce this student’s interest and motivation to make calculations, do in-depth research, be team leaders, etc. in the design and construction of the greenhouse.

**Annotated Bibliography**.

BC Greenhouses LTD<http://www.bcgreenhouses.com/index.php?_kk=solar%20greenhouse&_kt=56581252-0617-4f1e-861a-7a13db6c6c31&gclid=CK> This site has a helpful catalogue and kits available for schools to order for building greenhouses. Even though they are situated in BC, they have several outlets in Ontario. The phone number to call is  1-888-391-4433!.

Dunlop et al., Biology 11, McGraw-Hill Ryerson, Toronto, ON, CANADA, pgs. 528-625. The plant unit of this textbook was used for background information

Extreme How-To Video Building a Greenhouse. <http://www.youtube.com/watch?v=jILdnz4q2Xs>. This is an instruction video on how to build a greenhouse giving suggestions and options.

Grants for Greenhouses <http://www.ehow.com/list_6515306_greenhouse-grants-schools.html>

“Its Winter and Everything is Green. <http://www.youtube.com/watch?v=_jPVreSYS5w> This video shows an example of a simple working greenhouse.

Photosynthesis in animation, <http://www.youtube.com/watch?v=vgu2RzkCkJU&feature=related>. A short video with great animation and no speaking – good for an intro.

Plants-Interactive science <http://www.ngfl-cymru.org.uk/vtc/factors_plant_growth/eng/Introduction/MainSessionPart2.htm> Activites teaching factors that affect plant growth.

### [Solar Greenhouse Heat Sink - Solar](http://www.reuk.co.uk/Solar-Greenhouse-Heat-Sink.htm)

www.reuk.co.uk/**Solar**-**Greenhouse**-Heat-Sink.htm

Explains how to make a **solar powered** heatsink for your **greenhouse**

TeacherTube videos, <http://www.teachertube.com/viewVideo.php?video_id=62625>. Excellent rap with senior level diagrams, graphics explains photosynthesis.

The Ontario Curriculum, Grades 11 and 12, 2008, <http://www.edu.gov.on.ca/eng/curriculum/secondary/2009science11_12.txt>