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Education and Early
Childhood Development
English Programs

Prince Edward Island Science Curriculum

CURRICULUM

Science

Agriscience 801A/621A

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Foreword

The Pan-Canadian *Common Framework of Science Learning Outcomes K to 12*, released in October 1997, will assist in standardizing science education across the country. New provincial science curriculum is supported by the *Foundation for the Atlantic Canada Science Curriculum* document (1998).

This guide is intended to provide teachers with an overview of the outcomes framework for Agriscience 801A/621A. It also includes some suggestions to assist teachers in designing learning experiences and assessment tasks.

Introduction

Purpose

Agriscience 801A/621A seeks to promote an appreciation and understanding of the scientific principles and technology applied to the study of agriculture. Some course content is flexible to allow teachers and students to take advantage of selecting crops or areas of special interest. A portion of the course is dedicated to student-lead investigation where critical thinking, problem-solving, and decision-making skills will be developed in the process of examining and analysing agriculture issues related to crop production. With guidance and teacher-directed models, students will learn to follow a scientific inquiry process in their own investigations of agriculture issues.

Focus and Context

Agriscience 801A/621A will introduce students to the concepts and terminology associated with the study of agriculture. It will cover areas such as the Overview of Agriscience, Soil and Water Management, Plant Biology, Crop Production, and Green Spacing. Teachers will ensure all outcomes are addressed and the investigation process is integrated with content knowledge.

Agriscience 801A/621A requires students to follow a guided inquiry process that will result in an investigation and presentation of a crop production issue. Learners are able to conduct in-depth investigations of real world issues and challenges pertaining to agriculture. This type of learning engages students as they obtain a deeper knowledge of a subject area through research, experimentation, and the assistance of a community member.

In addition, Education for Sustainable Development (ESD) will be a foundational component of this course. The key themes of sustainable development - such as sustainable production and consumption, health promotion, and environmental conservation and protection - will be examined through a lens that highlights the profound interdependencies of ecological, societal, and economic systems.

With this in mind, it is important that teachers incorporate these key themes in their subject areas. One tool that can be used to support teachers is the searchable on-line database Resources for Rethinking, found at http://4r4.ca/en. It provides teachers with access to materials that integrate the ecological, social, and economic spheres through active, relevant, interdisciplinary learning.

Aim

The aim of science education in Prince Edward Island is to develop scientific literacy.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyse, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science;
- designing effective learning experiences that help students achieve designated outcomes;
- stimulating and managing classroom discourse in support of student learning;
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching;
- assessing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions;
- selecting teaching strategies from a wide repertoire.

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment that reflects a constructive, active view of the learning process. Learning occurs through actively constructing one's own meaning and assimilating new information to develop a new understanding.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum.

Learning experiences in science education should vary and should include opportunities for group and individual work, discussion among students as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the evidence accumulated provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

Communicating in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to learning. Students at all grade levels should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information by using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note making is an intrinsic part of learning in science, helping students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawings, and diagrams to represent data and results helps students learn, and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in, and demonstration of, the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging in science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important in their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Project Based Learning

Project Based Learning (PBL) is a teaching and learning methodology in which students engage in a rigorous, extended process of inquiry focused on complex, authentic questions and problems as they achieve the knowledge, skills, and attitudes defined by the curriculum outcomes. A set of learning experiences and tasks guide students in inquiry toward answering a central question, solving a problem, or meeting a challenge, as opposed to several activities tied together under a theme, concept, time period, culture, or geographic area (e.g., the Renaissance, the ocean, World War II, Canada).

PBL is unlike traditional projects in the sense that it is informed by the curriculum and drives the instruction and learning, as opposed to involving students in a "fun activity" or "making something". It is often focused on creating physical artifacts but must involve other intellectually challenging tasks and products focused on research, reading, writing, discussion, investigation, and oral presentation. Through PBL, students can develop and demonstrate in-depth understanding of academic knowledge and skills while enhancing habits of mind, along with collaboration, critical thinking, and communication skills. PBLs can be interdisciplinary in nature and allow for curriculum integration from different subject areas within one project. This learning experience ends with a high-quality product or performance created by the student(s) and presented to a public audience.

Two important components of PBL are the creation of a driving question and the collaboration with a subject matter expert.

The Driving Question

A well-crafted driving question is essential to all effective PBLs. It is this question that will form the basis of explicit links with the curriculum, create the focus of the project for the students, and encourage their process of inquiry and investigation. All driving questions should be provocative, challenging, open-ended, complex and must be linked to the core of what students are to learn as determined by the provincially authorized curriculum. Sample driving questions might include:

- Who are the heroes of our community?
- When is war justified?
- What effect does population growth have on our society?
- Is watching TV beneficial or harmful to teenagers?
- How can we create a piece of media to demonstrate diversity in our school?

Students may work in collaborative teams or individually to investigate, research, and refine knowledge and skills to adequately answer the driving question. Because the driving question is open-ended, students are able to reach a variety of potential conclusions in countless ways, while still building in-depth knowledge and skills. This creates the independent nature of the project and also the feeling of "voice and choice" for the students. The teacher then assumes more of a facilitator/coach role, assisting and guiding during an investigation and providing direct instruction when necessary.

Subject Matter Expert

A well crafted PBL also includes the role of a subject matter expert, or SME. These individuals/groups play a key role in PBL as they bring first-hand authentic knowledge and experience from the specific content field to the classroom. They may be sought out by the student(s) during their investigation or prearranged by the teacher depending on the project. These experts provide additional support and information to the students that the work they are completing is authentic and "real-world". The involvement of these experts allows educators to expand the classroom walls and make strong connections and links with surrounding communities.

At the conclusion of the PBL, students are required to present their findings to a public audience. Their peers in the classroom may act as the dress rehearsal for this presentation and provide valuable feedback to refine the presentation. However, in order to "raise the stakes" for the students' final presentation, students should present their findings to members of the community, experts in the field (including the involved SME), parents, or school administration in addition to presenting to their classroom peers. [Adapted with permission from PBL Starter Kit, (2009), The Buck Institute for Education. (ww.bie.org)]

In order for students of AGS801A/AGS621A to become fully engaged in the PBL model, they will need to draw on their prior knowledge, ask many questions, and conduct preliminary research to help them define the direction of their inquiry. Classroom discussions about specific agricultural issues may help them to decide where their inquiry will take them. Local geography, initiatives, or organizations may be another avenue to create interest in particular issues. Current events portrayed in the media may also be a catalyst to student inquiry as well as several other sources. An inquiry plan will ensure that students know what is expected of them and will aid in keeping track of progress throughout the PBL model.

Habits of Mind for Inquiry

Students grow as independent inquirers and critical thinkers by developing and refining learned inquiry skills, and by practising positive dispositions that support their inquiry. Habits of mind are the attitudes or dispositions that allow a person to set aside personal bias or self-limiting beliefs that may interfere with the ability to reach newer levels of understanding.

To achieve deeper understanding in any inquiry, students need to practice being

1) open-minded (willing to consider evidence that may oppose their own views);
2) fair-minded (willing to consider others' viewpoints);
3) independent-minded (willing to stand up for firmly held beliefs);
4) critical-thinkers (willing and able to question for clarity and validity).

Additional habits of mind that lead to a successful scientific inquiry include persistence, adaptability, and collaboration. These habits of mind enable a student to deal with common obstacles that arise during a PBL model. Persistence in researching, collecting, and analysing information, despite challenges, will ensure a broad range of information on which to base new meaning. Adaptability allows a student to deal with possible changes related to focus questions, resources, experimental conditions, or strategies. A willingness and ability to collaborate with others will enrich the inquiry process and lead to a broader and deeper understanding of new information for all involved. [Adapted from *Active Citizenship: Student Action Projects*, (2004) and *Standards for the 21st-Century Learner*, (2007), AASL.]

Inquiry Stages and Skills

Guided inquiry involves certain process skills (learned abilities), habits of mind (acquired attitudes), and responsibilities about interacting with new information. Independent thinkers will practise multiple strategies to maneuver through an inquiry process. A typical inquiry process may be considered to follow three stages: Beginning Inquiry, Ongoing Inquiry, and Concluding Inquiry, each stage associated with specific skills and corresponding to sequential phases within the Scientific Inquiry Model used in this document. Note that there may be some overlap of phases.

Beginning Inquiry Stage (Initiating and Planning):

- Use prior and background knowledge as a base to identify a topic area for new inquiry.
- Develop and refine inquiry questions.
- Plan the inquiry (SMART goals, Gantt and PERT charts).
- Find and select appropriate sources in a range of formats (e.g., textual, digital, visual, community) to pursue inquiry.

Ongoing Inquiry Stage (Performing & Recording, Analysing & Interpreting):

- Evaluate information for accuracy, validity, appropriateness, bias, relevance, point of view, and context.
- Conduct investigations into relationships among observable variables, and use tools and techniques to gather, record, and organize data.
- Analyse the data, accounting for sources of error, to develop and assess possible explanations for the results.
- Evaluate the relevance, reliability, and adequacy of data and data collection methods.
- Interpret patterns and trends in the data and relationships among the variables.
- Explain how the data support or refute the inquiry question.
- Review and revise the plan for inquiry.

Concluding Inquiry Stage (Communication and Teamwork)

- use writing, media and visual literacy, and technology skills to create a product that expresses new understandings
- use communication skills to share new understandings of a topic in a way that others can access, view, and use
- collaborate with others to exchange new ideas and develop new understandings
- recognize and discuss the environmental, economic, and societal implications of the project and recommend new avenues of experimentation
- use information and technology ethically and responsibly by documenting sources accurately, avoiding plagiarism, and respecting the rules of intellectual property

[Adapted from *Standards for the 21st-Century Learner*, (2007), AASL.]

Resource-Based Learning

Effective science teaching and learning actively involves students, teachers, and teacher librarians in the effective use of a wide range of print, non-print, and human resources. Resource-based learning fosters students' development by accommodating their diverse backgrounds, learning styles, needs, and abilities.

Resource-based learning supports students as they develop information literacy, specifically accessing, interpreting, evaluating, organizing, selecting, producing, and communicating information in and through a variety of media, technologies, and contexts. When students engage in their own research with appropriate guidance, they are more likely to take responsibility for their learning, and to retain information.

In a resource-based learning environment, students and teachers make decisions about appropriate sources of information and tools for learning, and how to access them. A resource-based approach raises the issues of selecting and evaluating information sources. Developing the critical skills needed for these tasks is essential to science.

The range of possible resources for studying environmental issues include the following:

- print — books, magazines, newspapers, documents, and other publications;
- visuals — maps, illustrations, photographs, charts, and graphs;
- artifacts — concrete objects and primary source documents;
- individual and community — interviews, field work, community sites;
- multimedia — films, audio and video tapes, television and radio, simulations;
- information technology — computer software, databases, CD-ROMs, DVDs, GPS, live-streaming broadcasts, podcasts, and data logging technologies;
- communication technology — Internet sites, blogs, e-mail, and social media.

Resource-based learning takes place in the science classroom through a variety of means. Text books, although a principal source of information for the student, are only one of many resources available. As a tertiary resource, it contains biases of its own and must be treated accordingly. Students in an agriscience class will make use of many other sources of information, including magazines, news articles, Internet websites, government publications, and local agricultural agencies. For a fully enriched learning experience, students should be encouraged to explore and engage in as many diverse sources of information as possible.

Literacy Through Science

Literacy has always been an important component of science education. In recent years, however, through the promotion of research in critical theory, the meaning of literacy has broadened to encompass all forms of communication. In today's science classrooms, learners are encouraged to examine, compose, and decode spoken, written, and visual texts to aid in their understanding of content and concepts, and to better prepare them for full and effective participation in their communities. Additionally, the goals of literacy include not only language development but also critical engagement with text, visuals, and auditory information. These goals have implications for the role of the science teacher.

The ability to read is critical for success in school. Therefore, it is vital that science teachers develop and use strategies that specifically promote students' abilities to read, comprehend, and compose text, no matter what form that text might take. Similarly, writing as a process should be stressed as a means that allows students to communicate effectively what they have learned and to raise the questions they need to ask.

Critical literacy in science addresses several goals. Through the implementation of various strategies, teachers will facilitate development of students' awareness of stereotyping, cultural bias, author's intent, hidden agendas, silent voices, and omissions. Students are encouraged to be aware that authors construct texts with specific purposes in mind. Further, critical literacy helps students comprehend texts at a deeper level by encouraging them to view content and ideas from a variety of perspectives and to interpret the various levels of meaning in a given text, both explicit and implicit.

In this regard, the level and focus of questioning becomes very important. The depth of a student's response will often be determined by the depth of questioning and inquiry. Teachers need to pose high-level, open-ended questions that allow students to use their prior knowledge and experiences, providing opportunity for a sustained engagement before, during, and after reading or viewing text.

Strategies that promote literacy through science include helping students comprehend the meaning of words, symbols, pictures, diagrams, and graphs in a variety of ways. It means engaging students in many learning opportunities which are designed to challenge and enhance their communication in a variety of modes, such as writing, debating, persuading, and explaining, and in a variety of media, such as the artistic and technological. In the science classroom, all literacy strands — reading, writing, speaking, listening, viewing, and representing — are significant.

In the context of agriscience, literacy also addresses the promotion of education for sustainable development (ESD). Literacy for ESD involves understanding ecological, economic, and social perspectives on agricultural issues, learning how to investigate current issues, and participating creatively and critically in community problem solving and decision making.

Integration of Technology in Science

Technology, including communication and information technology (CIT), plays a major role in science learning and teaching. Computers and related technologies are valuable classroom tools for acquiring, analysing, and presenting information. These technologies provide further opportunity for communication and collaboration and allow students to become more active participants in research and learning.

CIT and related technologies (digital video and digital cameras, scanners, CD-ROMs, word-processing software, graphics software, video-editing software, data logging equipment, HTML editors, and the Internet — including the World Wide Web, databases, electronic discussions, e-mail, and audio and video conferencing) afford numerous possibilities for enhancing learning. Computers and other technologies are intended to enhance science learning. In that context, technological resources can provide a variety of opportunities.

- The Internet and DVDs give teachers and students quick and easy access to extensive and current information. Information acquisition skills are key to efficient use of these resources. Questions of validity, accuracy, bias, and interpretation must still be applied to information available on the Internet and on DVDs.

- Interactions and conversations via e-mail, video and audio conferencing, student-created websites, on-line discussion groups, and other social media provide connections between students and people from their communities and around the world. This exposure to first-hand information will enable students to directly employ inquiry skills.

- Students present what they have learned in a wide variety of forms (e.g., graphs, maps, text, graphic organizers, websites, multimedia presentations) that fit their learning styles. These presentations can be shared with others, both in their classroom and beyond.

- Students are actively involved in their learning through controlling information gathering, processing, and presentation. For example, data logging technologies and Geographic Information Systems (GIS) software enables students to collect data about a community or region, plot the data using Global Positioning Systems (GPS), and analyse and present their findings by creating maps and graphs that demonstrate their learning.

Technology can open up a means of exploring up-to-date statistics, current agricultural or human issues, real-time events, and other on-line information while enabling communication with other jurisdictions in the country and around the world. Technology can also provide students with a means for communicating new learning and sharing of ideas and research with classmates and teachers through the use of various presentation tools. Diverse learning styles and abilities are found in every classroom and technology enables a myriad of approaches to the study of issues within a global context.

Science for EAL Learners

The Prince Edward Island science curriculum is committed to the principle that learners of English as an additional language (EAL) should be full participants in all aspects of science education. English deficiencies and cultural differences must not be barriers to full participation. All students should study a comprehensive science curriculum with high-quality instruction and co-ordinated assessment.

To this end,

- schools should provide EAL learners with support in their dominant language and English language while learning science;
- teachers, counsellors, and other professionals should consider the English-language proficiency level of EAL learners as well as their prior course work in science;
- the science proficiency level of EAL learners should be solely based on their prior academic record and not on other factors;
- science teaching, curriculum, and assessment strategies should be based on best practices and build on the prior knowledge and experiences of students and on their cultural heritage;
- the importance of science and the nature of the science program should be communicated with appropriate language support to both students and parents;
- to verify that barriers have been removed, educators should monitor enrolment and achievement data to determine whether EAL learners have gained access to, and are succeeding in, science courses.

Meeting the Needs of All Learners

The Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equitable opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of, and make adaptations to accommodate, the diverse range of learners in their classes. To adapt instructional strategies, assessment practices, and learning resources to the needs of all learners, teachers must create opportunities that will permit them to address their various learning styles.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching; they must also actively address cultural and gender stereotyping (e.g., about who is interested in and who can succeed in science and mathematics). Research supports the position that when science curriculum is made personally meaningful and socially and culturally relevant, it is more engaging for groups traditionally underrepresented in science, and indeed, for all students.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates.

Teachers should provide materials and strategies that accommodate student diversity and should validate students when they achieve the outcomes to the best of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equitable opportunities to experience success as they work toward achieving designated outcomes. Teachers should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Assessment and Evaluation

The terms **assessment** and **evaluation** are often used interchangeably, but they refer to quite different processes. Science curriculum documents provincially use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning. According to research, assessment has three interrelated purposes:

- assessment *for* learning to guide and inform instruction
- assessment *as* learning to involve students in self-assessment and setting of goals for their own learning
- assessment *of* learning to make judgments about student performance in relation to curriculum outcomes

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible and of the criteria by which their work will be assessed and evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

Provincial science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When assessing student progress, it is helpful to know some activities/skills/actions that are associated with each process of science learning. Student learning may be described in terms of ability to perform these tasks.

Assessment Techniques

Assessment techniques should match the style of learning and instruction employed. Several options are suggested in this curriculum guide from which teachers may choose, depending on the curriculum outcomes, class, and school/district policies. It is important that students know the purpose of an assessment, the method used, and the marking scheme being used. In order that assessment support learning, the results, when reported to students, should indicate the improvements expected.

Assessment Techniques *Continued...*

Observation (formal or informal)

This technique provides a way of gathering information fairly quickly while a lesson is in progress. When used formally, the student(s) would be made aware of the observation and the criteria being assessed. Informally, it could be a frequent, but brief, check on a given criterion. Observation may offer information about the student's participation level, use of a piece of equipment, or application of a given process. The results may be recorded in the form of checklists, rating scales, or brief written notes. It is important to plan in order that specific criteria are identified, suitable recording forms are ready, and all students are observed in a reasonable period of time.

Performance

This curriculum encourages learning through active participation. Many of the curriculum outcomes found in the guide promote skills and their application. There is a balance between scientific processes and content. In order that students appreciate the importance of skill development, it is important that assessment provide feedback on their various skills (e.g., how to use a piece of equipment; apply an experimental technique; interpret and follow instructions; research, organize, and present information). Assessing performance is most often achieved through observing the process.

Journal

Journals provide an opportunity for students to express thoughts and ideas in a reflective way. By recording feelings, perceptions of success, and responses to new concepts, a student may be helped to identify his or her most effective learning style. Knowing how to learn in an effective way is powerful information. Journal entries also give indicators of developing attitudes toward science concepts, processes, and skills, and application of these in the context of society. Self-assessment, through a journal, permits a student to consider strengths and weaknesses, attitudes, interests, and new ideas. Developing patterns may help in career decisions and choices of further study.

Interview

This curriculum promotes understanding and application of scientific concepts. Interviewing a student allows the teacher to confirm that learning has taken place beyond simple factual recall. Discussion allows a student to display an ability to use information and clarify understanding. Interviews may be brief discussions between teacher and student, or they may be more extensive and include student, parent, and teacher. Such conferences allow a student to be pro-active in displaying understanding. It is helpful for students to know which criteria will be used to assess formal interviews. The assessment technique provides an opportunity for students whose verbal presentation skills are stronger than their written skills to demonstrate their learning.

Assessment Techniques *Continued...*

Paper and Pencil (assignment or test)

These techniques can be formative or summative. Several curriculum outcomes call for displaying ideas, data, conclusions, and the results of practical or literature research. These can be in written form for display or for direct teacher assessment. Whether an activity is a part of learning or a final statement, students should know the expectations for the exercise and the rubric by which it will be assessed. Written assignments and tests can be used to assess knowledge, understanding, and application of concepts. They are less successful in assessing skills, processes, and attitudes. The purpose of the assessment should determine what form of paper and pencil exercise is used.

Presentation

The curriculum includes outcomes that require students to analyse and interpret information; to identify relationships between science, technology, society, and environment; to be able to work in teams; and to communicate information. Although the process can be time consuming, these activities are best displayed and assessed through presentations. These can be given orally, in written/pictorial form, by project summary (science fair), or by using electronic systems such as video or computer software. Whatever the level of complexity or format used, it is important to consider the curriculum outcomes as a guide to assessing the presentation. The outcomes indicate the process, concepts, and context for which and about which a presentation is made.

Portfolio

Portfolios offer another option for assessing student progress in meeting curriculum outcomes over a more extended period of time. This form of assessment allows the student to be central in the process. Decisions about the portfolio and its contents can be made by the student. What is placed in the portfolio, the criteria for selection, how the portfolio is used, how and where it is stored, and how it is evaluated are some of the questions to consider when planning to collect and display student work in this way. The portfolio should provide a long-term record of growth in learning and skills. This record of growth is important for individual reflection and self-assessment, but it is also important to share with others. For many students, it is exciting to review a portfolio and see the record of development over time.

Evaluation

Evaluation is a continuous, comprehensive, and systematic process. It brings interpretation, judgments, and decisions to the data collected during the assessment phase. Questions include the following: How valid and reliable is the data gathered? What does the data suggest about student achievement of course outcomes? Does student performance confirm the success of instructional practice or indicate the need to change it? Are students ready to move on to the next phase of the course, or is there need for remediation?

Teacher-developed assessments and the evaluations based on them have a variety of uses, including:

- providing feedback to improve student learning;
- determining whether curriculum outcomes have been achieved;
- certifying that students have achieved certain levels of performance;
- setting goals for future student learning;
- communicating with parents about their children's learning;
- providing information to teachers on the effectiveness of their teaching, the program, and the learning environment;
- meeting the goals of guidance and administrative personnel.

Evaluation is conducted within the context of the outcomes, which should be clearly understood by learners before teaching and evaluation take place. Students must understand what teachers expect of them and the basis on which they will be evaluated. The evaluation of a student's progress may be classified as pre-instructional, formative, or summative, depending on the purpose.

Pre-instructional evaluation is conducted before the introduction of unfamiliar subject matter or when learners are experiencing difficulty. It gives an indication of *where students are* and is not a measure of what they are capable of doing. The purpose is to analyse a student's progress to date in order to determine the type and depth of instruction needed. This type of evaluation is mostly conducted informally and continuously.

Formative evaluation is conducted throughout instruction. Its primary purpose is to improve instruction and learning. It is an indication of *how things are going*. It identifies a student's strengths or weaknesses with respect to specific curriculum outcomes so necessary adaptations can be made.

Summative evaluation occurs at the end of a designated period of learning. It is used, along with data collected during the formative stage, to determine learner achievement. This evaluation is used to report the degree to which curriculum outcomes have been achieved.

Planning, Assessing, Reporting, and Weighting in AGS801A/ AGS621A

Agriscience 801A/621A requires thoughtful and careful planning at the outset of the course. Due to its investigative component, teachers are advised to plan carefully in advance to ensure that appropriate inquiry skills are integrated into the daily learning activities and that students are fully aware of expectations.

Students' research projects may be based on the same agricultural issue or they may differ completely. Guided instruction and modelling are critical to the inquiry process. Students will need to fully understand at the beginning of the course what will be expected of them as well as how they will be assessed throughout the duration of the course. Ideally, by giving students the necessary process tools up front, many of them will be able to self-direct their learning as the course proceeds. This will allow the teacher to act as a process facilitator for some students while freeing up time to offer more direct assistance to others.

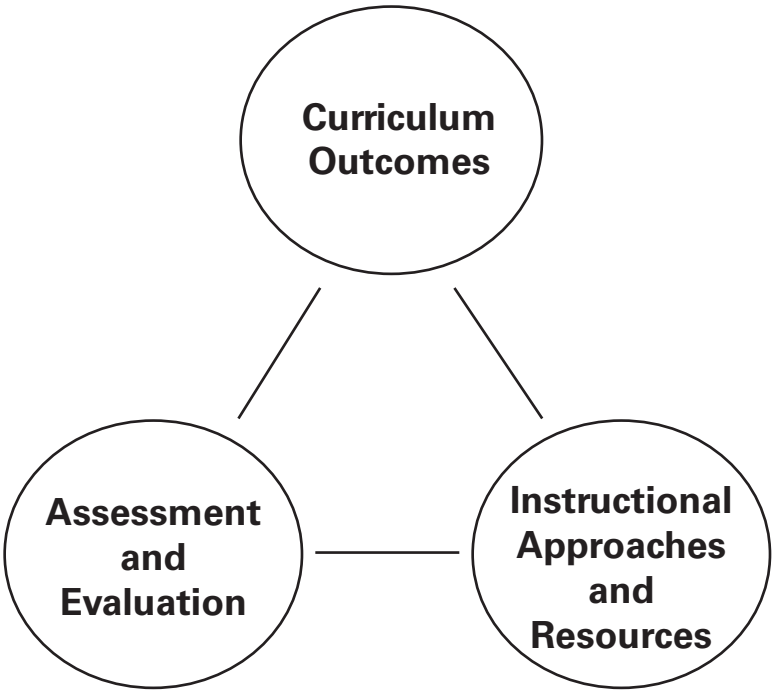
Assessment of learning in AGS801A/AGS621A should occur throughout the course. Assessment tools, criteria, and timelines (deadlines) should be established in advance to facilitate ongoing and informative assessment and feedback to students. Summative assessment may take place when an end-product is complete; however, teachers should consider the time and effort involved in all stages of a project to ensure that the end-product does not form the entire assessment.

Reporting methods and weighting of assessments should be determined before the course is underway so that students are aware of expectations. Some schools may have specific policies regarding weighting of major assessment pieces. AGS801A/AGS621A is easily adaptable to a variety of assessment weightings. It is important to note that this course emphasizes the inquiry process involved in investigation within an agricultural context. While specific content knowledge is important, the higher goal is in learning how information creates meaning.

Assessing and Evaluating Student Learning in the Science Classroom

There should be a congruence between what is taught, how it is taught, and what is emphasized in the evaluation process. Science educators should recognize that "...quality programming and instruction are neither content-based nor process-based, but a wise and judicious mixture of both" (Frost, 1989, p.11).

The assessment of student learning must be aligned with the curriculum outcomes and the types of learning opportunities made available to students. A "backward design" approach can help in determining the most effective way of measuring a student's level of learning. An essential question that often helps to focus on this goal is, "What evidence will I have that shows me that the student has achieved the outcome?" Once the evidence or criteria (assessment tool) has been established, teachers can plan effective instructional approaches and gather supporting resources that will help students to reach this goal.



(Adapted from *The Evaluation of Students in the Classroom: A Handbook and Policy Guide*, Department of Education, Government of Newfoundland and Labrador, 1990)

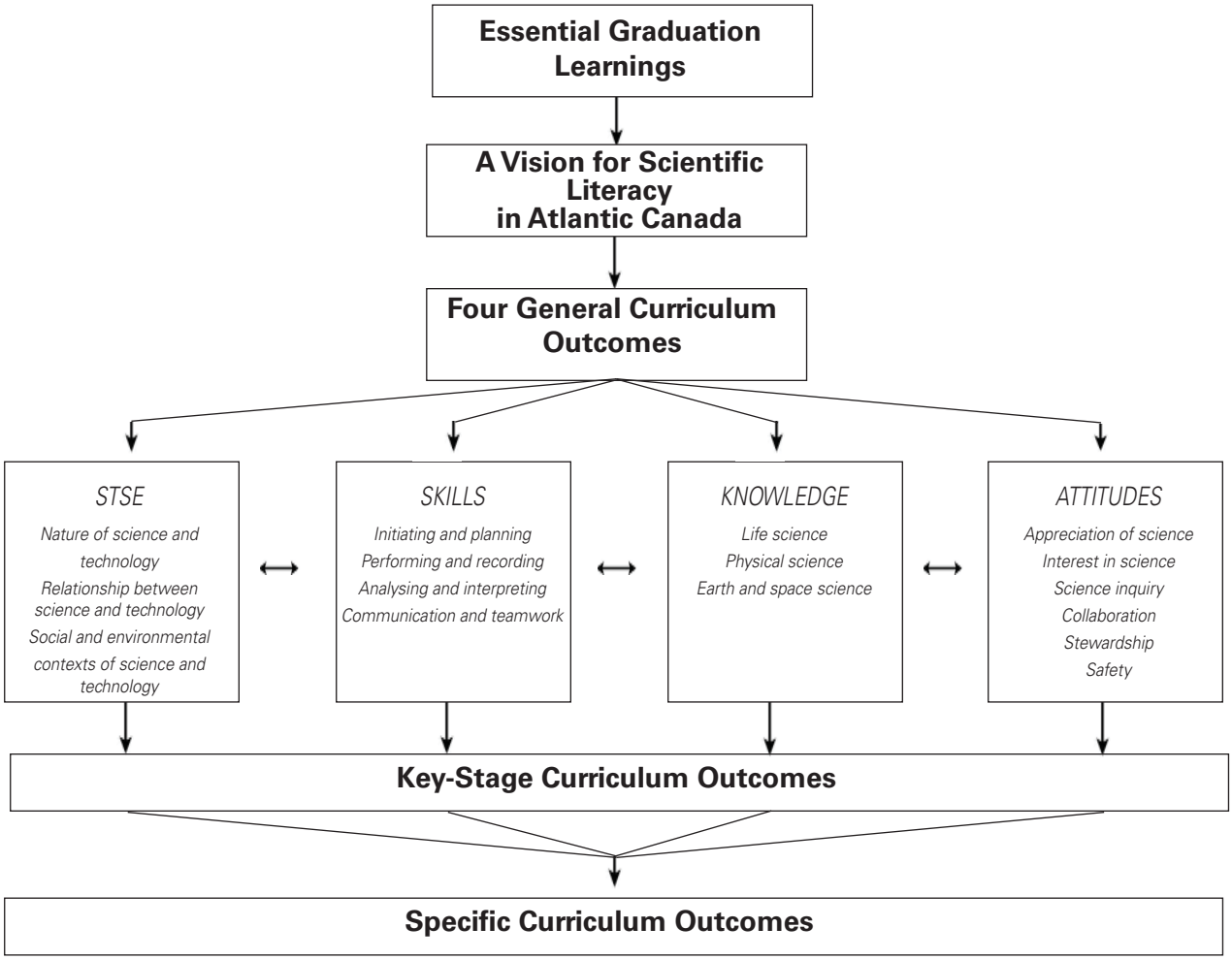
Curriculum Outcomes Framework

Overview

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general and key-stage curriculum outcomes reflect the Pan-Canadian C*ommon Framework of Science Learning Outcomes K to 12*. The specific curriculum outcomes are prescribed outcomes specially written for the Prince Edward Island agriscience curriculum. The diagram below provides the blueprint of the outcomes framework.

Outcomes Framework

FIGURE 1



Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. The essential graduation learnings are the following:

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Science, Technology, Society, and the Environment (STSE)

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of Grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K to 12*.

Specific Curriculum Outcomes

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in units for each grade level.

Attitude Outcomes

It is expected that the Prince Edward Island science program will foster certain attitudes in students throughout their school years. The STSE, skills, and knowledge outcomes contribute to the development of attitudes, and opportunities for fostering these attitudes are highlighted in the Elaborations — Strategies for Learning and Teaching sections of each unit.

Attitudes refer to generalized aspects of behaviour that teachers model for students by example and by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what students learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcome statements for attitudes are written as key-stage curriculum outcomes for the end of Grades 3, 6, 9, and 12. These outcome statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the Pan-Canadian *Common Framework of Science Learning Outcomes K to 12* for the end of Grade 12.

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

By the end of Grade 12, it is expected that students will be encouraged to

Appreciation of Science	Interest in Science	Scientific Inquiry
436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not **437** appreciate that the applications of science and technology can raise ethical dilemmas **438** value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds *Evident when students, for example,* • consider the social and cultural contexts in which a theory developed • use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on STSE issues • recognize the usefulness of being skilled in mathematics and problem solving • recognize how scientific problem solving and the development of new technologies are related • recognize the contribution of science and technology to the progress of civilizations • carefully research and openly discuss ethical dilemmas associated with the applications of science and technology • show support for the development of information technologies and science as they relate to human needs • recognize that Western approaches to science are not the only ways of viewing the universe • consider the research of both men and women	**439** show a continuing and more informed curiosity and interest in science and science-related issues **440** acquire, with interest and confidence, additional science knowledge and skills using a variety of resources and methods, including formal research **441** consider further studies and careers in science- and technology-related fields *Evident when students, for example,* • conduct research to answer their own questions • recognize that part-time jobs require science- and technology-related knowledge and skills • maintain interest in or pursue further studies in science • recognize the importance of making connections between various science disciplines • explore and use a variety of methods and resources to increase their own knowledge and skills • are interested in science and technology topics not directly related to their formal studies • explore where further science- and technology-related studies can be pursued • are critical and constructive when considering new theories and techniques • use scientific vocabulary and principles in everyday discussions • readily investigate STSE issues	**442** confidently evaluate evidence and consider alternative perspectives, ideas, and explanations **443** use factual information and rational explanations when analysing and evaluating **444** value the processes for drawing conclusions *Evident when students, for example,* • insist on evidence before accepting a new idea or explanation • ask questions and conduct research to confirm and extend their understanding • criticize arguments based on the faulty, incomplete, or misleading use of numbers • recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen • expend the effort and time needed to make valid inferences • critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation • critically assess their opinion of the value of science and its applications • criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist • insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged • seek new models, explanations, and theories when confronted with discrepant events or evidence

Common Framework of Science Learning Outcomes K to 12

Attitude Outcome Statements *(continued)*

By the end of Grade 12, it is expected that students will be encouraged to

Collaboration	Stewardship	Safety in Science
445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas *Evident when students, for example,* • willingly work with any classmate or group of individuals regardless of their age, gender, or physical and cultural characteristics • assume a variety of roles within a group, as required • accept responsibility for any task that helps the group complete an activity • give the same attention and energy to the group's product as they would to a personal assignment • are attentive when others speak • are capable of suspending personal views when evaluating suggestions made by a group • seek the points of view of others and consider diverse perspectives • accept constructive criticism when sharing their ideas or points of view • criticize the ideas of their peers without criticizing the persons • evaluate the ideas of others objectively • encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making • contribute to peaceful conflict resolution • encourage the use of a variety of communication strategies during group work • share the responsibility for errors made or difficulties encountered by the group	**446** have a sense of personal and shared responsibility for maintaining a sustainable environment **447** project the personal, social, and environmental consequences of proposed action **448** want to take action for maintaining a sustainable environment *Evident when students, for example,* • willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation • assume part of the collective responsibility for the impact of humans on the environment • participate in civic activities related to the preservation and judicious use of the environment and its resources • encourage their peers or members of their community to participate in a project related to sustainability • consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors • participate in social and political systems that influence environmental policy in their community • examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans • willingly promote actions that are not injurious to the environment • make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations • are critical-minded regarding the short- and long-term consequences of sustainability	**449** show concern for safety and accept the need for rules and regulations **450** be aware of the direct and indirect consequences of their actions *Evident when students, for example,* • read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood • criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment • consider safety a positive limiting factor in scientific and technological endeavours • carefully manipulate materials, cognizant of the risks and potential consequences of their actions • write into a laboratory procedure safety and waste-disposal concerns • evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms • use safety and waste disposal as criteria for evaluating an experiment • assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place • seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions • keep the work station uncluttered, with only appropriate lab materials present

Curriculum Guide Organization

Specific curriculum outcomes are organized in units for each grade level. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes. Suggested times for each unit are also provided. Although Agriscience 801A/621A is 110 hours (~90 classes) in duration, the cumulative topic instructional time allocated is 90 hours (~74 classes). The remaining 20 hours allows for summative assessment considerations.

The order in which the units of a course appear in the guide is meant to suggest a sequence. In some cases, the rationale for the recommended sequence is related to the conceptual flow across the semester. That is, one unit may introduce a concept that is then extended in a subsequent unit. Likewise, one unit may focus on a skill or context that will be built upon later in the semester.

Some units or certain aspects of units may also be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. The intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful and socially, culturally, and economically relevant contexts.

Unit Organization

Each unit begins with a two-page synopsis. On the first page, introductory paragraphs provide a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, and/or decision making) and possible contexts for the unit. Finally, a curriculum links paragraph specifies how this unit relates to science concepts and skills addressed in other grades so teachers will understand how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the Prince Edward Island prescribed specific curriculum outcomes that the unit will address. The numbering system indicates the unit and the outcome number. These code numbers appear before each specific curriculum outcome (SCO). Each outcome that students are expected to complete relates directly to one or more of the four general curriculum outcome categories: Science-Technology-Society-Environment (STSE) outcomes, Skills outcomes, Knowledge outcomes, Attitude outcomes.

The Four-Column Spread

All units have a two-page layout of four columns as illustrated below. In some cases, the four-column spread continues to the next two-page layout. Outcomes are grouped by a topic indicated at the top of the left page.

Two-Page, Four-Column Spread

Page One		Page Two	
Topic Outcomes	Elaborations — Strategies for Learning and Teaching	Tasks for Instruction and/or Assessment	Resources/Notes
Students will be expected to Specific curriculum outcome based on the Prince Edward Island prescribed outcomes (outcome number) Specific curriculum outcome based on the Prince Edward Island prescribed outcomes (outcome number)	elaboration of outcome and strategies for learning and teaching elaboration of outcome and strategies for learning and teaching	*Informal/Formal Observation* *Performance* *Journal* *Interview* *Paper and Pencil* *Presentation* *Portfolio*	Useful Teacher Resources

Column One: Outcomes

The first column indicates the specific curriculum outcomes. These are based on the Prince Edward Island prescribed outcomes. The statements involve the Science-Technology-Society-Environment (STSE), Skills, and Knowledge outcomes indicated by the outcome number(s) that appear(s) in parentheses after the outcome. Some STSE and skills outcomes have been written in a context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column one defines what students are expected to learn and be able to do.

Column Two: Elaborations — Strategies for Learning and Teaching

The second column may include elaborations of outcomes listed in column one and describes learning environments and experiences that will support students' learning.

The strategies in this column are intended to provide a holistic approach to instruction. In some cases, they address a single outcome; in other cases, they address a group of outcomes.

Column Three: Tasks for Instruction and/or Assessment

The third column provides suggestions for ways that students' achievement of the outcomes could be assessed. These suggestions reflect a variety of assessment techniques and materials that include, but are not limited to, informal/formal observation, performance, journal, interview, paper and pencil, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Some STSE, Skills, and Knowledge outcomes that appear after the assessment item may not appear in the first column. Although these outcomes are not the key outcome(s) for this section, the assessment item provides an opportunity to address these outcomes in a different context.

Column Four: Resources/Notes

This column provides an opportunity for teachers to make note of useful resources.

Course Overview

Overview of Agriscience Unit 801A

Students will be expected to

1.1 distinguish between agriculture and agriscience

1.2 examine the historical importance of the development of agricultural resources

1.3 explain ways in which agriscience is a diversified and changing industry

1.4 demonstrate an understanding of the contribution of agriscience to the social, economic, and environmental development of Prince Edward Island

1.5 demonstrate an understanding of the diversity and interdependence within the agricultural sector of Prince Edward Island

1.6 demonstrate an awareness of the principles of food sovereignty and food security

1.7 discuss factors that affect the sustainability of an agricultural system

1.8 compile career information and job opportunities in diverse agricultural enterprises and related services

1.9 demonstrate an awareness of economic trends and issues pertaining to agriculture

Soil and Water Management Unit 801A

Students will be expected to

2.1 describe water management practices relevant to an agriculture system

2.2 identify strategies to reduce water impacts from agricultural practices

2.3 conduct an experiment to determine the presence or concentration of water pollutants

2.4 describe the origin and composition of soils in Prince Edward Island

Overview of Agriscience Unit 621A

Students will be expected to

1.1 distinguish between agriculture and agriscience

1.2 examine the historical importance of the development of agricultural resources

1.3 explain ways in which agriscience is a diversified and changing industry

1.4 analyse the environmental, social, and economic significance of agriculture and agriscience to Prince Edward Island

1.5 demonstrate an understanding of the diversity and interdependence within the agricultural sector of Prince Edward Island

1.6 demonstrate an understanding of the principles of food sovereignty and food security

1.7 debate the concept of sustainability as it relates to agriculture

1.8 research career information and job opportunities in diverse agricultural enterprises and related services

1.9 demonstrate an understanding of economic trends and issues pertaining to agriculture

Soil and Water Management Unit 621A

Students will be expected to

2.1 assess the impact of water management practices on the sustainable production of agricultural commodities

2.2 develop strategies to reduce water impacts from agricultural practices

2.3 conduct an experiment to determine the presence or concentration of water pollutants

2.4 explain the origin and composition of soils in Prince Edward Island

Soil and Water Management Unit

801A

Students will be expected to

2.5 identify the relationship amoung soil productivity and its physical and chemical properties

2.6 demonstrate an understanding of soil conservation practices

2.7 investigate several properties of soil

Plant Biology Unit

801A

Students will be expected to

3.1 use a local plant to demonstrate an understanding of the fundamental principles of taxonomy

3.2 describe and apply classification systems and nomenclatures used in the plant sciences

3.3 demonstrate an understanding of the structure and function of basic plant parts

3.4 describe the relationship of plant parts to fruits, nuts, vegetables, and crops

3.5 relate the processes of photosynthesis, respiration, and transpiration

3.6 describe the requirements for the production of a plant commodity

3.7 relate the concepts of breeding, propagation, and selection to production practices

3.8 demonstrate an understanding of Mendelian genetics and predict the outcome of various genetic crosses

Soil and Water Management Unit

621A

Students will be expected to

2.5 describe how soil composition and fertility can be altered and how these changes could affect an ecosystem

2.6 demonstrate an understanding of soil conservation practices

2.7 design a soil experiment and identify specific variables

Plant Biology Unit

621A

Students will be expected to

3.1 demonstrate an understanding of the fundamental principles of taxonomy

3.2 create a dichotomous key to identify species of plants

3.3 demonstrate an understanding of the structure and function of basic plant parts

3.4 describe the relationship of plant parts to fruits, nuts, vegetables, and crops

3.5 relate the processes of photosynthesis, respiration, and transpiration

3.6 assess how air, water, light, media, and nutrients affect plant growth

3.7 relate the concepts of breeding, propagation, and selection to production practices

3.8 demonstrate an understanding of Mendelian genetics and predict the outcome of various genetic crosses

Crop Production Unit

801A

Students will be expected to

4.1 demonstrate an understanding of the importance of the crop production industry to Prince Edward Island and Canada

4.2 describe production techniques for a variety of vegetable commodities

4.3 describe applications of science and technology in addressing specific plant production needs

4.4 discuss trends and challenges to the industry

4.5a create a crop production report and presentation

OR

4.5b investigate a selected crop production issue using a guided inquiry process

Green Spacing Unit

801A

Students will be expected to

5.1 identify environmental factors in the successful selection of plants for a garden on Prince Edward Island

5.2 create a plot plan for a local fruit and vegetable garden

5.3 work collaboratively to create a green space within their school or community

Crop Production Unit

621A

Students will be expected to

4.1 demonstrate an understanding of the importance of the crop production industry to Prince Edward Island and Canada

4.2 describe production techniques for a variety of vegetable commodities

4.3 analyse the role of technology in the production, processing, transportation, and marketing of agricultural products

4.4 investigate a selected crop production issue using a guided inquiry process

Green Spacing Unit

621A

Students will be expected to

5.1 identify environmental factors in the successful selection of plants for a garden on Prince Edward Island

5.2 create a plot plan for a local fruit and vegetable garden

5.3 work collaboratively to create a green space within their school or community

Agriscience
801A

Overview of Agriscience

Introduction

The opening unit of the Agriscience 801A course provides an introduction to the concepts and terminology associated with the study of agriscience. While students may have an awareness of some agricultural issues and a keen interest in examining current world problems, it is important for them to recognize the fundamental ideas and concepts that constitute an issue at various levels. The "Overview of Agriscience" unit requires students to examine the economic, social, and environmental aspects of issues at a local, Canadian, or global scale and the key role that perspective plays in analysing complex problems. Students will also practise skills that may have been introduced in earlier grade levels such as differentiating between opinion and fact, detecting bias, and validating sources of information. These are necessary skills to practise in any critical analysis of agriscience issues.

Focus and Context

This introductory unit emphasizes scientific inquiry as students will begin to ask questions about agriscience issues pertaining to food security, sustainability, and economics at a local and global scale. They will also begin to explore problem solving and decision making through the use of critical thinking skills and considering different perspectives.

Science Curriculum Links

The issue of sustainability builds upon information that students have studied earlier in the science curriculum. A unit on sustainability of ecosystems in Science 421A/431A presents the Earth as a closed system, which means sustainable use of resources becomes a major concern. A discussion of ways in which natural populations are kept in equilibrium in relation to the availability of food resources occurs in Biology 521A and Environmental Science 621A. Previous to this, elementary students learned how humans and other living things depend on their environment.

801A Curriculum Outcomes

Students will be expected to

1.1 distinguish between agriculture and agriscience

1.2 examine the historical importance of the development of agricultural resources

1.3 explain ways in which agriscience is a diversified and changing industry

1.4 demonstrate an understanding of the contribution of agriscience to the social, economic, and environmental development of Prince Edward Island

1.5 demonstrate an understanding of the diversity and interdependence within the agricultural sector of Prince Edward Island

1.6 demonstrate an awareness of the principles of food sovereignty and food security

1.7 discuss factors that affect the sustainability of an agricultural system

1.8 compile career information and job opportunities of diverse agricultural enterprises and related services

1.9 demonstrate an awareness of economic trends and issues pertaining to agriculture

Introduction

Outcomes	Elaborations - Suggestions for Learning and Teaching
Students will be expected to	Agriscience is the application of scientific principles and new technologies to agriculture. To distinguish between agriculture and agriscience, students should be able to define each and be able to identify the major divisions and sciences related to agriscience.
1.1 distinguish between agriculture and agriscience	
1.2 examine the historical importance of the development of agricultural resources	Students should examine how agriculture has played a key role in the development of human civilization. Agricultural practices such as the domestication of animals and the cultivation of crops allowed human beings to move beyond hunter-gatherer societies. When farmers became capable of producing food beyond the needs of their own families, others in their society were freed to devote themselves to projects other than food acquisition. However, students should also understand that subsistence agriculture in which farmers focus on growing enough food to feed their families is still commonplace in many developing parts of the world. The book or video *Guns, Germs, and Steel* has a very good introduction of how agriscience has affected our world.
1.3 explain ways in which agriscience is a diversified and changing industry	Improvements in technology have had a huge impact on local and global agricultural practices. Teachers should lead the class in a discussion on how agriscience and emerging technologies (e.g., plow, reaper, tractor, barbed wire, milking machine, biotechnology and the Green Revolution) impacted how we produce food over the years.
1.4 demonstrate an understanding of the contribution of agriscience to the social, economic, and environmental development of Prince Edward Island	Teachers should discuss with students how agriculture in Prince Edward Island and Canada has evolved from subsistence agriculture to commercial agriculture and the impact that this has had on our society, economy, and environment. In 1931, more than 30 per cent of the people in this country lived on farms. That number has whittled to approximately 3 per cent nationally (4.5 per cent on Prince Edward Island). They should discuss if this move "off the farm" has lead Canadians and Islanders to lose touch with the value of food and how it is produced. Students should understand that people in many nations spend more than half of their income on food. Canadians, on the other hand, spend on average about 10% of our yearly wages on food. This can be partly attributed to government policy and corporate control that affect food market prices. This can also be attributed to the contributions of agriscience that have found ways to stimulate growth and production of animals and plants and to reduce losses from disease, insects, and parasites.

Introduction

Tasks for Instruction and/or Assessment

Journal

- How important do you think the agriculture sector is to people on Prince Edward Island? How important is it to you? (1.3)
- If your family had to spend more than half of its income on food, how would it affect your life? (1.4)

Paper and Pencil

- Compare Food Freedom Day in Canada to that of other developed and developing countries. (1.4)
- What is the difference between agriculture and agriscience? (1.1)
- Identify examples of agriscience in the world around you. (1.1)

Presentation

- Speak with a local farmer about how technology has changed agriculture operations (e.g., acreage, types of crops, production, yield) over the years. Present your findings to the class. (1.3)

Performance

- Create a timeline of the development of agriculture from early hunter-gatherer societies to today. (1.2)

Resources/Notes

The Real Dirt on Farming II

All About Food, Agri-Food Facts

Video and book: *Guns, Germs, and Steel* by Jared Diamond

Internet: The History of Agriculture
http://www.xtimeline.com/timeline/History-of-agriculture-1

Appendix A: Glossary of Terms

Appendix B: Agriculture Time Line

Introduction (continued...)

Outcomes

Students will be expected to

1.4 demonstrate an understanding of the contribution of agriscience to the social, economic, and environmental development of Prince Edward Island (continued...)

1.5 demonstrate an understanding of the diversity and interdependence within the agricultural sector of Prince Edward Island

Elaborations - Suggestions for Learning and Teaching

Teachers are recommended to download information from the Prince Edward Island Department of Agriculture or the Prince Edward Island Agriculture Sector Council which maintain current data on the level of agriculture on Prince Edward Island. Students should discuss the impact of the agriculture industry on Prince Edward Island from economic, social, and environmental perspectives. To do so, they should research factors such as the current levels of employment, impacts on the economy, number of active farms, primary products and by-products, and the impact of increased agricultural production on the environment.

Students should also be aware of the challenges and successes that Prince Edward Island farmers have had regarding finding new markets and growing new crops to help meet the world's food needs. Students should also understand that farmers seldom work in isolation and provide examples of interdependence within the agricultural sector (e.g., crop and livestock producers' interdependence, crop rotations, vertical integration, biotechnology sector).

Introduction (continued...)

Tasks for Instruction and/or Assessment

Journal

- Create a list of commodities that you think could be successfully marketed on Prince Edward Island. (1.5)
- Comment on the following statement: "All they grow on PEI is potatoes". (1.4, 1.5)

Paper and Pencil

- Explain why farmers grow different crops. (1.5)
- Provide some examples of how farmers work with other farmers. (1.5)
- How important is the agriculture sector to the Prince Edward Island economy? (1.4)
- Create a list of different commodities grown on Island farms. Compare your list with other members of the class and discuss the diversity of the Island agriculture sector. (1.5)

Performance

- Work collaboratively to research the impact of the agriculture industry on Prince Edward Island from economic, social, and environmental perspectives. Include the current levels of employment, impacts on the economy, number of active farms, primary products and by-products, and the impact of increased agricultural production on the environment. (1.4)

Resources/Notes

Internet: Prince Edward Island Department of Agriculture
http://www.gov.pe.ca/agriculture/

Internet: Prince Edward Island Agriculture Sector Council
http://www.peiagsc.ca/

Appendix C: Maritime Agriculture - A Brief History

World Issues

Outcomes

Students will be expected to

1.6 demonstrate an awareness of the principles of food sovereignty and food security

Elaborations - Suggestions for Learning and Teaching

To understand the significance of international interdependence as it relates to agricultural sustainability and to assess the impact of agriculture on global development and international relations, students should discuss food sovereignty and food security.

Food sovereignty is the claimed "right" of people to define their own food, agriculture, livestock and fisheries systems, in contrast to having food largely subject to international market forces. "Food sovereignty is the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems." - Nyéléni 2007: Forum for Food Sovereignty.

Food sovereignty holds it to be true that communities should be able to define their own means of production and that food is a basic human right. Many communities calling for food sovereignty are protesting the imposition of Western technologies on to their indigenous systems and agencies. Those who hold a "food sovereignty" position advocate banning the production of most cash crops in developing nations, thereby leaving the local farmers to concentrate on subsistence agriculture. Teachers should provide examples of how political/corporate decisions (e.g., company decisions to change banana distribution from a Pacific port to an Atlantic port in Panama, and moving pineapple production from Hawaii to the Philippines) affect global economies and developing nations. The video *Food Inc.* provides an overview of the food industry in North America.

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." - UN's Food and Agriculture Organization (FAO). A Prince Edward Island context to food security could be to explore its food distribution system and how much we depend on uninterrupted food supply to the Island. Students should also be aware of issues of undernutrition and the use of Food Banks on Prince Edward Island.

The core of the Food Justice movement is the belief that what is lacking is not food, but the political will to fairly distribute food regardless of the recipient's ability to pay. It notes that globally enough food is produced to feed the entire world population at a level adequate to ensure that everyone can be free of hunger and fear of starvation. That no one should live without enough food because of economic constraints or social inequalities is the basic goal.

World Issues

Tasks for Instruction and/or Assessment

Journal

- In your own words, explain what is meant by food sovereignty and food security. (1.6)

Paper and Pencil

- What would happen if the Confederation Bridge was closed due to a natural disaster? How would we eat? (1.6)
- Provide examples of how political/corporate decisions have affected global economies and developing nations. (1.6)
- Is food security an issue on Prince Edward Island? Explain your answer taking various perspectives into account. (1.6)

Performance

- As a class, debate the following resolution: Canada should close its borders to imports and prepare to grow all of its own food. (1.6)
- Enough food is produced to feed the entire world population at a level adequate to ensure that everyone can be free of hunger and fear of starvation. As a class, discuss how we could fairly distribute food to Islanders who can't afford to pay for it. (1.6)

Resources/Notes

Internet: The Canadian Federation of Agriculture
http://www.cfa-fca.ca/

Internet: Canada's Action Plan for Food Security
http://www.agr.gc.ca/index_e.php?s1=misb&s2=fsec-seca&page=action

Video: *Food Inc.*

World Issues (continued...)

Outcomes

Students will be expected to

1.6 demonstrate an awareness of the principles of food sovereignty and food security (continued...)

Elaborations - Suggestions for Learning and Teaching

To illustrate the vast inequalities in the distribution of food resources and wealth, have the students play the "Who Are the Lucky Ones?" simulation (see Appendix). This activity should allow students to compare the developed and developing nations in relation to agriscience and the surrounding issues. The Farmers Helping Farmers Global Classroom Initiative (see Appendix) is another excellent resource to raise awareness of agriculture issues in developed and developing nations.

To further students' understanding of international interdependence, teachers should discuss the implication of international agreements (NAFTA) on agricultural practices (e.g., government subsidies, quotas, marketing boards). Teachers should also provide examples of how corporate/government decisions affect global economies and developing nations. How do these factors affect a nation's food security or food sovereignty?

Having focused on the fact that agricultural practices cannot remain isolated at the local/provincial levels, discuss with students some recognizable links that tie Prince Edward Island to the global front. Use examples such as:

- international marketing in which Prince Edward Island is a player (e.g., seed potatoes, mussels, tuna, oysters, blueberries)
- the many information technology and biotechnology businesses based on Prince Edward Island that serve the global community
- aid programs in developing countries that are Prince Edward Island initiatives (e.g., Farmers Helping Farmers)

World Issues (continued...)

Tasks for Instruction and/or Assessment

Journal

- What do you think should be done to prevent and resolve a world food crisis? (1.6)

Paper and Pencil

- What are some examples of Prince Edward Island agricultural groups or products that work or are sold outside of Canada? (1.6)
- Prepare a comparison chart between Kenyan farming life and Prince Edward Island farming life. (1.6)

Resources/Notes

Video: *Food Inc.*

Internet: Mikinduri Children of Hope
http://mikinduri.com/

Appendix D: World - A Community of 1000

Appendix E: Who Are the Lucky Ones?

Appendix F: Farmers Helping Farmers Global Classroom Initiative

World Issues (continued...)

Outcomes

Students will be expected to

1.7 discuss factors that affect the sustainability of an agricultural system

Elaborations - Suggestions for Learning and Teaching

Farmers rely on the land to grow the crops and animals of their businesses. The key factors that affect sustainability of an agriculture system deal with the relationship between organisms and their environment. Plants, animals, insects, soil, water, and air must be kept in reasonable balance or all will suffer. Teachers should define stewardship and sustainability and have the students discuss how these terms relate to agricultural practices and agriscience.

Teachers should use the Internet to model and identify some significant world population trends. During the past 50 years, food production worldwide has increased at a rate that is greater than the increase in population. Students should be asked if they believe that this growth in food production is sustainable. They should understand that as the Earth's population continues to grow exponentially, the demands on our agricultural systems will also continue to grow.

Population growth, coupled with increased urbanization, can lead to a greater loss of agricultural land and a movement of the workforce from rural to urban centres. This will further stress the farm environments used to feed the world's population. Students should identify and discuss how these factors (e.g., population growth, urbanization, economic activity, soil depletion, loss of agricultural land) affect agricultural sustainability and how it may affect it in the future. They should also discuss how agriscience can mitigate these factors. An examination of land ownership legislation, programs (e.g., Alternate Land Use Services, ALUS), and zoning issues on Prince Edward Island could be reviewed as a case study or class debate.

World Issues (continued...)

Tasks for Instruction and/or Assessment

Journal

- Do you think that the environment can sustain our current farming practices? Why or why not? (1.7)

Paper and Pencil

- What factors affect the sustainability of an agricultural system? (1.7)
- How do the terms stewardship and sustainability relate to agriculture practices on Prince Edward Island? (1.7)
- Identify current agricultural practices on Prince Edward Island that are sustainable and others that are not. (1.7)
- How will factors such as population growth, urbanization, soil depletion, and loss of agricultural land affect the sustainability of our agriculture sector? (1.7)

Resources/Notes

Internet: World Population Trends
http://www.breathingearth.net/
http://www.gapminder.org/world

Internet: Alternate Land Use Services (ALUS) program
http://www.gov.pe.ca/growingforward/index.php3?number=1024407&lang=E

Economic Issues (ongoing)

Outcomes

Students will be expected to

1.8 compile career information and job opportunities of diverse agricultural enterprises and related services

Elaborations - Suggestions for Learning and Teaching

The outcomes addressed in the "Economic Issues" (pp. 48-49) provide an interesting and relevant context to enhance the agriculture learning environment. It is expected that the outcomes be addressed continuously throughout this course.

Students should understand that less than 15% of the total jobs in agriculture are actually on-farm jobs. The other 85% of agriculture jobs are in the fields of sales, research, processing, education, and health. Students should brainstorm and compare the scope of job opportunities on-farm and off-farm available on Prince Edward Island. They may research the career opportunities through various resources, such as Career Cruising, career profiles, Internet career recruitment websites (e.g., HRDC job bank, Workopolis), guest speakers (agricultural experts and entrepreneurs), and field trips.

Once they have selected a career of interest to them, they should prepare a career profile. In the profile, the students should

- describe the career (duties, responsibilities, time commitment);
- explain how the career is relevant to agriscience;
- identify the educational requirements;
- identify essential skills required for the position;
- provide a salary range;
- identify opportunities for work and labour market conditions/issues;
- list advantages/disadvantages of the career;
- identify aspects of the career that they like;
- contact someone currently employed in this career and choose one of the following options:
  - provide a voice or video recording of his/her comments and answers to your questions;
  - provide a written recording of his/her comments and answers to your questions;
  - invite the contact to be a guest speaker for the class.

Students could present their career profile in a variety of formats, such as a Webpage, podcast, online video, poster, or the class could conduct an agriculture expo - displaying the different job opportunities available.

Economic Issues (ongoing)

Tasks for Instruction and/or Assessment

Performance

- Identify a career related to this course that you find interesting. Use your imagination - farmer, veterinarian, lab technician, equipment designer, biotechnologist, processor - or simply perform a search on the Internet for "agriculture careers". Create a career profile that describes the career and identifies how it is relevant to agriscience. Identify the educational requirements, knowledge and skills required, salary range, present and potential future demand. Contact someone currently working in this career and gather additional information. (1.8)

Resources/Notes

Appendix G: Career Profile Project

Internet: Career Database/Labour Market Information (Websites):

- Service Canada (Job Futures) http://www.jobfutures.ca/
- Service Canada (Labour Market Information) http://www.labourmarketinformation.ca/
- Workopolis http://www.workopolis.com/
- Career Cruising http://www.careercruising.com/
- Job Bank http://www.jobbank.gc.ca/

Economic Issues (ongoing)

Outcomes

Students will be expected to

1.9 demonstrate an awareness of economic trends and issues pertaining to agriculture

Elaborations - Suggestions for Learning and Teaching

Since agriculture has evolved from subsistence farming to commercial farming, students should understand farming as an entrepreneurial venture. Students should be aware that farm operations may be run by sole-propriators, large corporations, or as cooperative farms or community farms. They should understand that the market price for farm commodities is influenced by supply and demand and the global market place. Teachers should assist students with understanding the basic operating costs related to different farm operations (e.g., potato farm, organic farm, mixed farm) and "fair pricing" for their products (e.g., potato/overhead costs, beef production costs).

Students should understand the importance of supporting local food production as a consumer. An awareness of offshore food production and its issues with food quality, safety, and fair pricing (e.g., coffee, fruit, seafood) should be discussed. This topic is well aligned with issues pertaining to food security and food sovereignty.

Teachers should also expand on markets for non-traditional products and alternative uses for crops (e.g., biofuels). Students could discuss value-added products, such as blueberries, pumpkins, cranberries, strawberries, and raspberries, and processing these products into juice, pies, wines, and other agri-food products. The focus should be on the possibility of marketing all our farm products regionally, nationally, and globally.

It is important that students also demonstrate an awareness of the ethical issues of farming and balancing the economic, environmental and cultural factors. Possible areas for discussion and debate include issues associated with land use, local food production, drinking water, genetically modified food, organically developed food, food for fuel, and Fairtrade products.

Economic Issues (ongoing)

Tasks for Instruction and/or Assessment

Journal

- What are your thoughts on the following quote from Peter Phillips, an agriculture economist and trade expert at the University of Saskatchewan: "There are some people who think that farming is about people with strong backs and weak minds. It's the opposite now. They need to be extremely educated, adaptable and entrepreneurial people." (1.9)

Paper and Pencil

- List the advantages and disadvantages of different types of farm operations (e.g., sole-propriator, large corporation, cooperative farm). (1.9)
- Perform calculations to determine the operating costs associated with a given agricultural commodity (e.g., potato farm, organic, mixed farm). (1.9)
- What factors must be considered in setting a "fair price" for an agricultural product? (1.9)
- What is meant by a value-added product? Give some local examples. (1.9)
- Identify and describe several ethical issues related to agriscience (e.g., Fairtrade products, food for fuel, water use and contamination, land use). (1.9)

Resources/Notes

Soil and Water Management

Introduction

The purpose of this unit is to provide students with an overview of resource management as it applies to soil resources and water resources. Due to the large breadth of this topic, the focus has been primarily kept at a local level, with factors and issues that are specific to Prince Edward Island. The intent is that once students have a better appreciation of the issues at a local level, they will be able to transfer their knowledge to the broader national and global levels.

Focus and Context

By considering questions that you and your students generate pertaining to soil and water resource management, various learning and assessment activities will meet specific curriculum outcomes. All three areas of scientific literacy, inquiry, problem solving, and decision making, will be explored as students ask questions about soil and water use, investigate possible conservation solutions, and then propose strategies to responsibly manage these resources.

Science Curriculum Links

The issue of natural resource management builds upon information that students have studied earlier in the science curriculum. Students learn about soil types and soil enrichments in grade 7 science. Water systems and soil erosion are investigated in grade 8 science. A unit on sustainability of ecosystems in Science 421A/431A presents the Earth as a closed system, which means sustainable use of natural resources becomes a major concern. Issues pertaining to natural resource management also arise in Oceanography 621A and Environmental Science 621A.

801A Curriculum Outcomes

Students will be expected to

2.1 describe water management practices relevant to an agriculture system

2.2 identify strategies to reduce water impacts from agricultural practices

2.3 conduct an experiment to determine the presence or concentration of water pollutants

2.4 describe the origin and composition of soils in Prince Edward Island

2.5 identify the relationship among soil productivity and its physical and chemical properties

2.6 demonstrate an understanding of soil conservation practices

2.7 conduct an experiment to investigate several properties of soil

Water Quality and Conservation

Outcomes

Students will be expected to

2.1 describe water management practices relevant to an agriculture system

2.2 identify strategies to reduce water impacts from agricultural practices

2.3 conduct an experiment to determine the presence or concentration of water pollutants

Elaborations - Suggestions for Learning and Teaching

Students should understand the importance of water to agriculture and all living things. Concepts related to the hydrologic cycle, irrigation, wetlands, land characteristics, conservation practices, and forestry should be described. The quantity and availability of water should be discussed through a review of the hydrologic cycle (e.g., watersheds, surface water, groundwater).

The advantages and disadvantages of irrigation and wetlands in an agriculture system should be weighed by the students. Also, the students should understand how land characteristics, agricultural practices (e.g., contour ploughing, crop choice, cover crops), and forestry management can affect water quality and conservation.

Water pollution kills millions of people worldwide every year. Students should understand how these pollutants enter water resources and distinguish between point sources and nonpoint sources. Strategies to prevent, clean, and monitor pollutants from point sources are easier than those from nonpoint sources. Municipal runoff and agricultural runoff are two such nonpoint sources that lead to cultural eutrophication. Students should discuss or present strategies to mitigate or prevent these water pollution sources. Some examples include buffer zones, manure storage, fuel storage and fencing that separates farming practices from water courses, the use of weather stations, enhanced environmental farm plans, the ALUS program, and other best management practices.

Elevated nitrate levels in Prince Edward Island groundwater is a common concern as this is our only source of drinking water. Pollutants that enter groundwater are often unseen and take a very long time to decompose. This makes removal of the contaminate difficult and costly. Students should propose strategies to protect groundwater from pollutants.

The recycling of animal waste as fertilizer is economical and is generally considered an environmentally sustainable practice. However, care must be taken that the manure does not run off into water sources, as it can contaminate them with nutrients and bacteria (e.g., *E. coli*). Teachers could have students investigate the tragedy at Walkerton, Ontario or other case studies of potential environmental impacts from agriculture.

Teachers should explain how coliform bacteria counts, dissolved oxygen levels, turbidity and colorimetry can be used to detect water pollutants. Students should conduct an experiment to test the water quality of various samples from local sources (e.g., wetland, stream, well, municipal water) and present their results. Note: experiments must be conducted in accordance to the *Science Safety Resource Manual*.

Water Quality and Conservation

Tasks for Instruction and/or Assessment

Journal

- How would you manage and protect Prince Edward Island's drinking water? (2.1, 2.2)

Paper and Pencil

- List several ways to prevent agriculture pollutants from entering groundwater resources. (2.2)
- Where does the water used in agriculture come from? Where does it go? (2.1)
- Identify some of the main culprits of cultural eutrophication on Prince Edward Island. Why are they so hard to detect or prevent? (2.2)
- What are some strategies that can reduce water impacts from agricultural practices. (2.2)

Performance

- Conduct an experiment to determine the presence and concentration of water pollutants. As a class, present the water quality test results from different water sources. Are there any geographic areas or water sources that had higher readings than others? If so, what could be the cause of these elevated readings? (2.3)
- Conduct a serial dilution of water samples along a fictional watershed to identify nitrate point sources. (2.3)

Resources/Notes

Internet: Alternate Land Use Services (ALUS) program
http://www.gov.pe.ca/growingforward/index.php3?number=1024407&lang=E

Science Safety Resource Manual

Video: *Flow for the Love of Wate*r

Appendix H: Prince Edward Island's Fresh Water Resource

Appendix I: Personal Water Use Activity

Soil Quality and Conservation

Outcomes

Students will be expected to

2.4 describe the origin and composition of soils in Prince Edward Island
or
2.5 identify the relationship among soil productivity and its physical and chemical properties

2.6 demonstrate an understanding of soil conservation practices

2.7 investigate several properties of soil

Elaborations - Suggestions for Learning and Teaching

Students should be able to describe the composition of soils on Prince Edward Island and factors that influence the formation of different kinds of soils (climate, living organisms, topography, time). Teachers should define soil classification, texture, and structure and relate soil quality to the farming industry of Prince Edward Island.

Teachers should discuss the fundamentals of soil amendment (pH and liming, fertilizers) and how they affect plant growth. It is important that students recognize that although soil is a renewable resource, mismanagement or changes in the climate can greatly affect its use. Students should be able to explain different ecologically sound practices for improving and maintaining soil structure, fertility and conservation. Examples of practices for improving soil structure, fertility, and conservation include crop rotation, fallowing, synthetic and non-synthetic chemicals, adding compost or manure, terracing, contour planting, strip cropping, windbreaks, buffer zones, and riparian zones. Students should identify and describe local examples of soil management practices.

The causes of soil erosion and soil degradation (e.g., road construction, poor forestry practices, urban development, conventional tillage) should be investigated at a local and global level. Students should also describe the affects of soil salinity on plant growth and describe strategies for managing saline soils.

Teachers should use this opportunity to conduct a laboratory experiment to measure the relationship among soil productivity and its physical and chemical properties. An analysis of soil samples from a local farm could be compared to samples from a non-cultivated area to highlight different concentrations or characteristics (e.g., nitrates, pH, salinity).

This would be an ideal opportunity for students to grow their own plants. They can control a specific physical or chemical property of the soil to determine how it affects plant growth. Students could use their plants throughout the rest of the course to help meet outcomes in the Plant Biology, Crop Production, and Home Gardening and Landscaping units. Teachers should encourage students to plant a variety of plants with different root systems and flowers such as tomatoes, potatoes, pumpkins, cucumbers, grains, corn, or soybeans.

Please note that all experiments should be conducted in accordance to the precautions outlined in the *Science Safety Resource Manual* to protect students from bacteria or fungi that may be present in soil samples.

Soil Quality and Conservation

Tasks for Instruction and/or Assessment

Journal

- Do you think that soil conservation should be a concern for farmers? Why or why not? (2.4, 2.6)

Paper and Pencil

- Where did the soil on Prince Edward Island come from? Is it different than other places in Canada? (2.4)
- Identify different physical and chemical properties that can affect plant growth. (2.5)
- Describe ecologically sound practices for improving soil structure, fertility, and conservation. (2.5, 2.6)
- Select local examples of soil management practices (e.g., crop rotation, amendments, contour planting, buffer zones) and explain how they improve soil structure, fertility, or conservation. (2.6)
- Propose some strategies to prevent soil erosion and degradation. (2.6)

Performance

- Conduct an experiment to measure the relationship among soil productivity and its physical and chemical properties. Grow identical plants but vary one physical or chemical property and record its affect on plant growth. (2.7)
- Analyse soil samples from a local farm and compare the samples to a non-cultivated area to highlight different concentrations or characteristics (e.g., nitrates, pH, salinity). (2.4)

Resources/Notes

Land Use Changes slideshow

Science Safety Resource Manual

Shoreline Erosion slideshow

Appendix J: Soil Texture Lab

Appendix K: Soil Labs - Pore Space, Water Holding Capacity, and Capillarity

Appendix L: Earthworm Lab

Plant Biology

Introduction

Reproduction is an essential biological mechanism for the continuity and diversity of species. Students should be provided with opportunities to explore the fundamental processes of sexual and asexual reproduction in plants. As well, heredity and the transmission of traits from one living generation to the next will be examined. The ability of agriscientists and technologists to manipulate, alter, and substitute genetic material in a variety of cells has increased greatly in recent years. Students will have the opportunity to investigate and debate the current developments and uses of gene manipulation in agriculture.

Focus and Context

The focus of this unit is inquiry. The unit is subdivided into four sections: taxonomy, structure and function, plant physiology, and reproduction. In the first section, students will investigate and apply the role of taxonomy in science. In the second section, students will explore the structure and function of different parts of a plant. In the third section, students will understand the requirements for plants to survive and relate the processes of photosynthesis and respiration. Finally, students will investigate and compare the processes of asexual and sexual reproduction in representative plants.

Science Curriculum Links

By the end of grade three, students have explored the life cycles of several common animals and plants. In grade 8 science, students were formally introduced to the cell as a living system that exhibits all the characteristics of life. Students also investigated the structural and functional relationships between and among cells, tissues, organs, and systems in the human body. An elementary introduction to the science of genetics was delivered in grade 9 science. Biology 521A develops students' understanding of classifying living things, photosynthesis, and respiration. Biology 621A develops students' understanding of genetic continuity.

801A Curriculum Outcomes

Students will be expected to

3.1 use a local plant to demonstrate an understanding of the fundamental principles of taxonomy

3.2 describe and apply classification systems and nomenclatures used in the plant sciences

3.3 demonstrate an understanding of the structure and function of basic plant parts

3.4 describe the relationship of plant parts to fruits, nuts, vegetables, and crops

3.5 relate the processes of photosynthesis, respiration, and transpiration

3.6 describe the requirements for the production of a plant commodity

3.7 relate the concepts of breeding, propagation, and selection to production practices

3.8 demonstrate an understanding of Mendelian genetics and predict the outcome of various genetic crosses

Taxonomy

Outcomes

Students will be expected to

3.1 use a local plant to demonstrate an understanding of the fundamental principles of taxonomy

3.2 describe and apply classification systems and nomenclatures used in the plant sciences

Elaborations - Suggestions for Learning and Teaching

Students should understand that, in science, taxonomy provides the means for grouping and classifying organisms into established categories according to their similar and different characteristics. Students should understand that the binomial nomenclature system allows people who speak different languages to recognize and identify living things all over the world. We cannot rely solely on the common name because they are not always universal or accurate. Students should understand that scientific classification begins with broad groups that are broken down into smaller and smaller categories (Kingdom, Phylum, Class, Order, Family, Genus, Species).

Teachers should discuss the different Kingdoms and then could compare two common plants (e.g., apples and oranges) to show their similarities and differences.

Common Name:	Orange	Apple
Kingdom:	Plantae	Plantae
(unranked):	Angiosperms	Angiosperms
(unranked):	Eudicots	Eudicots
(unranked):	Rosids	Rosids
Order:	Sapindales	Rosales
Family:	Rutaceae	Rosaceae
Genus:	Citrus	Malus
Species:	C. sinensis	M. domestica
Binomial Name:	Citrus sinensis	Malus domestica

Students should understand that the 300,000 identified plants on Earth can all be categorized into four major groups: mosses, ferns, conifers, and flowering plants.

Students should be given the opportunity to use a dichotomous key to demonstrate their understanding of classifying living things. Students could be asked to classify actual organisms, imaginary creatures, or their classmates. Appendix M has a sample investigation that could be used or modified.

Taxonomy

Tasks for Instruction and/or Assessment

Paper and Pencil

- Explain why taxonomy is important in science. (3.1)
- Provide an example of an organism that has different common names. (3.1)
- Observe the plants that are commonly grown in your area and indicate their common and scientific names. (3.1)

Performance

- Using the sheets of animalcules (imaginary critters, e.g., various candy, nuts and bolts) provided, prepare an efficient biological classification key that could be used to identify five of these imaginary creatures. (3.2)
- Using sample organisms provided by your teacher, develop a simple classification key suitable for their identification. Upon its completion, exchange this key with that of a classmate and use it to identify one of the organisms. Discuss with this classmate any strengths or weaknesses noticed in each other's work. (3.2)
- Develop a dichotomous key to classify your classmates into distinct categories. (3.2)

Resources/Notes

Appendix M: Empirical Grouping

Structure and Function

Outcomes

Students will be expected to

3.3 demonstrate an understanding of the structure and function of basic plant parts

3.4 describe the relationship of plant parts to fruits, nuts, vegetables, and crops

Elaborations - Suggestions for Learning and Teaching

To have a better understanding of plants, it is necessary for students to identify the parts that make up plants, their functions, and uses. Roots take water and nutrients from the soil and anchor the plant. Stems support the plant and conduct water, nutrients, and food throughout the plant. Leaves manufacture the food for the plant. All parts of the plant have the potential to store food (will vary from one species to another).

Students should understand which parts of plants are used by humans as food. Teachers could bring in samples of fruits and vegetables and have the students identify which plant parts they are actually eating (e.g., carrots and beets are roots; celery, onions, and potatoes are stems; lettuce and mustard are leaves).

The function of plant flowers in this section should be limited to the production of fruits and seeds. The flower's function in reproduction will be discussed in a later section. Healthy plants produce seeds, nuts, fruits, and vegetables used for reproduction of the plant. These parts are also used by humans and other animals for food. Students should understand the definition and differences among fruits, vegetables, and nuts.

Structure and Function

Tasks for Instruction and/or Assessment

Journal

- In your own words, explain the differences between fruits, nuts, and vegetables. (3.4)

Paper and Pencil

- Draw and label the major parts of plants. (3.3)
- Describe how different plant parts are used in agriculture. (3.4)
- What purpose do leaves, stems, and roots serve in plants? (3.3)

Presentation

- Bring to class examples of plant systems such as roots and leaves that are used as agriculture products. Report to the class on why and how each is used. What characteristics of the system make it useful? (3.3, 3.4)

Resources/Notes

Appendix O: Plant Structures and Taxonomy

Plant Physiology

Outcomes

Students will be expected to

3.5 relate the processes of photosynthesis, respiration, and transpiration

3.6 describe the requirements for the production of a plant commodity

Elaborations - Suggestions for Learning and Teaching

Students should relate the general processes of photosynthesis, respiration, and transpiration by:

- illustrating the formulas for photosynthesis and respiration;
- identifying the relationship between photosynthesis and respiration;
- developing an awareness of transpiration and its effects on plant health.

Like all living things, for a plant to survive, its basic needs (light, water, heat, air, and minerals) must be met. Students should understand that the climate of a region is the main factor affecting what plants will grow and reproduce in a given region. As such, plants with specific water requirements, heat units, and growing days are selected for agricultural purposes. Soil conditions of a specific region determine what nutrients are available in the ground and also dictate what plants can be produced in a certain area. Farmers are able to maximize these conditions to improve yield through management practices and advancements in technology. Teachers should lead students in a general discussion of the requirement and function of essential nutrients and micronutrients needed for local crops, although the intent is not for students to have to memorize a list of nutrients.

Once students are able to describe the requirements for the production of a certain plant commodity, they should discuss how farmers and agriscientists attempt to control these conditions. The purpose, benefits, and consequences of agriscience techniques such as irrigation, plant fertilization, use of greenhouses, and biotechnology (e.g., genetically modified canola seed developed to grow in Canadian climates) should be discussed.

Plant Physiology

Tasks for Instruction and/or Assessment

Journal

- What are your thoughts on the following statement: "The climate determines what plants can be grown in a given region"? (3.6)

Paper and Pencil

- Explain the differences between photosynthesis and respiration. (3.5)
- How does transpiration affect the health of a plant? (3.5)
- What are the basic needs that all plants require to live? (3.6)
- How do Island farmers and agriscientists attempt to control the production of plant commodities? What are the benefits and consequences of their techniques? (3.6)

Resources/Notes

Internet: Vesey's Seeds
http://www.veseys.com/ca/en/

Appendix P: Plant Physiology

Reproduction

Outcomes

Students will be expected to

3.7 relate the concepts of breeding, propagation, and selection to production practices

3.8 demonstrate an understanding of Mendelian genetics and predict the outcome of various genetic crosses

Elaborations - Suggestions for Learning and Teaching

Students should be able to distinguish between sexual and asexual reproduction in plants. The parts and function of the plant responsible for sexual reproduction should be discussed and students should understand the processes of pollination and fertilization of a flowering plant. Students should also demonstrate an understanding of seed structure (monocots and dicots)and requirements for germination (water, oxygen, temperature, and light). The importance of seed dispersal and pollen transfer to agricultural practices should be outlined. Students should discuss how production practices could be impacted by changes to these systems (e.g., honey bee decline impacts on fruit crops).

Students should be able to identify the primary methods of vegetative propagation and give examples of plants typically propagated by each method. Examples include layering (strawberry plants), cutting (potatoes), grafting (apples), and tissue culture (seed potatoes).

Once students understand the process of germination and vegetative propagation, they should explore existing propagation technology developed through agricscience and biotechnology. Improvement by selection for desirable characteristics (selective breeding) has evolved from Mendel's early experiments to advanced techniques in hybrid breeding and plant cell cultures. Teachers should briefly discuss trait predictability (e.g., principle of dominance, law of segregation, Punnett squares) and genetic engineering as it applies to plant breeding and selection. Students should understand that plant genetic engineering can be done to create varieties that grow larger and faster and varieties that are more resistant to disease and pests. They should also discuss the benefits and consequences of genetic modification (e.g., nutritional value, ecological impact).

Reproduction

Tasks for Instruction and/or Assessment

Journal

- What do you think would happen if all honey bees on Prince Edward Island suddenly disappeared? (3.7)

Paper and Pencil

- Explain why some plants produce flowers. (3.7)
- Provide examples of local plants produced by different methods of vegetative propagation. (3.7)
- Is it possible for two tall pea plants to produce a short pea plant? Is it possible for two short pea plants to produce a tall pea plant? Explain. (3.8)

Performance

- Genetically modified foods have been both promoted and opposed for several years (e.g., round-up ready soy beans, Canola oil). Research this issue. Use what you learn as the basis for a pro and con chart, class debate, or letter to a company president. (3.7, 3.8)

Resources/Notes

Appendix Q: Dining on DNA

Crop Production

Introduction

Crop production lies at the heart of the agriculture industry on Prince Edward Island. Students should be provided with opportunities to explore the overall contribution of crop commodities to the social, economic, and environmental development of Prince Edward Island. Teachers should provide an overview of crop products and a detailed description of the vegetable industry. This demonstration will prepare students to conduct an investigation and presentation of a crop or crop production issue. Students will have the opportunity to engage, individually or collaboratively, in a research project and integrate and present information on a specific crop produced on Prince Edward Island (e.g., fruit, grains and oil seeds, forage). The end product would be a crop production report and presentation on their selected crop.

Focus and Context

The unit's focusses are inquiry and decision making and are concentrated on students' collections and analyses of data as part of their crop production investigation. The context of the investigations will depend on the the crop selected or the local or regional issues related to crop production.

Science Curriculum Links

By the end of grade 3, students have explored plant growth and changes. The concept of how biotic and abiotic factors affect living things was addressed in Science 421A/431A. Students in Environmental Science 621A conducted a Project Based Learning activity similar to the inquiry investigation in this section.

801A Curriculum Outcomes

Students will be expected to

4.1 demonstrate an understanding of the importance of the crop production industry to Prince Edward Island and Canada

4.2 describe production techniques for a variety of vegetable commodities

4.3 describe applications of science and technology in addressing specific plant production needs

4.4 discuss trends and challenges to the industry

4.5a create a crop production report and presentation

OR

4.5b investigate a selected crop production issue using a guided inquiry process

Vegetables

Outcomes

Students will be expected to

4.1 demonstrate an understanding of the importance of the crop production industry to Prince Edward Island and Canada

4.2 describe production techniques for a variety of vegetable commodities

4.3 describe applications of science and technology in addressing specific plant production needs

4.4 discuss trends and challenges to the industry

Elaborations - Suggestions for Learning and Teaching

The overall contribution of agriscience to the social, economic, and environmental development of Prince Edward Island was outlined in the introduction section of this course. Teachers should provide a brief overview of the vegetable, fruit, grain and oil seed, and forage products. The remainder of this section focuses on the importance of the vegetable industry to Prince Edward Island and Canada. The overview of crop products and the detailed description of the vegetable industry will prepare students to conduct a crop investigation in the subsequent section.

Students should be able to identify various types of vegetables and varieties of potatoes grown on Prince Edward Island. In particular, they should discuss the importance of the potato industry and its sectors to Prince Edward Island's economy, environment, and society.

Time constraints do not allow for students to describe the production techniques of all vegetable commodities grown on Prince Edward Island. Teachers may select a variety common to the area or focus on the Island's largest vegetable commodity - potatoes. Items to identify and discuss in a vegetable's production technique would include:

- variety selection and uses
- soil management
- planting methods and considerations
- common pests (diseases, wildlife, insects, viruses, fungi, weeds, bacteria)
- the advantages and disadvantages of various pest and disease control methods (IPM, cultural control, biological control)
- harvesting techniques and equipment
- storing techniques and facilities
- processing techniques and facilities
- food safety and traceability
- marketing strategies

Advances in agriscience and technology have been used to address specific plant production needs. Students should be able to describe these applications and how they have improved farming practices. Examples include: seed bed preparation/soil fertility (zero till), planting/harvesting (air seeders), weed and pest control, biotechnology, plant propagation, maintaining soil moisture levels (hydroponics/irrigation), improved production and yields, food safety and traceability.

A discussion of trends and challenges to the industry should be driven by current events at the local and global level. Issues pertaining to vertical integration, production quotas, and new crop opportunities (e.g., bioscience, nutriceuticals) should be discussed. The teacher may wish to tie these topics to the earlier examination of food sovereignty and security issues. Students should also discuss what challenges and opportunities exist in the vegetable industry with regards to career opportunities now and in the future.

Vegetables

Tasks for Instruction and/or Assessment

Journal

- In your opinion, what is the most important vegetable currently produced on Prince Edward Island? Why? (4.1)
- What do you feel is the greatest challenge faced by the vegetable industry? (4.4)

Paper and Pencil

- How does potato production affect the Prince Edward Island economy, environment, and culture? (4.1)
- Using the information provided by your teacher, describe the production techniques for a locally produced vegetable. (4.2)
- What career opportunities are available in the vegetable industry on Prince Edward Island? (4.4)

Presentation

- Select an advance in agriscience and technology that addresses a specific plant production need (e.g., zero till, air seeders, biotechnology, irrigation). Describe to a group of your classmates how this advance has improved production and yields, food safety, or trace ability. (4.3)

Performance

- As a class, grow different varieties of potatoes in your school's green house. Describe their growing requirements, unique characteristics, and why they are well suited for Prince Edward Island's soil. Please note that due to disease control protocols, potatoes should be grown in the school and not outdoors. (4.1, 4.2, 4.3)

Resources/Notes

Internet: Prince Edward Island Department of Agriculture Factsheets
http://www.gov.pe.ca/agriculture/

Internet: Food Country Webisodes with Chef Michael Smith
http://chefmichaelsmith.com/food-country/

Internet: Atlantic Canada Potato Guide
http://www.gov.pe.ca/af/agweb/index.php3?number=1001552

Investigation

Outcomes

Students will be expected to

4.5a create a crop production report and presentation

Elaborations - Suggestions for Learning and Teaching

There are two suggested options for this project. In one option, the outcomes for this section can be addressed by providing students with an opportunity to engage, individually or collaboratively, in a research project that would require them to use print and electronic resources to research, select, and integrate information on a specific crop produced on Prince Edward Island (e.g., fruit, grains and oil seeds, forage). The end product would be a crop production report and presentation on their selected crop. In addition to the items identified in the previous vegetable section (planting, IPM, traceability, etc.), the report should discuss items specific to the students' selected crop:

Fruit
- demonstrate an understanding of the importance of the fruit industry to Prince Edward Island and Canada
- identify PEI fruit crops
- summarize the production and management of a fruit crop. Select from apple, blueberry, cranberry, or strawberry.
- discuss how technology has impacted the industry
- discuss trends and challenges for the industry

Grains and Oil Seeds
- demonstrate an understanding of the importance of the grains and oil seeds industry to Prince Edward Island and Canada
- demonstrate an understanding of the different products and by-products of cereals
- define important terms used in cereal crop production
- identify major crops grown for grain, oil, and special purposes
- classify field crops according to use
- discuss issues of growing grains and oil seeds for fuel vs. food
- discuss how technology has impacted the industry
- discuss trends and challenges for the industry

Forages
- demonstrate an understanding of the importance of forages to Prince Edward Island and Canadian agriculture
- demonstrate an understanding of forage and pasture production and management
- list common forage, grasses, and legumes
- focus on uses and how forages are integrated and interrelated with other crops
- connection to nutrition in livestock production
- discuss how technology has impacted the industry
- discuss trends and challenges for the industry

Investigation

Tasks for Instruction and/or Assessment

Performance

- Create a crop production report of a local crop of your choice. Include in your report:
  - variety selection and uses
  - soil management
  - planting methods and considerations
  - common pests (diseases, wildlife, insects, viruses, fungi, weeds, bacteria)
  - the advantages and disadvantages of various pest and disease control methods (IPM, cultural control, biological control)
  - harvesting techniques and equipment
  - storing techniques and facilities
  - processing techniques and facilities
  - food safety and traceability
  - marketing strategies
  - items specific to your selected crop (4.5a)

- Create a fact sheet and question sheet on your selected crop that you will share with the rest of the class. (4.5a)

Resources/Notes

Investigation (continued...)

Outcomes

Students will be expected to

4.5a create a crop production report and presentation

4.5b investigate a selected crop production issue using a guided inquiry process

Elaborations - Suggestions for Learning and Teaching

Students should be asked to present their crop production report to the class. Although standard oral presentations are fine, alternative presentation formats (e.g., podcast, video, website, webquest, interactive game) should be encouraged. Through questioning, students will be exposed to various perspectives and, as a result, will be expected to better appreciate the importance of communication and review in presenting new information.

In the second option, the outcomes for this section can be addressed by providing students with an opportunity to conduct in-depth investigations of current real-world issues and challenges related to crop production. Students would obtain a deeper knowledge of the subject area through inquiry, research, experimentation, and/or the assistance of a community mentor. The end product would answer a specific inquiry question related to crop production. Some example questions include:

- Should we be growing crops for fuel instead of food?
- Is genetic engineering the only way to increase food production?
- How can farmers ensure environmental sustainability as well as increase food production when pressure on environmental resources like land and water is growing?
- Is there a difference between applications of biotechnology in agriculture and medicine? Why are the two perceived differently?
- How can the food security or food sovereignty issues of developing countries be safeguarded?

Investigation (continued...)

Tasks for Instruction and/or Assessment

Presentation

- Present your crop production report to the rest of the class. The presentation could be in the form of an oral presentation, podcast, video, website, webquest, or interactive game. Students should be able to gather information from your presentation and answer questions about your specific crop. (4.5a)

Performance

- Conduct an in-depth investigation of a current real-world issue or challenge related to crop production. The end product and presentation should answer a specific inquiry question related to crop production. Your investigation should include:
  - develop a plan to investigate your question, idea, problem or issue;
  - conduct an investigation into the relationships between and among variables using a broad range of tools and techniques;
  - analyse the data to develop and assess possible explanations;
  - communicate your information, ideas, and results. (4.5b)

Resources/Notes

Green Spacing

Introduction

Home gardening and green spacing can be a practical and easy way to demonstrate an understanding of soil and water management, plant biology, and crop production. Students should be provided with an opportunity to develop, and hopefully carry out, a plan to grow a garden and develop a community green space. These hands-on opportunities to plan and create a green space can make the concepts learned throughout the course more authentic and meaningful.

Focus and Context

All three processes of inquiry, problem solving, and decision making will be explored in this unit as students apply the concepts and knowledge from previous units to the local level. They will develop a plan to grow a garden and develop a green space in their local community. Their prior course experience will help them determine what plants should be selected and how to grow and care for them.

Science Curriculum Links

By the end of grade 3, students have explored plant growth and changes. Students learn about soil types and soil enrichments in grade 7 science. The concept of how biotic and abiotic factors affect living things was addressed in Science 421A/431A.

801A Curriculum Outcomes

Students will be expected to

5.1 identify environmental factors in the successful selection of plants for a garden on Prince Edward Island

5.2 create a plot plan for a local fruit and vegetable garden

5.3 work collaboratively to create a green space within their school or community

Home Gardening and Landscaping

Outcomes	Elaborations - Suggestions for Learning and Teaching
Students will be expected to	In the Plant Physiology section of the Plant Biology unit, students described the requirements (e.g., nutrients, heat, water, light) for the production of a plant commodity. The outcomes of the Home Gardening and Landscaping section build on this prior knowledge by having the students select a fruit or vegetable that can be grown in a home garden on Prince Edward Island. The Agriculture and Agri-Food Canada website (http://www.agr.gc.ca) allows users to search The Plant Hardiness Zones map which outlines the different zones in Canada where various types of trees, shrubs, and flowers will most likely survive.
5.1 identify environmental factors in the successful selection of plants for a garden on Prince Edward Island	
5.2 create a plot plan for a local fruit and vegetable garden	Once students have determined what type of plant will most likely survive on Prince Edward Island, they are to generate a plot plan for the fruit or vegetable that they have selected to grow (this project could be done in conjunction with, or as an extension of, the soil experiment outlined in the Soil and Water Management unit). Their plan should include planting dates, harvesting dates, soil amendments, and pest control. Ideally, each student will have the opportunity to plant some vegetable and flower seeds and care for the young plants. Students taking this course in the fall may have to grow their plants to maturity inside. Students taking this course in the spring should be encouraged to transplant them into their home or community garden when they are able to survive outside.
5.3 work collaboratively to create a green space within their school or community	Students may choose to work collaboratively in creating a community garden at their school where they could transplant their fruit, vegetablesm or flowers. Alternatively, a hands-on continuous project could be to design and implement a school beautification green space. This green space could be a continuous project that is maintained and expanded by subsequent classes. Students should be encouraged to work with other students, teachers, and the community in creating the green space and in promoting its importance to their school environment. Teachers and students may wish to explore the Greening Spaces Program offered through the Prince Edward Island Department of Environment, Energy and Forestry for additional assistance and information.

Home Gardening and Landscaping

Tasks for Instruction and/or Assessment

Journal

- Do you think that everyone on Prince Edward Island should have their own garden? (5.3)

Paper and Pencil

- Identify trees, shrubs, flowers, fruits, and vegetables that can be successfully grown in Prince Edward Island gardens. (5.1)

Performance

- Gather information on the Greening Spaces Program offered through the Prince Edward Island Department of Environment, Energy and Forestry. Use this information, or other sources, to work collaboratively to plan and create a green space for your school or community. (5.3)

- Create a plot plan for a local fruit and vegetable garden. Include planting dates, harvesting dates, soil amendments, and pest control. (5.2)

Resources/Notes

Internet: Agriculture and Agri-Food Canada Website
http://www.agr.gc.ca/

Internet: Prince Edward Island Department of Agriculture and Forestry Greening Spaces Program
http://www.gov.pe.ca/agriculture/index.php3?number=1036445&lang=E

Internet: Veseys Seeds Planting Guides
http://www.veseys.com/

Agriscience
621A

Overview of Agriscience

Introduction

The opening unit of the Agriscience 621A course provides an introduction to the concepts and terminology associated with the study of agriscience. While students may have an awareness of some agricultural issues and a keen interest in examining current world problems, it is important for them to recognize the fundamental ideas and concepts that constitute an issue at various levels. The Overview of Agriscience unit requires students to examine the economic, social, and environmental aspects of issues at a local, Canadian, or global scale, and the key role that perspective plays in analysing complex problems. Students will also practise skills that may have been introduced in earlier grade levels such as differentiating between opinion and fact, detecting bias, and validating sources of information. These are necessary skills to practise in any critical analysis of agriscience issues.

Focus and Context

This introductory unit emphasizes scientific inquiry as students will begin to ask questions about agriscience issues pertaining to food security, sustainability, and economics at a local and global scale. They will also begin to explore problem solving and decision making through the use of critical thinking skills and considering different perspectives.

Science Curriculum Links

The issue of sustainability builds upon information that students have studied earlier in the science curriculum. A unit on sustainability of ecosystems in Science 421A/431A presents the Earth as a closed system, which means sustainable use of resources becomes a major concern. A discussion of ways in which natural populations are kept in equilibrium in relation to the availability of food resources occurs in Biology 521A and Environmental Science 621A. Previous to this, elementary students learned how humans and other living things depend on their environment.

621A Curriculum Outcomes

Students will be expected to

1.1 distinguish between agriculture and agriscience

1.2 examine the historical importance of the development of agricultural resources

1.3 explain ways in which agriscience is a diversified and changing industry

1.4 analyse the environmental, social, and economic significance of agriculture and agriscience to Prince Edward Island

1.5 demonstrate an understanding of the diversity and interdependence within the agricultural sector of Prince Edward Island

1.6 demonstrate an understanding of the principles of food sovereignty and food security

1.7 debate the concept of sustainability as it relates to agriculture

1.8 research career information and job opportunities in diverse agricultural enterprises and related services

1.9 demonstrate an understanding of economic trends and issues pertaining to agriculture

Introduction

Outcomes	Elaborations - Suggestions for Learning and Teaching
Students will be expected to	Agriscience is the application of scientific principles and new technologies to agriculture. To distinguish between agriculture and agriscience, students should be able to define each and be able to identify the major divisions and sciences related to agriscience.
1.1 distinguish between agriculture and agriscience	
1.2 examine the historical importance of the development of agricultural resources	Students should examine how agriculture has played a key role in the development of human civilization. Agricultural practices such as the domestication of animals and the cultivation of crops allowed human beings to move beyond hunter-gatherer societies. When farmers became capable of producing food beyond the needs of their own families, others in their society were freed to devote themselves to projects other than food acquisition. However, students should also understand that subsistence agriculture in which farmers focus on growing enough food to feed their families is still commonplace in many developing parts of the world. The book or video *Guns, Germs, and Steel* has a very good introduction of how agriscience has affected our world.
1.3 explain ways in which agriscience is a diversified and changing industry	Improvements in technology have had a huge impact on local and global agricultural practices. Teachers should lead the class in a discussion on how agriscience and emerging technologies (e.g., plow, reaper, tractor, barbed wire, milking machine, biotechnology and the Green Revolution) impacted how we produce food over the years.
1.4 analyse the environmental, social, and economic significance of agriculture and agriscience to Prince Edward Island	Teachers should discuss with students how agriculture in Prince Edward Island and Canada has evolved from subsistence agriculture to commercial agriculture and the impact that this has had on our society, economy, and environment. In 1931, more than 30 per cent of the people in this country lived on farms. That number has whittled to approximately 3 per cent nationally (4.5 per cent on Prince Edward Island). They should discuss if this move “off the farm” has lead Canadians and Islanders to have lost touch with the value of food and how it is produced. Students should understand that people in many nations spend more than half of their incomes on food. Canadians, on the other hand, spend on average about 10% of our yearly wages on food. This can be partly attributed to government policy and corporate control that affect food market prices. This can also be attributed to the contributions of agriscience that have found ways to stimulate growth and production of animals and plants and to reduce losses from disease, insects, and parasites.

Introduction

Tasks for Instruction and/or Assessment

Journal

- How important do you think the agriculture sector is to people on Prince Edward Island? How important is it to you? (1.4)
- Do you feel that the move of people "off the farm" and into more urban areas has caused Canadians to lose touch with the value of food and how it is produced? Explain why or why not. (1.4)

Paper and Pencil

- What is the difference between agriculture and agriscience? (1.1)
- Identify examples of agriscience in the world around you. (1.1)
- Compare Food Freedom Day in Canada to that of other developed and developing countries. (1.4)
- Explain what the limitations (economic, societal, environmental) are to people that are bound to subsistence agriculture. (1.2)
- What are some of the contributing factors that determine food market prices? (1.4)
- Why are food prices in Canada significantly lower than many developing and developed nations? (1.4)

Presentation

- Speak with a local farmer about how technology has changed agriculture operations (e.g., acreage, types of crops, production, yield) over the years. Present your findings to the class. (1.3)

Performance

- Create a timeline of the development of agriculture from early hunter-gatherer societies to today. (1.2)

Resources/Notes

The Real Dirt on Farming II

All About Food, Agri-Food Facts

Video and book: *Guns, Germs, and Steel* by Jared Diamond

Internet: The History of Agriculture
http://www.xtimeline.com/timeline/History-of-agriculture-1

Appendix A: Glossary of Terms

Appendix B: Agriculture Time Line

Introduction (continued...)

Outcomes

Students will be expected to

1.4 analyse the environmental, social, and economic significance of agriculture and agriscience to Prince Edward Island (continued...)

1.5 demonstrate an understanding of the diversity and interdependence within the agricultural sector of Prince Edward Island

Elaborations - Suggestions for Learning and Teaching

Teachers are recommended to download information from the Prince Edward Island Department of Agriculture or the Prince Edward Island Agriculture Sector Council which maintain current data on the level of agriculture on Prince Edward Island. Students should discuss the impact of the agriculture industry on Prince Edward Island from economic, social, and environmental perspectives. To do so, they should research factors such as the current levels of employment, impacts on the economy, number of active farms, primary products and by-products, and the impact of increased agricultural production on the environment.

Students should also be aware of the challenges and successes that Prince Edward Island farmers have had regarding finding new markets and growing new crops to help meet the world's food needs. Students should also understand that farmers seldom work in isolation and provide examples of interdependence within the agricultural sector (e.g., crop and livestock producers' interdependence, crop rotations, vertical integration, biotechnology sector).

Introduction (continued...)

Tasks for Instruction and/or Assessment

Journal

- Create a list of commodities that you think could be successfully marketed on Prince Edward Island. (1.5)
- Comment on the following statement, "All they grow on PEI is potatoes." (1.4, 1.5)

Paper and Pencil

- Provide examples of interdependence within the agricultural sector. What are some of the benefits and detriments of this level of interdependence? (1.5)
- Why are certain crops grown on Prince Edward Island? (1.4, 1.5)
- How important is the agriculture sector to the Prince Edward Island economy? (1.4)
- Trend the levels of employment, impacts on the economy, number of active farms, etc., in the Island agriculture sector over the past few years. What does this trending infer about the contribution of agriscience to the social, economic, and environmental development of Prince Edward Island? (1.4)
- Create a list of different commodities grown on Island farms. Compare your list with other members of the class and discuss the diversity of the Island agriculture sector. (1.5)

Presentation

- Work collaboratively to research a commodity that Island farmers have been successful in finding a market. Present your group's findings to the class, outlining why the commodity was successful. (1.5)

Resources/Notes

Internet: Prince Edward Island Department of Agriculture
http://www.gov.pe.ca/agriculture/

Internet: Prince Edward Island Agriculture Sector Council
http://www.peiagsc.ca/

Appendix C: Maritime Agriculture - A Brief History

World Issues

Outcomes

Students will be expected to

1.6 demonstrate an understanding of the principles of food sovereignty and food security

Elaborations - Suggestions for Learning and Teaching

To understand the significance of international interdependence as it relates to agricultural sustainability and to assess the impact of agriculture on global development and international relations, students should discuss food sovereignty and food security.

Food sovereignty is the claimed "right" of peoples to define their own food, agriculture, livestock and fisheries systems, in contrast to having food largely subject to international market forces. "Food sovereignty is the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems." - Nyéléni 2007: Forum for Food Sovereignty.

Food sovereignty holds it to be true that communities should be able to define their own means of production and that food is a basic human right. Many communities calling for food sovereignty are protesting the imposition of Western technologies to their indigenous systems and agency. Those who hold a "food sovereignty" position advocate banning the production of most cash crops in developing nations, thereby leaving the local farmers to concentrate on subsistence agriculture. Teachers should provide examples of how political/corporate decisions (e.g., company decisions to change banana distribution from a Pacific port to an Atlantic port in Panama, and moving pineapple production from Hawaii to the Philippines) affect global economies and developing nations. The video *Food Inc.* provides an overview of the food industry in North America.

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." - United Nation's Food and Agriculture Organization (FAO). A Prince Edward Island context to food security could be to explore its food distribution system and how much we depend on uninterrupted food supply to the Island. Students should also be aware of issues of undernutrition and the use of Food Banks on Prince Edward Island.

The core of the Food Justice movement is the belief that what is lacking is not food, but the political will to fairly distribute food regardless of the recipient's ability to pay. It notes that globally, enough food is produced to feed the entire world population at a level adequate to ensure that everyone can be free of hunger and fear of starvation. That no one should live without enough food because of economic constraints or social inequalities is the basic goal.

World Issues

Tasks for Instruction and/or Assessment

Journal

- In your own words, explain what is meant by food sovereignty and food security. (1.6)
- Do you agree with the underlying principles of food sovereignty? Why or why not? Do you think that your opinion would change if you lived in a developing nation? (1.6)

Paper and Pencil

- What would happen if the Confederation Bridge was closed due to a natural disaster? How would we eat? (1.6)
- Explain how political/corporate decisions can affect global economies and developing nations. (1.6)
- Is food security an issue on Prince Edward Island? Explain your answer taking various perspectives into account. (1.6)

Performance

- As a class, debate the following resolution: Canada should close its borders to imports and prepare to grow all of its own food. (1.6)

Presentation

- Select an agricultural commodity and research how international interdependence affects its marketing, production, and sustainability. Present your findings to the class. (1.6)

Resources/Notes

Internet: The Canadian Federation of Agriculture
http://www.cfa-fca.ca/

Internet: Canada's Action Plan for Food Security
http://www.agr.gc.ca/index_e.php?s1=misb&s2=fsec-seca&page=action

Video: *Food Inc.*

World Issues (continued...)

Outcomes

Students will be expected to

1.6 demonstrate an understanding of the principles of food sovereignty and food security (continued...)

Elaborations - Suggestions for Learning and Teaching

To illustrate the vast inequalities in the distribution of food resources and wealth, have the students play the "Who Are the Lucky Ones?" simulation (see Appendix). This activity should allow students to compare the developed and developing nations in relation to agriscience and the surrounding issues. The Farmers Helping Farmers Global Classroom Initiative (see Appendix) is another excellent resource to raise awareness of agriculture issues in developed and developing nations.

To further students' understanding of international interdependence, teachers should discuss the implication of international agreements (NAFTA) on agricultural practices (e.g., government subsidies, quotas, marketing boards). Teachers should also provide examples of how corporate/government decisions affect global economies and developing nations. How do these factors affect a nation's food security or food sovereignty?

Having focused on the fact that agricultural practices cannot remain isolated at the local/provincial levels, discuss with students some recognizable links that tie Prince Edward Island to the global front. Use examples such as:

- international marketing in which Prince Edward Island is a player (e.g., seed potatoes, mussels, tuna, oysters, blueberries)
- the many information technology and biotechnology businesses based on Prince Edward Island that serve the global community
- aid programs in developing countries that are Prince Edward Island initiatives (e.g., Farmers Helping Farmers)

World Issues (continued...)

Tasks for Instruction and/or Assessment

Journal

- What do you think should be done to resolve the world's food crisis? (1.6)

Paper and Pencil

- What are some of the implications of international agreements on agricultural practices? (1.6)

Resources/Notes

Video: *Food Inc.*

Internet: Mikinduri Children of Hope
http://mikinduri.com/

Appendix D: World - A Community of 1000

Appendix E: Who Are the Lucky Ones?

Appendix F: Farmers Helping Farmers Global Classroom Initiative

World Issues (continued...)

Outcomes

Students will be expected to

1.7 debate the concept of sustainability as it relates to agriculture

Elaborations - Suggestions for Learning and Teaching

Farmers rely on the land to grow the crops and animals of their businesses. The key factors that affect sustainability of an agriculture system deal with the relationship between organisms and their environment. Plants, animals, insects, soil, water, and air must be kept in reasonable balance, or all will suffer. Teachers should define stewardship and sustainability and have the students discuss how these terms relate to agricultural practices and agriscience.

Teachers should use the Internet to model and identify some significant world population trends. During the past 50 years, food production worldwide has increased at a rate that is greater than the increase in population. Students should be asked if they believe that this growth in food production is sustainable. They should understand that as the Earth's population continues to grow exponentially, the demands on our agricultural systems will also continue to grow.

Population growth, coupled with increased urbanization, can lead to a greater loss of agricultural land and a movement of the workforce from rural to urban centres. This will further stress the farm environments used to feed the world's population. Students should identify and discuss how these factors (e.g., population growth, urbanization, economic activity, soil depletion, loss of agricultural land) affect agricultural sustainability and how they may affect it in the future. They should also discuss how agriscience can mitigate these factors. An examination of land ownership legislation, programs (e.g., Alternate Land Use Services, ALUS), and zoning issues on Prince Edward Island could be reviewed as a case study or class debate.

In addition to understanding the factors that affect agricultural sustainability, students should prepare to debate a specific issue pertaining to this topic. Some possible topics include: population growth / urbanization, stewardship / Aboriginal beliefs, impacts of technology, issues of growing crops for fuel vs. food, rezoning of agricultural land, land ownership legislation. Once a topic or topics are selected, students should be divided into groups on either side of the issue. They should research the issue and defend their position in a class setting.

World Issues (continued...)

Tasks for Instruction and/or Assessment

Paper and Pencil

- Identify current agricultural practices on Prince Edward Island that are sustainable and others that are not. (1.7)
- How do the terms stewardship and sustainability relate to agriculture practices on Prince Edward Island? (1.7)
- Explain how agriscience can improve agricultural sustainability. (1.7)
- How will factors such as population growth, urbanization, soil depletion, and loss of agricultural land affect the sustainability of our agriculture sector? Consider the social, environmental, and economic perspectives in your answer. (1.7)

Performance

- Conduct a class debate on a topic related to agricultural sustainability. In groups, research the issue and summarize the main points to defend your position. Possible sustainability topics include
  - population growth / urbanization;
  - stewardship / Aboriginal beliefs;
  - impacts of technology;
  - issues of growing crops for food vs. fuel;
  - rezoning agricultural land;
  - land ownership legislation.

Resources/Notes

Internet: World Population Trends
http://www.breathingearth.net/
http://www.gapminder.org/world

Internet: Alternate Land Use Services (ALUS) program
http://www.gov.pe.ca/growingforward/index.php3?number=1024407&lang=E

Economic Issues (ongoing)

Outcomes

Students will be expected to

1.8 research career information and job opportunities in diverse agricultural enterprises and related services

Elaborations - Suggestions for Learning and Teaching

The outcomes addressed in the Economic Issues section (pp. 94-95) provide an interesting and relevant context to enhance the agriculture learning environment. It is expected that the outcomes be addressed continuously throughout this course.

Students should understand that less than 15% of the total jobs in agriculture are actually on-farm jobs. The other 85% of agriculture jobs are in the fields of sales, research, processing, education, and health. Students should brainstorm and compare the scope of job opportunities on-farm and off-farm available on Prince Edward Island. They may research the career opportunities through various resources, such as Career Cruising, career profiles, Internet career recruitment websites (e.g., HRDC job bank, Workopolis), guest speakers (agricultural experts and entrepreneurs), and field trips.

Once they have selected a career of interest to them, they should prepare a career profile. In the profile, the students should

- describe the career (duties, responsibilities, time commitment);
- explain how the career is relevant to agriscience;
- identify the educational requirements;
- identify essential skills required for the position;
- provide a salary range;
- identify opportunities for work and labour market conditions/issues;
- list advantages/disadvantages of the career;
- identify aspects of the career that they like;
- contact someone currently employed in this career and choose one of the following options:
    - provide a voice or video recording of his/her comments and answers to your questions;
    - provide a written recording of his/her comments and answers to your questions;
    - invite the contact to be a guest speaker for the class.

Students could present their career profile in a variety of formats, such as a Webpage, podcast, online video, poster, or the class could conduct an agriculture expo - displaying the different job opportunities available.

Economic Issues (ongoing)

Tasks for Instruction and/or Assessment

Performance

- Research a career related to this course that you find interesting. Use your imagination - farmer, veterinarian, lab technician, equipment designer, biotechnologist, processor - or simply perform a search on the Internet for "agriculture careers". Create a career profile that describes the career and identifies how it is relevant to agriscience. Identify the educational requirements, knowledge and skills required, salary range, and present and potential future demand. Contact someone currently working in this career and gather additional information. (1.8)

Resources/Notes

Appendix G: Career Profile Project

Internet: Career Database/Labour Market Information (Websites):

- Service Canada (Job Futures) http://www.jobfutures.ca/
- Service Canada (Labour Market Information) http://www.labourmarketinformation.ca/
- Workopolis http://www.workopolis.com/
- Career Cruising http://www.careercruising.com/
- Job Bank http://www.jobbank.gc.ca/

Economic Issues (ongoing)

Outcomes

Students will be expected to

1.9 demonstrate an understanding of economic trends and issues pertaining to agriculture

Elaborations - Suggestions for Learning and Teaching

Since agriculture has evolved from subsistence farming to commercial farming, students should understand farming as an entrepreneurial venture. Students should be aware that farm operations may be run by sole-proprietors, large corporations, or as cooperative farms or community farms. They should understand that the market price for farm commodities is influenced by supply and demand and the global marketplace. Teachers should assist students with understanding the basic operating costs related to different farm operations (e.g., potato farm, organic farm, mixed farm) and "fair pricing" for their products (e.g., potato/overhead costs, beef production costs).

Students should understand the importance of supporting local food production as a consumer. An awareness of offshore food production and its issues with food quality, safety, and fair pricing (e.g., coffee, fruit, seafood) should be discussed. This topic is well aligned with issues pertaining to food security and food sovereignty.

Teachers should also expand on markets for non-traditional products and alternative uses for crops (e.g., biofuels). Students could discuss value-added products, such as blueberries, pumpkins, cranberries, strawberries, and raspberries, and processing these products into juices, pies, wines, and other agri-food products. The focus should be on the possibility of marketing all our farm products regionally, nationally, and globally.

It is important that students also demonstrate an awareness of the ethical issues related to farming, as well as balancing the economic, environmental and cultural factors. Possible areas for discussion and debate include issues associated with land use, local food production, drinking water, genetically modified food, organically developed food, food for fuel, and Fairtrade products.

Economic Issues (ongoing)

Tasks for Instruction and/or Assessment

Journal

- What are your thoughts on the following quote from Peter Phillips, an agriculture economist and trade expert at the University of Saskatchewan: "There are some people who think that farming is about people with strong backs and weak minds. It's the opposite now. They need to be extremely educated, adaptable and entrepreneurial people." (1.9)

Paper and Pencil

- List the advantages and disadvantages of different types of farm operations (e.g., sole-proprietor, large corporation, cooperative farm). (1.9)
- Determine and compare the operating costs of an organic farming practice versus a conventional farming practice. (1.9)
- What factors must be considered in setting a "fair price" for an agricultural product? (1.9)
- What is meant by a value-added product? Give some local examples. (1.9)

Performance

- Investigate several ethical issues related to agriscience (e.g., Fairtrade products, food for fuel, water use and contamination, land use). Prepare a position paper on one of the issues and share your paper with a classmate. (1.9)

Resources/Notes

Soil and Water Management

Introduction

The purpose of this unit is to provide students with an overview of resource management as it applies to soil resources and water resources. Due to the large breadth of this topic, the focus has been primarily kept at a local level, with factors and issues that are specific to Prince Edward Island. The intent is that once students have a better appreciation of the issues at a local level, they will be able to transfer their knowledge to the broader national and global levels.

Focus and Context

By considering questions that you and your students generate pertaining to soil and water resource management, various learning and assessment activities will meet specific curriculum outcomes. All three areas of scientific literacy: inquiry, problem solving, and decision making, will be explored as students ask questions about soil and water use, investigate possible conservation solutions, and then propose strategies to responsibly manage these resources.

Science Curriculum Links

The issue of natural resource management builds upon information that students have studied earlier in the science curriculum. Students learn about soil types and soil enrichments in Grade 7 science. Water systems and soil erosion are investigated in Grade 8 science. A unit on sustainability of ecosystems in Science 421A/431A presents the earth as a closed system, which means sustainable use of natural resources becomes a major concern. Issues pertaining to natural resource management also arise in Oceanography 621A and Environmental Science 621A.

621A Curriculum Outcomes

Students will be expected to

2.1 assess the impact of water management practices on the sustainable production of agricultural commodities

2.2 develop strategies to reduce water impacts from agricultural practices

2.3 conduct an experiment to determine the presence or concentration of water pollutants

2.4 explain the origin and composition of soils in Prince Edward Island

2.5 describe how soil composition and fertility can be altered and how these changes could affect an ecosystem

2.6 demonstrate an understanding of soil conservation practices

2.7 design a soil experiment and identify specific variables

Water Quality and Conservation

Outcomes

Students will be expected to

2.1 assess the impact of water management practices on the sustainable production of agricultural commodities

2.2 develop strategies to reduce water impacts from agricultural practices

2.3 conduct an experiment to determine the presence or concentration of water pollutants

Elaborations - Suggestions for Learning and Teaching

Students should understand the importance of water to agriculture and all living things. Concepts related to the hydrologic cycle, irrigation, wetlands, land characteristics, conservation practices, and forestry should be described. The quantity and availability of water should be discussed through a review of the hydrologic cycle (e.g., watersheds, surface water, groundwater).

The advantages and disadvantages of irrigation and wetlands in an agriculture system should be weighed by the students. Also, the students should understand how land characteristics, agricultural practices (e.g., contour ploughing, crop choice, cover crops), and forestry management can affect water quality and conservation.

Water pollution kills millions of people worldwide every year. Students should understand how these pollutants enter water resources and distinguish between point sources and nonpoint sources. Strategies to prevent, clean, and monitor pollutants from point sources are easier than those from nonpoint sources. Municipal runoff and agricultural runoff are two such nonpoint sources that lead to cultural eutrophication. Students should discuss or present strategies to mitigate or prevent these water pollution sources. Some examples include buffer zones, manure storage, fuel storage, and fencing that separate farming practices from water courses, the use of weather stations, enhanced environmental farm plans, the ALUS program, and other best management practices.

Elevated nitrate levels in Prince Edward Island groundwater is a common concern as this is our only source of drinking water. Pollutants that enter groundwater are often unseen and take a very long time to decompose. This makes removal of the contaminate difficult and costly. Students should propose strategies to protect groundwater from pollutants.

The recycling of animal waste as fertilizer is economical and is generally considered an environmentally sustainable practice. However, care must be taken that the manure does not run off into water sources, as it can contaminate them with nutrients and bacteria (e.g., *E. coli*). Teachers could have students investigate the tragedy at Walkerton, Ontario or other case studies of potential environmental impacts from agriculture.

Teachers should explain how coliform bacteria counts, dissolved oxygen levels, turbidity and colorimetry can be used to detect water pollutants. Students should conduct an experiment to test the water quality of various samples from local sources (e.g., wetland, stream, well, municipal water) and present their results. Note: experiments must be conducted in accordance to the *Science Safety Resource Manual*.

Water Quality and Conservation

Tasks for Instruction and/or Assessment

Journal

- Do you think that irrigation should be used on Prince Edward Island? Why or why not? (2.1)

Paper and Pencil

- Propose several strategies to prevent pollutants from entering groundwater resources. (2.2)
- Why is groundwater so hard to clean once polluted? (2.2)
- Explain some of the main culprits of cultural eutrophication on Prince Edward Island. Why are they so hard to detect or prevent? (2.2)
- Assess how irrigating farmers' fields impacts the availabity of water. Are there some geographic areas where this practice is more sustainable than others? (2.1)
- Explain the importance of wetlands to sustainable agriculture practices and predict what would happen if an existing wetland was removed from an agriculture system. (2.1)

Performance

- Conduct an experiment to determine the presence and concentration of water pollutants. As a class, present the water quality test results from different water sources. Are there any geographic areas or water sources, that had higher readings than others? If so, what could be the cause of these elevated readings? (2.3)
- Conduct a serial dilution of water samples along a fictional water shed to identify nitrate point sources. (2.3)

Resources/Notes

Internet: Alternate Land Use Services (ALUS) program
http://www.gov.pe.ca/growingforward/index.php3?number=1024407&lang=E

Science Safety Resource Manual

Video: *Flow for the Love of Water*

Appendix H: Prince Edward Island's Fresh Water Resource

Appendix I: Personal Water Use Activity

Soil Quality and Conservation

Outcomes

Students will be expected to

2.4 explain the origin and composition of soils in Prince Edward Island

2.5 describe how soil composition and fertility can be altered and how these changes could affect an ecosystem

2.6 demonstrate an understanding of soil conservation practices

2.7 design a soil experiment and identify specific variables

Elaborations - Suggestions for Learning and Teaching

Students should be able to describe the composition of soils on Prince Edward Island and factors that influence the formation of different kinds of soils (climate, living organisms, topography, time). Teachers should define soil classification, texture, and structure and relate soil quality to the farming industry of Prince Edward Island.

Teachers should discuss the fundamentals of soil amendment (pH and liming, fertilizers) and how they affect plant growth. It is important that students recognize that although soil is a renewable resource, mismanagement or changes in the climate can greatly affect its use. Students should be able to explain different ecologically sound practices for improving and maintaining soil structure, fertility, and conservation. Examples of practices for improving soil structure, fertility and conservation include crop rotation, fallowing, synthetic and nonsynthetic chemicals, adding compost or manure, terracing, contour planting, strip cropping, windbreaks, buffer zones, and riparian zones. Students should identify and describe local examples of soil management practices.

The causes of soil erosion and soil degradation (e.g., road construction, poor forestry practices, urban development, conventional tillage) should be investigated at a local and global level. Students should also describe the affects of soil salinity on plant growth and describe strategies for managing saline soils.

Teachers should use this opportunity to conduct a laboratory experiment to measure the relationship among soil productivity and its physical and chemical properties. An analysis of soil samples from a local farm could be compared to samples from a non-cultivated area to highlight different concentrations or characteristics (e.g., nitrates, pH, salinity).

This would be an ideal opportunity for students to grow their own plants. They can control a specific physical or chemical property of the soil to determine how it affects plant growth. Students could use their plants throughout the rest of the course to help meet outcomes in the Plant Biology, Crop Production, and Home Gardening and Landscaping units. Teachers should encourage students to plant a variety of plants with different root systems and flowers such as tomatoes, potatoes, pumpkins, cucumbers, grains, corn, or soybeans.

Please note that all experiments should be conducted in accordance to the precautions outlined in the *Science Safety Resource Manual* to protect students from bacteria or fungi that may be present in soil samples.

Soil Quality and Conservation

Tasks for Instruction and/or Assessment

Journal

- Do you think that soil should be considered to be a natural resource similar to water or forests? Why or why not? (2.6)

Paper and Pencil

- Explain how the composition of Island soil is different than other soils in Canada. (2.4)
- Describe some ways that soil amendments can affect plant growth. (2.5)
- Describe ecologically sound practices for improving soil structure, fertility, and conservation. (2.5, 2.6)
- Select local examples of soil management practices (e.g., crop rotation, amendments, contour planting, buffer zones) and explain how they improve soil structure, fertility, or conservation. (2.6)
- Propose some strategies to prevent soil erosion and degradation. (2.6)

Performance

- Design an experiment to measure the relationship among soil productivity and its physical and chemical properties. Plan the procedure, perform the experiment, analyse and interpret the results, and communicate your conclusions. (2.7)
- Analyse soil samples from a local farm and compare the samples to a non-cultivated area to highlight different concentrations or characteristics (e.g., nitrates, pH, salinity). (2.4)

Resources/Notes

Land Use Changes slideshow

Science Safety Resource Manual

Shoreline Erosion slideshow

Appendix J: Soil Texture Lab

Appendix K: Soil Labs - Pore Space, Water Holding Capacity, and Capillarity

Appendix L: Earthworm Lab

Plant Biology

Introduction

Reproduction is an essential biological mechanism for the continuity and diversity of species. Students should be provided with opportunities to explore the fundamental processes of sexual and asexual reproduction in plants. As well, heredity and the transmission of traits from one living generation to the next will be examined. The ability of agriscientists and technologists to manipulate, alter, and substitute genetic material in a variety of cells has increased greatly in recent years. Students will have the opportunity to investigate and debate the current developments and uses of gene manipulation in agriculture.

Focus and Context

The focus of this unit is inquiry. The unit is subdivided into four sections: taxonomy, structure and function, plant physiology, and reproduction. In the first section, students will investigate and apply the role of taxonomy in science. In the second section, students will explore the structure and function of different parts of a plant. In the third section, students will understand the requirements for plants to survive and relate the processes of photosynthesis and respiration. Finally, students will investigate and compare the processes of asexual and sexual reproduction in representative plants.

Science Curriculum Links

By the end of grade three, students have explored the life cycles of several common animals and plants. In Grade 8 science, students were formally introduced to the cell as a living system that exhibits all the characteristics of life. Students also investigated the structural and functional relationships between and among cells, tissues, organs, and systems in the human body. An elementary introduction to the science of genetics was delivered in Grade 9 science. Biology 521A develops students' understanding of classifying living things, photosynthesis, and respiration. Biology 621A develops students' understanding of genetic continuity.

621A Curriculum Outcomes

Students will be expected to

3.1 demonstrate an understanding of the fundamental principles of taxonomy

3.2 create a dichotomous key to identify species of plant

3.3 demonstrate an understanding of the structure and function of basic plant parts

3.4 describe the relationship of plant parts to fruits, nuts, vegetables, and crops

3.5 relate the processes of photosynthesis, respiration, and transpiration

3.6 assess how air, water, light, media, and nutrients affect plant growth

3.7 relate the concepts of breeding, propagation, and selection to production practices

3.8 demonstrate an understanding of Mendelian genetics and predict the outcome of various genetic crosses

Taxonomy

Outcomes

Students will be expected to

3.1 demonstrate an understanding of the fundamental principles of taxonomy

3.2 create a dichotomous key to identify species of plant

Elaborations - Suggestions for Learning and Teaching

Students should understand that in science, taxonomy provides the means for grouping and classifying organisms into established categories according to their similar and different characteristics. Students should also understand that the binomial nomenclature system allows people who speak different languages to recognize and identify living things all over the world. We can not rely solely on the common name because they are not always universal or accurate. Students should understand that scientific classification begins with broad groups that are broken down into smaller and smaller categories (Kingdom, Phylum, Class, Order, Family, Genus, Species).

Teachers should discuss the different Kingdoms and then could compare two common plants (e.g., apples and oranges) to show their similarities and differences.

Common Name:	Orange	Apple
Kingdom:	Plantae	Plantae
(unranked):	Angiosperms	Angiosperms
(unranked):	Eudicots	Eudicots
(unranked):	Rosids	Rosids
Order:	Sapindales	Rosales
Family:	Rutaceae	Rosaceae
Genus:	Citrus	Malus
Species:	C. sinensis	M. domestica
Binomial Name:	Citrus sinensis	Malus domestica

Students should understand that the 300,000 identified plants on Earth can all be categorized into four major groups: mosses, ferns, conifers, and flowering plants.

Students should be given the opportunity to create a dichotomous key to demonstrate their understanding of classifying living things. Students could be asked to classify actual organisms, imaginary creatures, or their classmates. Appendix M and Appendix N have sample investigations that could be used or modified.

Taxonomy

Tasks for Instruction and/or Assessment

Paper and Pencil

- Explain why taxonomy is important in science. (3.1)
- Provide an example of an organism that has different common names. (3.1)
- Observe the plants that are commonly grown in your area and indicate their common and scientific names. (3.1)

Performance

- Using the sheets of animalcules (imaginary critters, e.g., various candy, nuts, and bolts) provided, prepare an efficient biological classification key that could be used to identify five of these imaginary creatures. (3.2)
- Using sample organisms provided by your teacher, develop a simple classification key suitable for their identification. Upon its completion, exchange this key with that of a classmate and use it to identify one of the organisms. Discuss with this classmate any strengths or weaknesses noticed in each other's work. (3.2)
- Develop a dichotomous key to classify your classmates into distinct categories. (3.2)

Resources/Notes

Appendix M: Empirical Grouping

Appendix N: Creating a Dichotomous Key

Structure and Function

Outcomes

Students will be expected to

3.3 demonstrate an understanding of the structure and function of basic plant parts

3.4 describe the relationship of plant parts to fruits, nuts, vegetables, and crops

Elaborations - Suggestions for Learning and Teaching

To have a better understanding of plants, it is necessary for students to identify the parts that make up plants, their functions, and uses. Roots take water and nutrients from the soil and anchor the plant. Stems support the plant and conduct water, nutrients, and food throughout the plant. Leaves manufacture the food for the plant. All parts of the plant have the potential to store food, although this will vary from one species to another.

Students should understand which parts of plants are used by humans as food. Teachers could bring in samples of fruits and vegetables and have the students identify which plant parts they are actually eating (e.g., carrots and beets are roots; celery, onions, and potatoes are stems; lettuce and mustard are leaves).

The function of plant flowers in this section should be limited to the production of fruits and seeds. The flower's function in reproduction will be discussed in a later section. Healthy plants produce seeds, nuts, fruits, and vegetables used for reproduction of the plant. These parts are also used by humans and other animals for food. Students should understand the definition and differences among fruits, vegetables, and nuts.

Structure and Function

Tasks for Instruction and/or Assessment

Journal

- In your own words, explain the differences between fruits, nuts, and vegetables. (3.4)

Paper and Pencil

- Draw and label the major parts of a plant. (3.3)
- Describe how different plant parts are used in agriculture. (3.4)
- What purpose do leaves, stems, and roots serve in plants? (3.3)
- Explain how legumes are different from other plants. (3.3)

Presentation

- Bring to class examples of plant systems such as roots and leaves that are used as agriculture products. Report to the class on why and how each is used. What characteristics of the system make it useful? (3.3, 3.4)

Resources/Notes

Appendix O: Plant Structures and Taxonomy

Plant Physiology

Outcomes

Students will be expected to

3.5 relate the processes of photosynthesis, respiration, and transpiration

3.6 assess how air, water, light, media, and nutrients affect plant growth

Elaborations - Suggestions for Learning and Teaching

Students should relate the general processes of photosynthesis, respiration, and transpiration by

- illustrating the formulas for photosynthesis and respiration;
- identifying the relationship between photosynthesis and respiration;
- developing an awareness of transpiration and its effects on plant health.

Like all living things, for a plant to survive, its basic needs (light, water, heat, air, and minerals) must be met. Students should understand that the climate of a region is the main factor affecting what plants will grow and reproduce in a given region. As such, plants with specific water requirements, heat units, and growing days are selected for agricultural purposes. Soil conditions of a specific region determine what nutrients are available in the ground and also dictate what plants can be produced in a certain area. Farmers are able to maximize these conditions to improve yield through management practices and advancements in technology. Teachers should lead students in a general discussion of the requirement and function of essential nutrients and micronutrients needed for local crops, although the intent is not for students to have to memorize a list of nutrients.

Once students are able to describe the requirements for the production of a certain plant commodity, they should discuss how farmers and agriscientists attempt to control these conditions. The purpose, benefits, and consequences of agriscience techniques such as irrigation, plant fertilization, use of greenhouses, and biotechnology (e.g., genetically modified canola seed developed to grow in Canadian climates) should be discussed.

Plant Physiology

Tasks for Instruction and/or Assessment

Journal

- What are your thoughts on the following statement: "The climate determines what plants can be grown in a given region"? (3.6)

Paper and Pencil

- Explain the differences between photosynthesis and respiration. (3.5)
- How does transpiration affect the health of a plant? (3.5)
- What are the basic needs that all plants require to live? (3.6)
- How do Island farmers and agriscientists attempt to control the production of plant commodities? What are the benefits and consequences of their techniques? (3.6)

Performance

Work collaboratively to research the specific growth requirements of a locally produced plant (e.g., potato, corn, wheat). Obtain a sample of the plant and conduct an investigation into relationships between air, water, media, or nutrients and the plant's growth. Communicate your results to the class. (3.6)

Resources/Notes

Internet: Vesey's Seeds
http://www.veseys.com/ca/en/

Appendix P: Plant Physiology

Reproduction

Outcomes

Students will be expected to

3.7 relate the concepts of breeding, propagation, and selection to production practices

3.8 demonstrate an understanding of Mendelian genetics and predict the outcome of various genetic crosses

Elaborations - Suggestions for Learning and Teaching

Students should be able to distinguish between sexual and asexual reproduction in plants. The parts and function of the plant responsible for sexual reproduction should be discussed and students should understand the processes of pollination and fertilization of a flowering plant. Students should also demonstrate an understanding of seed structure (monocots and dicots) and requirements for germination (water, oxygen, temperature, and light). The importance of seed dispersal and pollen transfer to agricultural practices should be outlined. Students should discuss how production practices could be impacted by changes to these systems (e.g., honey bee decline impacts on fruit crops).

Students should be able to identify the primary methods of vegetative propagation and give examples of plants typically propagated by each method. Examples include layering (strawberry plants), cutting (potatoes), grafting (apples), and tissue culture (seed potatoes).

Once students understand the process of germination and vegetative propagation, they should explore existing propagation technology developed through agricscience and biotechnology. Improvement by selection for desirable characteristics (selective breeding) has evolved from Mendel's early experiments to advanced techniques in hybrid breeding and plant cell cultures. Teachers should briefly discuss trait predictability (e.g., principle of dominance, law of segregation, Punnett squares) and genetic engineering as it applies to plant breeding and selection. Students should understand that plant genetic engineering can be done to create varieties that grow larger and faster and varieties that are more resistant to disease and pests. They should also discuss the benefits and consequences of genetic modification (e.g., nutritional value, ecological impact).

Reproduction

Tasks for Instruction and/or Assessment

Journal

- What do you think would happen if all honeybees on Prince Edward Island suddenly disappeared? (3.7)

Paper and Pencil

- Explain why some plants produce flowers. (3.7)
- Provide examples of local plants produced by different methods of vegetative propagation. (3.7)
- Is it possible for two tall pea plants to produce a short pea plant? Is it possible for two short pea plants to produce a tall pea plant? Explain. (3.8)
- In tomatoes, red fruit (R) is dominant over yellow fruit (r). If a homozygous red fruit is crossed with a yellow fruit,
  (a) What is the appearance of the first generation?
  (b) What are the genotypes of the second generation if two plants from the first generation are crossed?
  (c) What are the phenotypes of the second generation? (3.8)

Performance

- Genetically modified foods have been both promoted and opposed for several years (e.g., round-up ready soy beans, Canola oil). Research this issue. Use what you learn as the basis for a pro and con chart, class debate, or letter to a company president. (3.7, 3.8)

Resources/Notes

Appendix Q: Dining on DNA

Appendix R: Determining Plant Genotypes

Crop Production

Introduction

Crop production lies at the heart of the agriculture industry on Prince Edward Island. Students should be provided with opportunities to explore the overall contribution of crop commodities to the social, economic, and environmental development of Prince Edward Island. Teachers should provide an overview of crop products and a detailed description of the vegetable industry. This demonstration will prepare students to conduct an investigation and presentation of a crop or crop production issue. Students will have the opportunity to engage, individually or collaboratively, in a research project and integrate and present information on a specific crop produced on Prince Edward Island (e.g., fruit, grains and oil seeds, forage). The end product would be a crop production report and presentation on their selected crop.

Focus and Context

The unit's focuses are inquiry and decision making, and are concentrated on students' collections and analyses of data as part of their crop production investigation. The context of the investigations will depend on the the crop selected or the local or regional issues related to crop production.

Science Curriculum Links

By the end of Grade 3, students have explored plant growth and changes. The concept of how biotic and abiotic factors affect living things was addressed in Science 421A/431A. Students in Environmental Science 621A conduct a Project Based Learning activity similar to the inquiry investigation in this section.

621A Curriculum Outcomes

Students will be expected to

4.1 demonstrate an understanding of the importance of the crop production industry to Prince Edward Island and Canada

4.2 describe production techniques for a variety of vegetable commodities

4.3 analyse the role of technology in the production, processing, transportation, and marketing of agricultural products

4.4 discuss trends and challenges to the industry

4.5 investigate a selected crop production issue using a guided inquiry process

Vegetables

Outcomes

Students will be expected to

4.1 demonstrate an understanding of the importance of the crop production industry to Prince Edward Island and Canada

4.2 describe production techniques for a variety of vegetable commodities

4.3 analyse the role of technology in the production, processing, transportation, and marketing of agricultural products

4.4 discuss trends and challenges to the industry

Elaborations - Suggestions for Learning and Teaching

The overall contribution of agriscience to the social, economic, and environmental development of Prince Edward Island was outlined in the introduction section of this course. Teachers should provide a brief overview of the vegetable, fruit, grain and oil seed, and forage products. The remainder of this section focuses on the importance of the vegetable industry to Prince Edward Island and Canada. The overview of crop products and the detailed description of the vegetable industry will prepare students to conduct a crop investigation in the subsequent section.

Students should be able to identify various types of vegetables, and varieties of potatoes, grown on Prince Edward Island. In particular, they should discuss the importance of the potato industry, and its sectors, to Prince Edward Island's economy, environment, and society.

Time constraints do not allow for students to describe the production techniques of all vegetable commodities grown on Prince Edward Island. Teachers may select a variety common to the area or focus on the Island's largest vegetable commodity - potatoes. Items to identify and discuss in a vegetable's production technique would include

- variety selection and uses;
- soil management;
- planting methods and considerations;
- common pests (diseases, wildlife, insects, viruses, fungi, weeds, bacteria);
- the advantages and disadvantages of various pest and disease control methods (IPM, cultural control, biological control);
- harvesting techniques and equipment;
- storing techniques and facilities;
- processing techniques and facilities;
- food safety and traceability;
- marketing strategies.

Advances in agriscience and technology have been used to address specific plant production needs. Students should be able to describe these applications and how they have improved farming practices. Examples include seed bed preparation/soil fertility (zero till), planting/harvesting (air seeders), weed and pest control, biotechnology, plant propagation, maintaining soil moisture levels (hydroponics/irrigation), improved production and yields, food safety, and traceability.

A discussion of trends and challenges to the industry should be driven by current events at the local and global level. Issues pertaining to vertical integration, production quotas, and new crop opportunities (e.g., bioscience, nutriceuticals) should be discussed. The teacher may wish to tie these topics to the earlier examination of food sovereignty and security issues. Students should also discuss what challenges and opportunities exist in the vegetable industry with regard to career opportunities now and in the future.

Vegetables

Tasks for Instruction and/or Assessment

Journal

- In your opinion, what is the most important vegetable currently produced on Prince Edward Island? Why? (4.1)
- What do you feel is the greatest challenge faced by the vegetable industry? (4.4)

Paper and Pencil

- How does potato production affect the Prince Edward Island economy, environment, and culture? (4.1)
- Using the information provided by your teacher, describe the production techniques for a locally produced vegetable. (4.2)
- What career oportunities are available in the vegetable industry on Prince Edward Island? (4.4)

Presentation

- Select an advance in agriscience and technology that addresses a specific plant production need (e.g., zero till, air seeders, biotechnology, irrigation). Describe to a group of your classmates how this advance has improved production and yields, food safety, or trace ability. (4.3)

Performance

- As a class, grow different varieties of potatoes in your school's greenhouse. Describe their growing requirements, unique characteristics, and why they are well suited for Prince Edward Island's soil. Please note that due to disease control protocols, potatoes should be grown in the school and not outdoors. (4.1, 4.2, 4.3)

Resources/Notes

Internet: Prince Edward Island Department of Agriculture Factsheets
http://www.gov.pe.ca/agriculture/

Internet: Food Country Webisodes with Chef Michael Smith
http://chefmichaelsmith.com/food-country/

Internet: Atlantic Canada Potato Guide
http://www.gov.pe.ca/af/agweb/index.php3?number=1001552

Investigation

Outcomes

Students will be expected to

4.5 investigate a selected crop production issue using a guided inquiry process

Elaborations - Suggestions for Learning and Teaching

The outcomes for this section can be addressed by providing students with an opportunity to conduct in-depth investigations of current real-world issues and challenges related to crop production. Students would obtain a deeper knowledge of the subject area through inquiry, research, experimentation, and/or the assistance of a community mentor. Students should be asked to present their investigation to the class and to a group of community mentors/experts. Through questioning, students will be exposed to other various perspectives and, as a result, will be expected to better appreciate the importance of communication and review in presenting new information. The end product and presentation would answer a specific inquiry question related to crop production. Some example questions include:

- Should we be growing crops for fuel instead of food?
- Is genetic engineering the only way to increase food production?
- How can farmers ensure environmental sustainability as well as increase food production when pressure on environmental resources like land and water is growing?
- Is there a difference between applications of biotechnology in agriculture and medicine? Why are the two perceived differently?
- How can the food security or food sovereignty issues of developing countries be safeguarded?

Investigation

Tasks for Instruction and/or Assessment

Performance

- Conduct an in-depth investigation of a current real-world issue or challenge related to crop production. The end product and presentation should answer a specific inquiry question related to crop production. Your investigation should include
  - developing a plan to investigate your question, idea, problem, or issue;
  - conducting an investigation into the relationships between and among variables, using a broad range of tools and techniques;
  - analysing the data to develop and assess possible explanations;
  - communicating your information, ideas, and results. (4.5)

Resources/Notes

Green Spacing

Introduction

Home gardening and green spacing can be a practical and easy way to demonstrate an understanding of soil and water management, plant biology, and crop production. Students should be provided with an opportunity to develop, and hopefully carry out, a plan to grow a garden and develop a community green space. These hands-on opportunities to plan and create a green space can make the concepts learned throughout the course more authentic and meaningful.

Focus and Context

All three processes of inquiry, problem solving, and decision making will be explored in this unit as students apply the concepts and knowledge from previous units to the local level. They will develop a plan to grow a garden and develop a green space in their local community. Their prior course experience will help them determine what plants should be selected and how to grow and care for them.

Science Curriculum Links

By the end of Grade 3, students have explored plant growth and changes. Students learn about soil types and soil enrichments in Grade 7 science. The concept of how biotic and abiotic factors affect living things was addressed in Science 421A/431A.

621A Curriculum Outcomes

Students will be expected to

5.1 identify environmental factors in the successful selection of plants for a garden on Prince Edward Island

5.2 create a plot plan for a local fruit and vegetable garden

5.3 work collaboratively to create a green space within their school or community

Home Gardening and Landscaping

Outcomes

Students will be expected to

5.1 identify environmental factors in the successful selection of plants for a garden on Prince Edward Island

5.2 create a plot plan for a local fruit and vegetable garden

5.3 work collaboratively to create a green space within their school or community

Elaborations - Suggestions for Learning and Teaching

In the Plant Physiology section of the Plant Biology unit, students described the requirements (e.g., nutrients, heat, water, light) for the production of a plant commodity. The outcomes of the Home Gardening and Landscaping section build on this prior knowledge by having the students select a fruit or vegetable that can be grown in a home garden on Prince Edward Island. The Agriculture and Agri-Food Canada website (http://www.agr.gc.ca) allows users to search The Plant Hardiness Zones map which outlines the different zones in Canada where various types of trees, shrubs, and flowers will most likely survive.

Once students have determined what type of plant will most likely survive on Prince Edward Island, they are to generate a plot plan for the fruit or vegetable that they have selected to grow (this project could be done in conjunction with, or as an extension of, the soil experiment outlined in the Soil and Water Management unit). Their plan should include planting dates, harvesting dates, soil amendments, and pest control. Ideally, each student will have the opportunity to plant some vegetable and flower seeds and care for the young plants. Students taking this course in the Fall may have to grow their plants to maturity inside. Students taking this course in the Spring should be encouraged to transplant them into their home or community garden when they are able to survive outside.

Students may choose to work collaboratively in creating a community garden at their school where they could transplant their fruit, vegetables, or flowers. Alternatively, a hands-on continuous project could be to design and implement a school beautification green space. This green space could be a continuous project that is maintained and expanded by subsequent classes. Students should be encouraged to work with other students, teachers, and the community in creating the green space and in promoting its importance to their school environment. Teachers and students may wish to explore the Greening Spaces Program offered through the Prince Edward Island Department of Environment, Energy and Forestry for additional assistance and information.

Home Gardening and Landscaping

Tasks for Instruction and/or Assessment

Journal

- Do you think that everyone on Prince Edward Island should have their own garden? (5.3)

Paper and Pencil

- Identify trees, shrubs, flowers, fruits, and vegetables that can be successfully grown in Prince Edward Island gardens. (5.1)

Performance

- Gather information on the Greening Spaces Program offered through the Prince Edward Island Department of Environment, Energy and Forestry. Use this information, or other sources, to work collaboratively to plan and create a green space for your school or community. (5.3)

- Create a plot plan for a local fruit and vegetable garden that includes planting dates, harvesting dates, soil amendments, and pest control. (5.2)

Resources/Notes

Internet: Agriculture and Agri-Food Canada Website
http://www.agr.gc.ca/

Internet: Prince Edward Island Department of Agriculture and Forestry Greening Spaces Program
http://www.gov.pe.ca/agriculture/index.php3?number=1036445&lang=E

Internet: Veseys Seeds Planting Guides
http://www.veseys.com/

Appendix A

Glossary of Terms

This glossary defines terms as used in this guide. The glossary is provided for clarity only and is not meant to be an exhaustive list of terminology related to this curriculum.

A

Agriculture – the broad industry engaged in the production of plants and animals, the provision of agricultural supplies and services, and processing, marketing, and distribution of agricultural products.

Agriscience – the application of scientific principles and new technologies to agriculture.

Allele – a matched pair of genes that control a characteristic.

ALUS – Alternate Land Use Service. A voluntary program for PEI landowners and farmers that protects water, fish, and wildlife habitat.

Asexual reproduction – propagation using a part or parts of one parent plant.

B

Biodiversity – the variety of different species and ecosystems within the environment.

Biofuel – liquid, solid, or gaseous energy sources created from organic materials that come from agricultural products.

Biosecurity – methods to reduce disease transfer.

Biotechnology – use of cells or components of cells to produce products or processes.

Breeding – the activity of controlling the mating and production of offspring of plants and animals.

Buffer zone – an area of land designated for environmental protection.

Byproducts – a secondary product left from the production of a primary commodity.

C

Canola – a genetically engineered plant that produces an oil-bearing seed.

Cash crop – a crop grown for cash sale.

Cereal crop – grain or a product made from grain.

Certified organic – producing food without the use of chemical fertilizers or pesticides.

Chromosome – condensed strands of genetic material in the nucleus that determine the characteristics of an organism.

Cloning – producing an organism by asexual means, with the exact same genetic makeup as another.

Commercial agriculture – the production of crops for sale and distribution to wholesalers or retail outlets (e.g., supermarkets).

Commodity – a primary agricultural product that can be bought and sold.

Contour ploughing – ploughing across the slope of the land to prevent soil erosion.

Cover crop – crops established for the purpose of adding organic material to the soil. They are usually planted in the winter and ploughed under in the spring.

Crop – a cultivated plant that is grown as food.

Cultural eutrophication – overnourishment of aquatic ecosystems with plant nutrients (usually nitrates and phosphates) because of human activities such as agriculture, urbanization, and discharges from industrial plants.

Cutting – vegetative part removed from the parent plant and managed so it will regenerate itself.

D **Dichotomous key** – a written tool used for the identification of plants and animals.

Dicot – plants whose seed have more than one cotyledon or seed leaves, such as beans.

DNA – deoxyribonucleic acid, the genetic compound that controls inheritance.

Dominant gene – a gene that expresses its characteristics over the characteristics of the gene with which it is paired.

E **Eukaryotic cell** – cells that contain a membrane-bound nucleus and other membrane-bound organelles.

F **Fallowing** – land that is ploughed and tilled but left unseeded during a growing season.

Farming – the activity or business of growing crops or raising livestock or poultry.

Fertilizer – any organic or inorganic material added to soil or water to provide plant nutrients and to increase the growth, yield, or quantity of the plants.

Food justice – a view that no one should live without enough food because of economic constraints or social inequalities.

Food security – refers to the availability of food and one's access to it.

Food sovereignty – to define one's own food, agriculture, livestock, and fisheries systems, in contrast to having food largely subject to international market forces.

Forage – livestock feed that consists mainly of the leaves and stalks of plants.

Fruit – mature ovary; the structure of the plant that contains its seed.

G **Genes** – small coded pieces of DNA.

Genetics – study of how organisms pass on characteristics from one generation to the next.

Genetic engineering – the alteration of the genetic components of organisms by human intervention.

G **Genetically modified organism** (GMO) – organism whose genetic makeup has been modified by genetic engineering.

Genotype – actual genetic code of an organism.

Germination – the process of a plant emerging from a seed.

Global warming – warming of the Earth's atmosphere because of increases in the concentration of green house gases primarily as a result of human activities.

Grafting – the process of joining parts of different plants together to form a new plant.

Greenhouse – a structure covered in glass or plastic that is heated or cooled to provide the proper environment for growing plants.

Grains and oil seeds – cultivate cereal crops used for food.

H **Hardiness** – a plant's ability to survive adverse growing conditions.

Heritability – The extent to which a characteristic of a living organism is genetically determined rather than shaped by the surrounding environment.

Heredity – characteristics that are passed from parent to offspring.

Heterozygous – having one copy of two different genes.

Homozygous – having two copies of the same gene.

Hydrological cycle – the complete cycle through which water passes, commencing as atmospheric water vapor, passing into liquid and solid form as precipitation, into the ground surface, and finally again returning in the form of atmospheric water vapor by means of evaporation and transpiration.

I **Integrated pest management** (IPM) – a system of controlling pests that includes a variety of methods.

Irrigation – addition of water to plants to supplement that provided by rain or snow.

L **Layering** – the method of propagating plants by covering portions of their stems or branches with soil so that they take root while still attached to the parent plant.

M **Mendelian genetics** – the branch of genetics concerned with inheritance.

Monocot – plants having a single cotyledon or seed leaf, such as corn.

Monoculture – the cultivation of a single crop in a given area.

N **No-till farming** – a method of farming where the land is not ploughed before planting. It can increase the amount of water and nutrients in the soil and reduce erosion.

Nonpoint source pollution – pollution that enters the environment from large areas such as crop fields, streets, and lawns.

Nutrient – a substance that aids in the support of life.

Nuts – hard shelled fruit of some plants.

P

Pesticides – substances that are used to kill pests.

Phenotype – the observed characteristic of an animal without regard to its genetic makeup.

Photosynthesis – the process by which green plants, using chlorophyll and sunlight, produce carbohydrates from water and carbon dioxide.

Point source pollution – pollution that enters the environment from a single, identifiable source.

Pollination - transfer of pollen from anther to stigma, allowing for sexual reproduction in plants.

Processing – a business engaged in processing agricultural products and preparing them for market.

Prokaryotic cell – cells that do not have a membrane-bound nucleus and lack other membrane-bound organelles.

Propagation – to create new organisms from old organisms.

Punnett square – a diagram that is used to predict the results of genetic crosses.

R

Recessive gene – a gene that remains hidden and only expresses itself in the absence of a dominant gene.

Respiration – a process in which energy and carbon dioxide are released due to digestion or the break down of plant tissues during periods of darkness.

Riparian zone – thin strips and patches of vegetation that surround streams.

Runoff – water that flows across the ground after a rain.

S

Selective breeding – choosing the best plants or animals and using those plants or animals for breeding purposes.

Sexual reproduction – reproduction that requires the uniting of an egg and a sperm.

Soil – the mineral and organic surface of the earth capable of supporting plants.

Soil amendment – any material added to the soil that improves it.

Soil degradation – a severe reduction in the quality of soils, often accelerated by human activities.

Soil erosion – the wearing away of the soil through the action of wind or water.

Stewardship – refers to our responsibility to care for our natural resources sustainably so future generations can enjoy them.

Strip cropping – the planting of different crops on alternating strips of land to prevent soil erosion.

Subsistence agriculture – agriculture in which farmers only grow enough food to feed their families.

Sustainable agriculture – agricultural practices aimed at maintaining yields of plants and animals over a period of time.

T

Taxonomy – the structured classification system for organisms.

Technology – application of science to an industrial or commercial objective.

Terracing – making a number of flat areas resembling a set of steps on steep slopes to reduce soil erosion.

Tissue culture – the process of making plant or animal tissue grow in a culture medium outside the organism.

Traceability – record-keeping systems that provide the ability to identify the path and the history of an animal, food product, or food ingredient through the food supply chain.

Transpiration – process by which a plant loses water vapor.

U

Urbanization – the physical growth of rural areas into cities and the transformation of land from agricultural to urban.

V

Vegetable -

Vertical integration – occurs when several steps in the production, marketing, and processing of plants or animals are joined together.

Vegetative propagation – asexual reproduction in plants by methods such as cuttings, grafting, or layering.

W

Wetland – a parcel of land that stays wet for most of the year.

Windbreak – rows of trees or hedges planted to partially block wind flow and reduce soil erosion on cultivated land.

Appendix B

Agriculture Timeline

Timeline of Agriculture and Food Technology

- 12000 BC – Neolithic Revolution, the initial transition from hunting and gathering to settled agriculture, begins in the modern Middle East.
- 11500 BC (to 6,200 BC) – Rice domesticated in China.
- 8500 BC –sites across the Fertile Crescent growing domestic wheat, barley, chickpeas, peas, beans, and flax. Sheep and goat are domesticated.
- 7000 BC – Domestication of cattle and chicken in Pakistan.
- 6000 BC – Granary built for storage of excess food.
- 4000 BC – Egyptians discover how to make bread using yeast.
- 4000 BC – First use of light wooden ploughs in Mesopotamia (Modern day Iraq).
- 3500 BC – Irrigation being used in Mesopotamia.
- 1700 BC – Wind powered machine developed in Mesopotamia.
- 500 BC – The moldboard iron plough is invented in China.
- 900 – Wind powered, geared gristmills (machines that grind wheat into flour) developed and built in present-day Afghanistan, Pakistan and Iran.
- 1000 – Cash cropping and a crop rotation system in which land was cropped four or more times in a two-year period is introduced in the Islamic Empire.
- 1000 – The Islamic Empire introduced agricultural innovations such as a variety of sophisticated irrigation methods and the introduction of fertilizers.
- 1804 – Canadian David Fife develops first rust resistant wheat.
- 1809 – French confectioner Nicolas Appert invents canning.
- 1837 – John Deere invents steel plough.
- 1866 – Gregor Mendel publishes his paper describing Mendelian inheritance.
- 1871 – Louis Pasteur invents pasteurization.
- 1892 – John Froelich invents and builds the first gasoline-powered tractor in the United States.
- 1895 – Refrigeration for domestic and commercial food preservation introduced in the United States and the United Kingdom, respectively.
- 1944 – Green Revolution begins in Mexico.
- 1974 – China creates the first hybrid rice, thus starting a food revolution that has benefited tens of millions around the world.
- 2000 – Genetically modified plants cultivated around the world.

Appendix C

Maritime Agriculture - A Brief History

Resource Notes:

Agriculture has been a part of Maritime history for over three centuries. It had its beginnings with the arrival of the first non-natives to the region.

The first European settlement in the Maritimes was at Port Royal (now Annapolis Royal) in 1605. The French settlers grew wheat, oats, and flax. They also brought with them cattle, horses, sheep, goats, and poultry. In the ensuing years, French settlements were established throughout Acadia, which is present-day Nova Scotia, New Brunswick, and Prince Edward Island. Their ancestors today are known as Acadians, many of whom still farm.

The French settlers suffered a great deal of hardship in establishing a subsistence farm economy in the Maritimes. They had to contend with harsh conditions and often with tragedy. For instance, in PEI, major foes were mice which ate the settlers' crops. In fact, the town of Souris (the French word for mouse) was named after this occurrence. In addition to the hardship created by the natural environment, the Acadians had to contend with uncertainty resulting from wars between Britain and France.

After the French, several other immigrant groups began to arrive in the Maritimes, many of whom involved themselves in agriculture. Immigrants came from England, Scotland, Ireland, Switzerland, Germany, and the United States. This latter group came to the Maritimes in the 1770's, during and after the American Revolution. They are commonly known as United Empire Loyalists. Many of the Loyalists settled in the Saint John River Valley. Other groups settled in NS and PEI.

Regardless of their origins, the settlers sought a new life and opportunity, and farming was a natural course to follow. Many had experience in the vocation prior to their arrivals. As well, farming offered the security of owning land and brought a renewed sense of independence. The settlers worked hard pulling stumps and tilling the soil with rather crude implements. The real beneficiaries of their efforts were the generations to follow.

Until the 1800's, agriculture in the Maritimes was practised at a subsistence level. That is, many of the farmers produced for their own needs and perhaps bartered any excess produce with neighbours. It was not until the mid-1800's that agriculture began to develop into a major industry. These were the days of trade reciprocity with the US, which needed food for its rapidly expanding population. More people were going into farming. Small canneries and other agriculture-related industries sprang up throughout the Maritimes. The agricultural economy was expanding and booming. Times were good. In fact, this was one of the major reasons that the Maritime colonies were hesitant to join a federation called Canada. However, by the mid-1860's, reciprocity with the US had run its course, and the boom times in agriculture had ended.

Between the 1880's and 1920's, agriculture entered a decline, and many Maritimers left the industry. This period of decline was followed by the Great Depression in the 1930's. Although life on the Maritime farm did not promise riches, it did ensure survival. During the Depression, survival on the Maritime farm was preferable to the soup lines found in American or Canadian cities. People remained on the farm, and many others were attracted back to the industry. Agriculture remained reasonably stable during World War II, doing its part to support the war effort.

Labour-saving devices were being introduced into agriculture throughout the 19th and 20th centuries. However, it was following WWII that the full force of mechanization was felt. The team of horses gave way to a tractor on the average farm, and many new and improved implements were being made available to farmers. Mechanization allowed the farmer to till more land with less labour. As a result, farms grew larger in size. The combination of mechanization and farm expansion meant fewer people were required in order to produce farm products. Consequently, many people left farming and the rural areas to make a living in urban centres.

The face of agriculture has changed dramatically over the past forty years. Farming has moved away from the traditional mixed operation towards specialization, whereby a farmer grows one or two crops and raises one or two species of livestock. Modern technology is commonplace on Maritime farms as evidenced by huge tractors and computerized cattle feeding systems. As well, businesses associated with farming, such as food processing firms, have become modernized. Today, Maritime agriculture is a world class industry, able to compete on an international scale.

Despite the trend in agriculture toward expansion, there have been some interesting developments within the industry in recent years. While there has been an increase in the numbers of large commercial speciality farms, there has also been an increase in small speciality farms. The net result is that the overall number of farms has remained stable.

While increasing production remains a major thrust in Maritime agriculture, other factors have gained importance in recent years. These include an emphasis on marketing, managing farm debt, and managing the agricultural resources. It will be interesting to see how this most dynamic industry meets these challenges.

Resource Notes:

Agriculture has played an important part in the social development of the Maritime provinces. At one time, much of the region's population lived in rural areas and was most likely involved in farming or was well aware of developments in the industry. Today, although most Maritimers live in cities or towns, farming still plays a role in people's lives. Whether it be a source of employment, business, or social values, agriculture's influence continues to be felt.

Farmers are often noted for their sense of independence and self-reliance. For the farmer, this spirit is embodied within the land. Land not only represents security in an uncertain world, but it also represents freedom from outside interference and the continuance of the way of life.

Farmers have traditionally guarded their land holdings in order to preserve their sense of independence. This was true of the initial settlers, and it has continued to the present day. In fact, much of the political and social history of the Maritimes has revolved around issues concerning land. For instance, the absentee landlord and land use issues have tended to dominate Prince Edward Island's political and social history.

The romantic image of the strong, independent farmer is common. However, it tends to misrepresent the farmer's full character. Farmers recognize the importance of others to their well-being. The farmer views his relationship with the outside world as interdependent.

The farmer's reliance on others actually begins at the farm level with the family. Traditionally, the farmer, spouse, and children have all been involved in operating the farm. This family effort has tended to develop and strengthen family relations. Because farming by nature is a family affair, parents and children not only live together but work together. Farming is one of the few vocations where the whole family is involved in making a livelihood. In fact, the words "family" and "farm" are often used together to describe farming in the Maritimes.

Both men and women have played an important role in the development of agriculture. Farming is often viewed as a partnership involving the husband and wife. Consequently, there has been a higher degree of sexual equality within farm families.

The farmer's reliance on others is not limited to the family. The community also plays a significant role in the farmer's life. In order to keep their operations going, farmers often cooperate. This may involve bartering their labour and machinery. In some cases, farmers form cooperatives through which they purchase goods and services and/or market their products. As a result, farm communities have a strong sense of community and unity. This unity is also complimented by their community institutions such as churches and schools. For example, until two decades ago, school children had a holiday in the fall months so they could help with the harvest.

Farming and rural lifestyle have undergone significant changes in this century, particularly since World War II. Agriculture has become more mechanized and farm sizes have increased. This has meant the number of farms in the Maritimes has decreased. For instance, the number of Maritime farms in 1946 was approximately 50,000 compared to 12,000 in 1984. As a result, rural communities have lost a number of residents. At the same time, our urban centres have grown.

Despite the move from the rural to urban areas, farming remains an important part of the social life in the Maritime provinces. A number of cities and towns rely on agriculture for their social and economic well-being. This includes places like Hartland, NB, Truro, NS, and Kensington, PEI. Agriculture gives these communities life, and many people organize their lives around the industry.

Agriculture has provided some important contributions to Maritime society. Beyond its economic importance, farming has made a social contribution. Its particular emphasis on family and community is in some ways ideal. The industry has changed over the years. However, it continues to be a source of social well-being.

Appendix D

Who Are the Lucky Ones?

Purpose:

a. To illustrate the vast inequalities in distribution of resources brought about by the workings of present global economic systems, with special reference to food.

b. To encourage a questioning attitude toward the morality of the way goods are now distributed.

Equipment:

1. Bowl of wrapped candies (twice as many candies as there are players)

2. Set of chance cards (exactly as many cards as there are players)
Thirty chance cards are included with the game.

If you have less than thirty participants in your group, eliminate the cards with the highest numbers. (i.e., if you have 25 students, take out numbers 26-30)

How The Game Works:

a. Explain to the group there are 60 treats in the bowl (or twice as many treats as players). Possibly discuss with them how they think these should be distributed to the group.

b. Tell them that today there will be a game with real treats. How many each student gets will depend on the luck of the draw.

c. Have each student come to the front of the room, choose a chance card, read it aloud to the rest of the group, and follow the instructions on it. Unless the card tells them not to, they should start to eat their treats immediately upon getting them. They then place the card in a different pile and sit down.

Content of The Chance Cards:

The cards should be set up so that 80% of the members of the group get 20% of the treats and 20% get the rest. This is the approximate way the consumption of the world's resources is divided at present. For example, if 30 students are in the group and 60 treats are in the bowl, then 24 of the people will get 12 treats between them (at least 12 students will go without) and 6 students will get 48 treats between them. Cards for the 24 students who get very little give various reasons why there is so much poverty in many of the countries of Asia, Africa, and Latin America (of course, the game can only cover some of the reasons). The cards for the 6 who get the most treats cover some of the reasons why we are relatively well off.

Post-Game Discussion: The most IMPORTANT part of the Game

Plan this activity so there is time for discussion of reactions immediately following the game. By the next day, many valuable emotions will have been lost.

(a) Ask the students how they felt using the following questions as starting points for discussion.

1. Should anyone have received more?
2. Should anyone have received less?
3. Does the reason on your card seem logical to you? Did it seem fair?
4. How did you feel about the attitudes of the lucky ones? Of the unlucky ones?
5. Would you like to play the game again? If you knew you'd get the same card? If your treat was your spending money for the upcoming month? If your treat was your food for the upcoming month?
6. How could we change the game so more would get to share the treats?

(b) Does this game have anything to do with the real world (i.e., the way things are distributed in the real world)?

1. If you got 0 or 1 treat, what country did you live in?
2. If you got many treats, where did you live?
3. In the real world, what share do Canadians get?
4. How do others probably feel about us?
5. How could we improve the chances of the unlucky ones in the real world without increasing the total supply of resources?
6. How could we increase the resources available (e.g., increase supply / decrease price, lower illiteracy rates, unemployment, price structure of commodities)?
7. If we increased the supply, but the distribution system stayed the same, how much would that improve the relative position of the unlucky ones

1. A flood wiped out your family's crops and you have no money. Take **NO** treat.	2. Because of the efforts of a Canadian well driller, your village now has water to use on the fields. Therefore you can now afford **ONE** treat.
3. You just graduated from school and were lucky enough to get a job. However, you need all your money to help send your younger brother to school. Take **NO** treat.	4. There was such a bad draught that the crops your family planted didn't grow. You **CANNOT** have a treat.
5. Your family's small farm produced very little this year because fertilizer costs were too high to afford. Take **NO** treat.	6. Your father got free schooling and now has a very good job. Take **TEN** treats and eat as many as you can as fast as you can.
7. You have just helped the family harvest the crop. It has been very hard work. You can now afford **ONE** treat.	8. Using what you learned in school, you helped your family grow a garden this year. You can afford **ONE** treat.
9. Your family crop was mostly eaten by locusts this year and you couldn't afford pesticides. Take **NO** treat.	10. Your parents both have tuberculosis and are too ill to work. Take **NO** treat.
11. Your family grows coffee. Since the crop was very good this year, there is a surplus and the price has fallen. You may have **ONE** treat instead of the two you got last year.	12. Your father just got a big wage increase. You may take **EIGHT** treats. Eat as many as you can as fast as you can.
13. A teacher taught your family how to keep a few chickens to provide you with eggs to improve your health. You can now afford **ONE** treat.	14. Your father goes blind due to an infection from the water. Your mother cannot work because she has no one to look after the children. Take **NO** treat.

15. Your family has just harvested a big crop of jute (used to make Burlap bags). Since many buyers of jute have switched to using plastic bags, the price of jute has fallen. You may have **ONE** treat instead of the two last year.	16. Your family owns and runs a small business. Because you all have worked hard, you have done quite well. You may have **EIGHT** treats. Eat as many as you can as fast as you can.
17. Your father cannot get a job because he cannot read or write. (There was no school in your village when he was young). Take **NO** treat.	18. Even though your parents are unemployed, they get insurance payments because you live in a developed country. You may have **FOUR** treats. Eat as many as you can as fast as you can.
19. Your father has been looking for a job, but there are many people applying for jobs and he hasn't gotten one yet. Take **NO** treat.	20. You harvested a big crop this year. You would be able to afford three treats if the farm were yours, but you have to give 2/3 of your income to the landowner who lives in a big house in the city. Take **ONE** treat.
21. Your father just lost his job in a factory that makes cloth. The wealthy country which has been buying much of the cloth decided they should produce more of their own cloth. Take **NO** treat.	22. Your family's food bills have gone up this year because of large orders for grain and soybeans to fatten the beef cattle in a wealthy country. Take **TWO** treats. Eat **ONE** now and at the end of the game give ONE to the person who got the most treats.
23. Your father has a good job but he must pay school fees for you and your three sisters. Take **ONE** treat.	24. Your family has just inherited a great deal of money from a wealthy relative. You can have **TWELVE** treats. Eat as many as you can as fast as you can.
25. All of your family's income this year was needed to cover the hospital bills when you broke your leg. Take **NO** treat.	26. Your parents both work, although their wages are not high. You can afford **SIX** treats. Eat as many as you can as fast as you can.

27. Although your family is one of the wealthiest in the village, they have spent a lot of money for your grandfather's funeral. (People would have thought you were very disrespectful if you hadn't) Take **ONE** treat.	28. Your father works at an iron mine. Raising his wages would mean that the company would get fewer profits for the owners in the wealthy countries. Take **ONE** treat.
29. Your father works on a fishing boat, but the fish he catches are sold to feed pets of wealthy people. Take **TWO** treats. Eat **ONE** now and at the end of the game give ONE to the person who got the most treats.	30. Ever since your father got sick with malaria, he couldn't work. Take **NO** treats.
31. Your father died before he could pay his debt. You have inherited his debt. Take **NO** treats.	

Appendix E

World: A Community of 1000

In a world of 1000 persons,

180 of us live high on a hill called the developed world;
820 live on the rocky bottom land called the rest of the world.

The fortunate **180** on the hill have **80** percent of the wealth of the whole town, over half of all the rooms in town with over two rooms per person, **85** percent of all the automobiles, **80** percent of all the TV sets, **93** percent of all the telephones, and an average income of **$5000** per person per year.

The not so fortunate **820** people on the bottom get by on **$700** per person per year, many of them on less than $75. They average five persons to a room.

How does the fortunate group of hill-dwellers use its incredible wealth? Well, as a group they spend less than 1 percent of their income to aid the lower land. In the United States, for example, of every $100 earned,

$18.30 goes for food;
$6.60 is spent on recreation and amusement;
$5.80 buys clothes;
$2.40 buys alcohol;
$1.50 buys tobacco;
$1.30 is given for religious and charitable uses and only a small part of that goes outside the U.S.

How do you suppose the villagers on the crowded plain, a third of whose people are suffering from malnutrition, feel about the folks on the hill?

Appendix F

Farmers Helping Farmers
Global Classroom Initiative

Global Classroom Initiative

"Connecting Classrooms and Communities for Global Awareness"

Additional Resources in Global Awareness for Agriscience 801A/621A & Animal Science 801A/621A

Introduction

The intent of the following lessons is to provide students/teachers with additional resources in support of the following curriculum outcomes as described in the P.E.I. Department of Education and Early Childhood Development Curriculum Guide for Agriscience 801A/621A:

1.6 demonstrate an awareness of the principles of food sovereignty and food security

1.7 identify and discuss the factors that affect sustainability of an agricultural system

1.9 demonstrate an awareness of economic trends and issues pertaining to agriculture

IMPORTANT NOTE:
THE LESSONS IN THE FOLLOWING UNIT ARE DEVELOPED AT TWO LEVELS IN ORDER TO MEET THE DIVERSE LEARNING LEVELS IN THE AGRISCIENCE CLASSROOM.

Level 1 is designed for students who need very specific tasks in order to achieve.
Lessons 1-6, pages 150-179
Level 2 is intended to provide challenging activities for the independent learner.
Activities 1-10, pages 181-195

Caution to teachers regarding web site URLs:

At the time of publication, the web sites contained within this module were functioning and appropriate in content. However, with time, there is always a possibility that the URLs have moved, become non-functional, or corrupted. Teachers are advised to check out each URL before distributing to students to ensure that the integrity of the site is intact.

Caution regarding use of resources:

In each of the Global Classroom Units, references have been made to organizations that assist others around the world, or articles and news clippings have been included as resources. While care has been taken in their selection, teachers are reminded to use their professional wisdom and judgement when using the resources. Materials, as is common practice, should be pre-viewed before used by students. Organizations and media, however noble the cause, will represent their own agendas; thus students and teachers must critically evaluate each source.

Lesson I - Drought: A Challenge that a Farmer May Face in Kenya

Estimated time to complete: 1 class for research, 1 to make posters

THEME: Lack of access to water due to drought has a major impact on the lives of many farmers and their families in Kenya and other countries in the eastern part of Africa.

Students will locate the following internet site: http://www.unicef.org/childalert/hornofafrica/.
This site is a multi-media report on how the drought is impacting life for people in 'The Horn of Africa'. Several topics are listed at the left side of this web page.

Student Instructions:

1. Click on the interactive map: ***drought cycle***. Make sure you have the map displayed high enough on the screen so you can read the information at the bottom. Click on the arrows under the map to move forward or to review the previous information.

Answer the following questions on the worksheet:

a. Where is the Horn of Africa?
   Why do you think this area has been given this name?
   What countries are included? (5 in all)
   What is a pastoralist?
   How many are there in this area?

Note: Kenya is considered to be in East Africa, although on the above UNICEF site it is included as part of the Horn of Africa.

b. This area has two rainy seasons.
   Describe the long rain - when does it normally happen?
   When does the short rain normally happen?
   In what ways are these rains important to the pastoralists?

c. What happened in 2006 to the expected rains?
   Look at the bar graph. About what percent of Kenya was affected by the drought?
   In 1998 to 2000, how many people in the area died due to that drought period?

d. When the rains returned in the late spring of 2006, what challenges were faced by the farmers and their families even though there was now enough rain?

2. View the following videos and photo essays that are listed on the left of the home page above:
   Photo essay: Child Pastoralists
   Video: Malnutrition
   Video: Falling Behind
   Video: Conflict for Resources
   Video: The Burden on Children
   Video: Disease
   Video: The Burden on Mothers

3. NOTE: Since November 2006, several countries in the Horn of Africa (such as Somalia, Kenya, Ethiopia), that had not yet recovered from several years of extreme drought, have been now hit by much higher than normal rainfall in the short rainy season. This has in turn created more problems for local people.

Read the articles, *"Up to 1 million people threatened by flooding in southern Somalia, UN warns", "Flooding affects over 100,000 people in Dadaab, Kenya",* and *"Threat of disease outbreaks as flooding persists"* which explain the problems resulting from too much rain. Find and describe at least six problems caused by too much rain.

4. Assignment:
   Part 1 - Write two pages of notes in point form about the impact of drought (or of too much rain) in the Horn of Africa. Include ways in which drought or flooding impacts children, health/disease, nutrition, mothers, and the future prospects for the family. These notes are to be handed in with the poster.

   Part 2 - Using the information you gathered from the video, make a poster showing some of the effects of lack of rain **or** the impact of too much rain.

   Guide for Assessment of Research and Poster

   Part 1 - Research (25 marks)
   - 2 pages of point form notes are to be passed in with the poster
   - notes are to be included from:
     - answers to questions (a completed work sheet)
     - a photo essay (Child Pastoralists)
     - video sites (words under pictures)
     - article

   Part 2 - Poster on 11" x 17" Paper (50 marks)
   - suggested evaluation criteria:
   - title (1)
   - 5 sketches (10)
   - 20 facts (20)
   - 5 colours/shading (5)
   - creativity (4)
   - effort (10)

Name:_____

Activity Sheet: The Impacts of Drought and Flooding

1. Using information given on the video clips, answer the following questions on the impact of drought.

a. Where is the Horn of Africa? _____
Why do you think this area has been given this name? _____
_____
What countries are included? (Five in all) _____
What is a pastoralist? _____
_____
How many are there in this area? _____

b. This area has two rainy seasons.
Describe the long rain - when does it normally happen? _____
_____
When does the short rain normally happen? _____
In what ways are these rains important to the pastoralists? _____
_____

c. What happened to the expected rains early in 2006? _____
_____
Look at the bar graph. About what percent of Kenya was affected by the drought? _____
Between 1998 to 2000, how many people in the area died due to that drought period?
_____

d. When the rains returned in the late spring of 2006, what challenges were faced by the farmers and their families even though there was now enough rain? _____
_____

2. Since November 2006, several countries in the Horn of Africa or east Africa (such as Somalia, Kenya, Ethiopia) that had not yet recovered from several years of extreme drought have been hit by much higher than normal rainfall in the <u>short</u> rainy season. This has in turn created more problems for local people.

3. The following article, *"Up to 1 million people threatened by flooding in southern Somalia, UN warns"* explains some of the problems resulting from too much rain.

   a. Find six problems caused by too much rain._____ _____
   _____

   b. How do you think too much rain affects farmers in Kenya? _____
   _____
   _____

Lesson II - Protecting Soil and Water: A Challenge for a Farmer in P.E.I.

Estimated time to complete: 1 - 2 classes

Theme: A challenge for farmers in P.E.I. and other provinces is protecting our soil and water supply. Currently, P.E.I. has much more water and arable soil than many parts of the world. This resource must be protected to ensure future supply.

Student Instructions

Part A: Protecting our water supply

1. Go to the following web-address:
   http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1187368724250&lang=eng

2. Watch this video (Use "pause" as necessary).

3. Assignment: From this video clip, answer the following questions by completing the Robocow Activity Sheet that follows this lesson.

   a. What water safety hazards did Robocow find on the farm?
   b. What were the solutions for each hazard?

Part B: Conserving our Soil and Water

4. Go to the following web-site for the Eastern Canada Soil and Water Conservation Centre.
   http://www.ccse-swcc.nb.ca/bmp/index.cfm
   For teacher information, the relevant information from this web-site is included with this lesson.
   It is important to note that the following agencies have supported the development of this site:
   - New Brunswick Agricultural Council (funding - Canadian Adaptation and Rural Development)
   - Agriculture and Agri-Food Canada
   - New Brunswick Department of Agriculture, Fisheries and Aquaculture
   - several cooperative producer and farm organizations

5. Click on "Soil Conservation".

6. Click on "Features" to view the 5 main sections and other information associated with these sections.

7. Assignment:
   Use this information to make a flow chart on a large piece of paper.
   Include the following:
   - title
   - 39 pieces of information from the site (main sections and corresponding subsections)
   - 1 sketch for each of the 5 main sections

Summary Activity for Lessons 1 and 2: Comparing and Contrasting P.E.I. and Kenya

A. Write a page about the importance of farmers' contributions to a prosperous community, referring to Kenya and P.E.I.

OR

B. Discuss the following questions in a group (may be assigned individually) and submit your own answers.

1. Compared to Kenya, is it as important that our farmers are able to grow lots of food? Yes or no? State 2 reasons to support your answer.

2. List 3 things that you think might happen in P.E.I. if farmers were not able to produce food to eat and sell.

3. Compared to Kenya, state 4 ways in which farming is easier in P.E.I.

4. Besides adequate rainfall, what is important for Kenyan farmers to be successful?

5. Why is it important for farmers (and all citizens) to act in ways that protect our water and soil?

6. List 8 soil conservation methods that P.E.I. farmers can use to protect our soil.

7. List 6 ways that you personally can contribute to the protection and conservation of our water.

Summary of Video:

http://water.lgc.org/publication-resources/robocow-operation-h2o

Robocow: Operation H20
It's a bird. It's a plane. No, it's RoboCow. Able to leap tall silos in a single bound, this animated environmental advocate uses her ground-scan radar vision to detect on-farm perils. Like the best of all super heroes, she maps out solutions to hazards like improperly stored chemicals, pesticide run-off, and stream contamination. Once her mission is successfully accomplished, she flies off to seek other pastures in need of greening. This Flash animation, conceived to make students from grades six to 10 aware of best farm management practices, won an award of merit from the Association for Media and Technology in Education in Canada based in Etobicoke, ON.

FOR TEACHERS: Two other flash videos are on this site that may be of interest - see descriptions below.

http://www5.agr.gc.ca/eng/?id=1187637343829

On-farm Surface Water (Flash video)
Obtaining good quality water from farm surface water sources is challenging. The key is protecting and enhancing the water source and using a series of treatment processes. These treatment processes are called barriers. Each barrier reduces specific water quality problems from being passed on in the water. This cover screen shows how a multiple barrier approach can be used on farm dugouts to obtain high quality water for rural uses. The approach starts with managing the land effectively, aerating dugouts, and using a number of water treatment steps in sequence. The approach could be used on other similar (or better quality) surface water sources. By clicking on each barrier, a new animation will start, explaining each barrier process in more detail. A word of caution: Each barrier must be properly designed, well-operated, and regularly maintained. Multiple barriers, like a chain, are only as strong as their weakest link. If one barrier fails, the final water quality will deteriorate and may not be safe for its intended use.

http://www5.agr.gc.ca/eng/?id=1187369503771

Robocow: The Aquifer Connection (Flash video)
It was an average year by all accounts; the rainfall was adequate and the wildlife was doing well. There were no disasters or elections, the economy was doing fine, and day to day life was even to the point where the media had little news to report. The people in the city did their normal bustling to and fro, and for the farmers it was business as usual, growing their crops, managing their livestock, and caring for their resources. It was on one of these ordinary days that something appeared on the horizon, rapidly approaching. It had appeared before, at about the time when water quality in the area was beginning to suffer. Once again, things were not as they seemed. Robocow detects problems in the Aquifer.

Name:_____

"Robocow" Activity Sheet

Farm Water Problem Detected	Action Taken to Solve the Problem

Water and Soil Conservation - Eastern Canada

Web-site content summary from the Eastern Canada Soil and Water Conservation Centre web-site found at: http://www.ccse-swcc.nb.ca/bmp/bmp.cfm?numero=1

Permission has been obtained to copy information from this site.

The "Best Management Practices" describe ways in which Eastern Canadian farmers can play a major role in protecting our soil and water. When clicking on the section, "Best Management Practices", students will find sections explaining each Soil or Water Conservation practice and case studies demonstrating these best practices.

Under Soil Conservation are the following subtitles:

- Crop rotation
  - Forages
  - Cereal and oilseed crops
- Winter cover
  - Cover crops
  - Mulching
- Tillage practices
  - Conservation tillage
  - No-Till
  - Residue management
  - Tillage erosion control
- Conservation practices
  - Contouring
  - Strip cropping
  - Water erosion control structures
  - Wind erosion control
- Soil drainage
  - Surface drainage
  - Subsurface drainage
  - Alleviating soil compaction

In each of these sections and in the Water Conservation section are photos illustrating the methods of soil or water conservation.

Lesson III - Comparing the crops grown in P.E.I. to those grown in Kenya

Estimated time to complete: 2 classes if both activities are completed

Theme: What are the main crops produced and animals raised in the agricultural industry in P.E.I.? What about in Kenya? Are any of these common to both P.E.I. and Kenya? Why do you think some crops can be grown in Kenya but not in P.E.I.? What are the steps in growing potatoes and tea as examples of crops grown in P.E.I. and/or Kenya?

Student Instructions:

1. View the two sites listed below to identify the main crops that are grown in P.E.I. and Kenya. List them on the activity sheet: "Comparing Crops Grown in P.E.I. and Kenya" as you find them in the text.

   P.E.I. crops http://www.gov.pe.ca/af/agweb/index.php3?number=71208

   World - by country or crop http://www.fao.org/es/ess/top/country.html?

2. When you have gathered the information on crops, answer the questions on the activity sheet
   a) What crops are in common?
   b) Why do you think some crops can be grown in Kenya but not in P.E.I.?

3. Tea and potatoes - Using either the web-sites below or the information sheet obtained from your teacher, complete the research sheet "How crops are grown and processed" related to **tea** which is grown in Kenya and for potatoes grown in P.E.I.

Web-sites for tea growth and processing:
http://www.ashworthtea.com/how_manufacture.htm Article 1
http://www.peets.com/learn/tea_growing.asp Article 2

Website for P.E.I. potatoes: Article 3
http://www.spudinpei.com/?page=potatoes

Article 1 - How tea is grown and manufactured

The tea plant, Camellia sinensis, can be grown almost anywhere. The best teas are grown in cooler climates and/or at higher elevations.

Once the tea plant has reached maturity, the leaves can be harvested from it for many years. The leaves are harvested, in cooler climates or at higher elevations, four to five times a year. When the plant begins a growth spurt or flush, the picking is started at exactly the right time to assure that the leaves are large enough but not too old. Just the top two leaves and the bud are picked for the best black and green teas. Only the buds are picked for some very special teas.

There are two major objectives in the processing of tea. The first is to preserve the tea by driving most of the moisture from the leaves. The second objective is to bring flavor out on the surface of the leaves so that it can transfer quickly to the water during the steeping process.

After picking, the green leaves are spread out to wither between 12 to 18 hours. During the withering process, the leaves lose most of their moisture, becoming soft and pliable. This allows the leaves to be rolled without tearing. Rolling breaks the membranes of the leaves, releasing the natural juices to collect on the surface of the leaf. After rolling, the leaves are brought into large, cool, humid rooms to ferment. The fermentation process produces essential oils from the natural juices. The essential oils give each black tea its characteristic aroma and flavor. The fermentation process must be stopped at the point where the aroma and flavor of the tea have fully developed. This is done by firing the leaves in large ovens. The essential oils dry on the surface of the leaves and remain relatively stable until exposed to boiling water during infusion. In the last step of production, the leaves must be sorted by size. During the production process, approximately 80% of tea leaves are broken or crushed so that the finished tea consists of full leaves, broken leaves, smaller particles (fannings), and tea dust. Since the necessary steeping time increases with the size of the leaf, the tea must be sorted into lots of equal leaf size. The large leaves, 20% of the tea, is the best grade; the small broken leaves are the next grade. The fannings and tea dust are used in tea bags.

Any region's growth may be manufactured into green, oolong, or black tea. The growing conditions of a particular region may make tea suited to one manufacture over another.

Source:
http://www.ashworthtea.com/how_manufacture.htm

Article 2 - How tea is grown

The tea plant (Camellia sinensis) grows best in a humid tropical or subtropical climate with plenty of rain. Areas that are well-drained, with a high-acidity sandy loam, tend to produce the best teas. Higher elevations also yield better quality, perhaps because the evening coolness causes the leaves to grow more slowly, thus concentrating their flavor.

There are two important subspecies of the tea plant, the China type and the Assam type. The China type is grown in China, Taiwan, Japan, and parts of Darjeeling, and produces smaller leaves with a softer flavor. The indigenous Assam type is grown in India, Sri Lanka, and throughout the rest of the tea-producing world, producing larger leaves with more strength. Within each subspecies, there are dozens of local varietals created by generations of seed propagation and "clonal" planting using leaf cuttings.

For good quality teas, only the newest growth (two leaves and a bud) is plucked by hand; this process is called "fine plucking." "Coarse plucking" describes the practice of taking three or four leaves with the bud, and while the yield at the end of the day is much higher, the quality is much poorer. As any home gardener knows, repeated tip pinching promotes new growth, so the bushes produce multiple pluckings throughout the year - as few as three in climates with distinct seasonal variability to twelve or more in tropical regions. Raw leaf quality varies greatly with the seasons, and while a given estate may produce dozens of lots of tea each year, only a handful of these may have great flavor.

A typical tea bush may produce over a thousand leaves each year, a seemingly large number until one realizes that a single pound of fully processed tea may contain two to three thousand leaves.

How tea is processed

Black Teas

Plucking starts early in the day, and by noon the pluckers begin returning from the fields to the factory. The freshly plucked leaves are spread out on racks where much of the leaf's water content is evaporated over the next 8 to 24 hours in a step known as withering. When the leaves have become soft and pliable, they are ready for rolling.

From the withering racks, the soft, green leaf passes to rolling machinery where it is twisted and rolled to break up the leaf cells and liberate the enzymes that will develop the tea's flavor. Varying degrees of pressure are used between rotating brass plates so as to fully twist the leaf without creating too much damaging heat.

The rolled leaf is then moved to the oxidation table for between two and three hours. Here, upon exposure to air, the newly released juices oxidize, causing the leaves to turn black. This step - traditionally but imprecisely called "fermentation" - gives black tea its characteristic flavor as well as its colour.

At the point at which the leaves have reached the optimal oxidation level (according to the style of black tea that is being attempted), the leaves are ready for firing. The fully "fermented" leaf is placed in a thin layer on a moving belt that winds its way through the drying chamber in approximately twenty minutes. At the end of this, the leaf's moisture content should be about 2%, and in the absence of significant moisture, the oxidation comes to a halt.

Though nearly done, the tea is not ready to be drunk until it has been graded for size. The rolling process creates leaf particles of all sizes, which need to be separated into consistent sizes for better infusion and flavor. The dried leaf is sent through a series of mechanically shaken sieves until it is separated into whole leaf, broken leaf, and fannings grades.

Green Teas
Unlike black tea, fresh plucked leaves destined for green tea are not first slowly withered, but go directly into a de-enzyming stage. There are two basic methods to accomplish this: dry heat and steam. In China, the leaves are typically stirred in a hot metal pan or in a tumbling heated drum. In Japan, the leaves are typically placed in a rotating cylinder filled with steam. In either case, the process lasts less than a minute and results in two developments. All enzymatic reactions within the leaf cells are prevented, and it renders the leaf flaccid and pliable for rolling.

With the enzymes neutralized, rolling can proceed without developing black tea colour and flavor. For many types of green tea, rolling is accomplished using the same type of machinery as is used with black tea, although with less pressure applied. For many of the finest green teas, rolling is done entirely by hand as an extension of the initial pan-heating and can result in flat-leaf green teas, ball shapes, curled shapes, etc. The resulting shape is a part of the visual appreciation of the tea, and the methods used to achieve that shape in large part determine flavour.

The leaf is then fired. This can be done in a conventional drier, or the leaf can be pan-fired until fully dry. Finally, the leaf is graded according to leaf size. Green teas tend to yield only a small amount of broken leaf and fannings grades.

Oolong Teas
Oolongs are the most time-consuming and difficult teas to produce, although they can be understood most easily by viewing them as a halfway step between green and black tea. First, the leaves are withered but for a shorter time than for black tea - typically about eight hours.

Then the leaves go through a series of repeated light rollings, partial oxidation, and gentle firings. The leaves are rolled gently by tumbling in bamboo baskets, rolled in large sacks, or by hand pressure; this results in a bruising of the outside of the leaf which initiates partial oxidation. After a short period, the leaves are given a brief firing to partially reduce the moisture content. This proceeds in a repeating series of stages until the tea is ready for a final firing.

Interestingly, the plucking standard for oolong tea is usually three leaves and a bud. This accounts for the appearance of large, whole leaves even in the highest quality oolongs.

Source: http://www.peets.com/learn/tea_growing.asp?rdir=1&

Article 3 - History of the P.E.I. Potato

From the beginning, it was obvious that the Island was an ideal location for growing potatoes. The first Governor of the Island, Walter Patterson, reported in 1771 that the potato harvest was a "phenomenal success". By 1790, small amounts of potatoes were being exported to other colonies. Lord Selkirk further encouraged potato farming. In 1802, Selkirk brought settlers from the Scottish highlands to the area around Orwell Bay. He provided his settlers with potatoes to grow, and for the first few years the Highlanders survived almost exclusively on a diet of potatoes and cod. By 1806, John Stewart, in his book about the Island, could say of potatoes: "Potatoes are raised in great abundance, and in no country better."

Growing the Potato: Settler Style

The early settlers did not grow potatoes in the same way we do today. They did not have the benefit of large fields. The Island was almost entirely covered by a dense forest and settlers had to clear the woods tree by tree in order to make room for their farms. Even after they had chopped down all the trees in a field, the tree stumps, which were firmly rooted in the ground, still remained. Often it would take several years to completely clear a field of tree stumps.

To make the most of their cleared land, settlers took to planting potatoes in among the stumps while their efforts at clearing went on. The seed potatoes were planted, buried with ash, and left alone until harvesting time. This method produced a source of food for the settlers and involved very little work. The settlers were left free to focus on other tasks like clearing the land. This method of potato planting continued well into the 1800's. The letters of Walter Johnstone, written in 1822, describe potato planting among newly cleared tree stumps and describe the piles of earth covering the potatoes as looking like "mole-hills."

The modern potato industry for which P.E.I. is now world famous really began in the 1920's after the introduction of two new varieties of potatoes, Irish Cobbler and the Green Mountain, and the invention of processing technologies.

Prince Edward Island has been exporting potatoes now for over 200 years.

Potato Growing: Stages

Growth Stage I: Planting to Emergence
- seed pieces are planted
- sprouts and roots develop
- seed piece is the sole energy source for developing plants
- management: focuses on weed control
- activity: cultivation between rows

Growth Stage II: Vegetation Growth
- plants are actively growing, 6-8 inches tall
- leaves and branches form above ground while roots and shoots develop below
- roots begin to take up nutrients from the soil
- photosynthesis is occurring: light is absorbed by the plant to be converted into sugars for respiration to occur. The unused sugars are converted into starch. As plants emerge, some disease may appear (i.e., Rhizoctonia), and planting misses appear
- management: scouting begins for insects (e.g., Colorado Potato Beetle (CPB), aphids, leaf hoppers, flea beetles, and European Corn Borers) and diseases (e.g., blight)
- activity: cultivation involves hilling potatoes 8-13 cm below top of hill

Growth Stage III: Tuber Initiation

- lasts 10 to 14 days
- tubers form at stolon tips but do not enlarge
- end of stage III happens at the same time as early flowering, buds opening
- management: make sure the plants have plenty of water
- activity: petiole sampling to monitor nutrient deficiencies, scouting continues

Growth Stage IV: Tuber Bulking

- plants are now at full size, rows are filled in
- majority of plant nutrients have been taken up
- tuber bulking, enlarging
- management: maintain soil water availability
- activity: scouting is at its peak to check for disease and pests

Growth Stage V: Tuber Maturation

- vines look quite old–lose colour and leaves
- tuber skins are setting or hardening
- in preparation of harvesting, the vines are killed

Source: P.E.I. Spud-in Ceremony http://www.spudinpei.com/?page=potatoes

The Work of a Potato Farmer throughout the Year

January	February	March
- grading, shipping, and packing for processors and/or fresh table market - shipping seed to export markets - planning current season - planting schedule	- grading, shipping, and packing for processors and/or fresh table market - shipping seed to export markets - trade shows - planning current season - planting schedule	- grading, shipping, and packing for processors and/or fresh table market - shipping seed to export markets - trade shows - prepare equipment for seed bed preparation and planting - buying seed for current season planting
April	**May**	**June**
- grading, shipping, and packing for processors and/or fresh table market - shipping seed to export markets - spring land preparation - soil testing, lime and fertilizer applications - warm seed in storage (2 weeks prior to planting) - late April: plant early maturing varieties	- grading, shipping, and packing for processors and/or fresh table market - warm seed in storage and cut seed for planting - soil testing, lime and fertilizer applications - mid to late May: plant late maturing varieties	- cultivation of weeds and first hill on potatoes - crop scouting begins for weeds, early disease symptoms, Colorado Potato Beetle - top dress fertilizer on crop - spray program begins for blight - roguing potatoes for removal of virus and diseased plants - late June: first Agriculture Canada inspection

July	August	September
- cultivation of weeds and second hilling on potatoes - crop scouting begins for Colorado Potato Beetles and eggmasses and larvae, Flea beetles, Potato and Buckthorn Aphids, Corn Borer moths, diseases, Late Blight - roguing potatoes for removal of virus and diseased plants - continuation of spray program for blight - mid July: "new" potatoes harvested for the fresh market - second Agriculture Canada inspection - top dress fertilizer on crop	- crop scouting for Colorado Potato Beetles and egg masses and larvae, Flea beetles, Potato and Buckthorn Aphids, Corn Borer moths, diseases, Late Blight - roguing potatoes for removal of virus and diseased plants - continuation of spray program for blight - third Agriculture Canada inspection - mid August: top kill for seed potato crops - harvest equipment maintenance - disinfect harvest equipment, pallet boxes and warehouse facilities	- continuation of spray program for blight - crop scouting is slowing down - mid to late September: top kill processing crop - mid September: harvest seed crop
October	**November**	**December**
- early October: second top kill applied - harvest the processing crop - ploughing land for next season planting - grading and shipping current season crop to processors or fresh market	- finish harvest - grading and shipping current season crop to processors or fresh market - soil sampling and lime application - clean and disinfect harvest equipment	- grading, packing, and shipping current season crop to processors or fresh market

Source: P.E.I. Spud-in Ceremony http://www.spudinpei.com/?page=potatoes

Name:_____

ACTIVITY SHEET 1: Comparing Crops Grown in P.E.I. and Kenya

1. In this box, list the main crops grown in P.E.I.

2. In this box, list the main crops grown in Kenya.

3. What crops are grown in both places? List them here.

4. Why do you think some crops can be grown in Kenya but not be grown in P.E.I.?

Name: _____

ACTIVITY SHEET 2: Tea or Potatoes Anyone?

Using the information from the web-sites or from the printed material, draw a flow chart, diagram, or poster to show the steps in growing tea or potatoes.

Try to include all major steps.

Crop described: _____

Lesson IV - Where do the ingredients in your favourite snack food come from?

Estimated time to complete: 1 class

Lesson adapted from Snack Search found at
http://oklahoma4h.okstate.edu/aitc/lessons/extras/geography/cropmap.pdf

Theme: Even in our everyday lives, we are dependent upon many other countries /regions.

Materials:

Labels from favourite snack foods
Web-site access or information sheets
Activity sheet

Student Instructions:

1. Remove the label carefully from your favourite snack food. On this label you will find an ingredients list. These ingredients are listed in order of amount in the snack (from largest to smallest amount). List the first five ingredients from the label in order on your activity sheet.

2. Using the web-site listed below, for each ingredient find the top five countries that produce this food product. Using an atlas or a map, look at each item and decide which country would be the most likely source for that product if the snack food were to be produced in Canada. Why did you select that country? What other factors might determine whether the product actually came from that country?

World production by country or crop http: //www.fao.org/es/ess/top/country.html?
(On this United Nations Food and Agricultural Organization site (FAO), you can find the top countries in the world where specific raw materials are produced, listed by country or by product.)

Raw materials listed on this site include:
Nuts - almonds, cashews, peanuts (ground nuts), hazelnuts, pistachios, walnuts
Other products - cocoa beans, coconuts, cherries, cinnamon, honey, milk of various kinds, oats, soy beans, sugar beets, sugar cane, vanilla

ACTIVITY SHEET **Name:** _____

Where do the ingredients in your favourite snack food come from?

SNACK FOOD: _____

From the label, can you find where this snack food is manufactured? _____

Part A.

Main ingredients	Top five countries where this ingredient is grown/produced
1.	
2.	
3.	
4.	
5.	

Part B. Using an atlas or a map, look at each item and decide which country would be the most likely source for that product if the snack food were to be produced in Canada. Why did you select that country? What other factors do you think might determine whether the product actually came from that country?

Lesson V - A Farm in P.E.I. and Kenya

Estimated time to complete: 1-2 classes depending upon what research is assigned

Theme: Comparison of farming in P.E.I. and Kenya

Materials:

Contact information for farmers in local area (can be generated from the class/school)
Slide show "Farming in Kenya"
Activity sheet: A Farm Day in P.E.I. and Kenya

Student Instructions:

1. View the slide show "Farming in Kenya" and answer the questions on the Activity Sheet.
2. Contact a farmer in P.E.I., asking him or her the same questions that you answered for the slide show for Farming in Kenya.

3. Assignment:
   Answer the following questions in sentence form.

   A. Name five ways that farming in P.E.I. is similar to farming in Kenya.

   B. Name five ways that it is different.

   C. What was the most interesting thing you learned about farming in Kenya? Describe it.

   D. What was the most interesting thing you learned about farming in P.E.I.? Describe it.

Activity - Farming in Kenya Name: _____

Answer the following questions after viewing the slide show "Farming in Kenya":

1) What is the size of a typical farm in Kenya?

2) What animals might be found on this farm? If there are cows, how many would there likely be?

3) What crops are grown on Kenyan farms?

4) How is soil prepared for planting?

5) Name 5 things you learned about how cattle food is prepared by Kenyan farmers?

6) Describe a modern barn in Kenya. What do Kenyan farmers need to do to keep their animals free from diseases caused by insects?

7) Describe what a farmer does to get milk to market in Kenya.

8) Write a paragraph to describe the role that women and children play in farming in Kenya.

9) In a paragraph, write your main impressions about farming in Kenya. What do you think is most interesting? The most difficult?

Activity - Farming in Prince Edward Island

Name:_____ Person interviewed :_____

Answer the following questions about farming in P.E.I.:

1) What is the size of a typical farm in Prince Edward Island?

2) What animals might be found on P.E.I. farms? If there are dairy cows, how many would there likely be?

3) What crops are grown on P.E.I. farms?

4) How is soil prepared for planting?

5) Name 5 things you learned about how cattle food is prepared/obtained by P.E.I. farmers?

6) Describe a modern barn in P.E.I. What do P.E.I. farmers need to do to keep their animals free from diseases caused by insects?

7) Describe what a farmer does to get milk to market in P.E.I.

8) Write a paragraph to describe the role that women and children play in farming in P.E.I.

9) In a paragraph, write your main impressions about farming in P.E.I. What do you think is most interesting? The most difficult?

Slide Show Script: Farming in Kenya

Slide 2 - Photo of a corporate wheat farm in Kenya.

Slide 3 - Although this corporate farm is in Kenya, it does not represent farming in Kenya. Most farms have little land (1-5 acres) and only a few animals.

Slide 4 - Sub-title: <u>From the Soil to the Table</u>

Slide 5 - Preparing the land for planting - it is necessary to use heavy hoes to chop the soil into workable pieces before planting - usually women's work in Kenya.

Slide 6 - Some farmers will have a one furrow plough which can be pulled by a team of oxen. Here are two young boys trying to plough.

Slide 7 - The farm wife will germinate tomato seeds under this shield of hay so the sun does not dry out the emerging seedlings.

Slide 8 - Due to deforestation in Kenya, firewood for cooking is very scarce. Women often plant trees as a future source of firewood. After germination of the seeds, they put the seedlings in wire cages to protect them from being eaten by the farm animals.

Slide 9 - Cultivation equipment is not available on most farms so weeding is done by hand, most often by women. Kenyan farm families must 'live out of their gardens' as store-bought food is too expensive.

Slide 10 - Photo of a home garden.

Slide 11 - Corn is the staple food for Kenyans and peas are often planted between the rows and eaten as a protein source for meals.

Slide 12 - Hospitals may have large gardens as they have little money to buy food for their patients.

Slide 13 - Farm plots may be close together as on this hilly landscape.

Slide 14 - A Farmers Helping Farmers member is helping to distribute seed donated by Vesey's Seeds.

Slide 15 - Ruuju school garden- As part of the school lunch program, students must produce their own food.

Slide 16 - Ruuju school kitchen - Food is prepared in large pots in this wood-fueled stove. Each student takes their turn bringing a stick of wood to school to fuel this kitchen stove.

Slide 17 - School children waiting for lunch to be served. This will often be their most nutritious meal of the day.

Slide 18 - Lunch is served!

Slide 19 - Sub-title: <u>Preparing Feed for the Cattle</u>

Slide 20 - Bringing home cattle feed - a farm woman carrying home a heavy load of branches and leaves to feed the farm animals. There are no pickup trucks for such work and few farms would even own a wheelbarrow.

Slide 21 - Napier grass is ready to be chopped for feed or for making silage.

Slide 22 - Forage chopper - this machine consists of a large wheel with two sharp blades. This is very strenuous work usually done by hand. More modern machines may be powered by gasoline or electric motors.

Slide 23 - Napier grass is made into silage by chopping the stems and leaves into pieces about two centimeters long. This is mixed with molasses and put into plastic bags. The farmer shown is tramping down the material so it will be free of air to help prevent spoilage.

Slide 24 - Silage is made during the rainy season for use during the dry season when crop growth is poor.

Slide 25 - Farmers who have land to grow hay do not have the equipment to bale it so must hire a custom operator. This baler has seen a lot of service.

Slide 26 - When a farmer can purchase feed for his milking cows, he buys it one bag at a time. The bag is too heavy to carry, weighing as much as 75 kilograms, so a bicycle may be used.

Slide 27 - Because of the scarcity of land, many farms are zero grazing - the cattle are fed rather than being put in a pasture.

Slide 28 - In areas where land is available, young farm boys are usually given the chore of looking after the cattle so they do not wander off.

Slide 29 - Photo - Young man herding his cattle.

Slide 30 - Sub-title: <u>Caring for the Cattle</u>

Slide 31 - An old and dirty barn with a mud floor. This makes it difficult to keep the cattle clean and they are more apt to become sick.

Slide 32 - A modern dairy barn with a cement floor to keep the cows clean and a roof for shade on sunny days.

Slide 33 - Tanks provide water for the cows. Water is a scarce resource and none is wasted.

Slide 34 - Cattle dip - in the tropics, cattle often become infested with insects. The farm animals are forced to walk or swim through a tank of water to which an insecticide has been added.

Slide 35 - School barn - these young cattle are being kept at a school where they are part of the agriculture course. They also provide milk for the school lunch program. If a family cannot afford school fees (secondary school), the family may give a calf to the school to cover school fees. They may also exchange farm labour for fees.

Slide 36 - Farmers gather in a barnyard for a presentation on animal health delivered by a visiting veterinarian and vet students. This program was sponsored by Farmers Helping Farmers.

Slide 37 - Kenyan farmers may also raise goats, sheep, and poultry on their farms. In addition, other crops such as coffee, tea, and macadamia nuts are important cash crops.

Slide 38 - This young child is picking weeds out of a tea field. The picking of the tea leaves is often done by older women.

Slide 39 - In the next slide, women are sorting coffee beans. Day labourers have spent the morning picking beans; in the afternoon, the beans must be sorted to remove unripe ones. Sorting is considered women's work, so the men are sitting nearby watching.

Slide 40 - Photo - Women sorting coffee beans.

Slide 41 - Carrying a bag of coffee to the coffee processing plant - the coffee beans (seeds) are set out to dry on the racks seen in the background.

Slide 42 - Sub-title: Milk production

Slide 43 - Milking a cow by hand- usually considered women's work. The average farm has one to two cows which produce an average of 8 litres per cow per day.

Slide 44 - This woman is carrying milk by hand to the collection point very early in the morning.

Slide 45 - Carrying the milk in a can on a bicycle is much easier and faster than by hand.

Slide 46 - Many of these farmers got up at 4:00 a.m. in order to do the milking and arrive at the collection point in time.

Slide 47 - Photo - At the collection station.

Slide 48 - The milk each farmer delivers to the collection point must be weighed and tested before it can be accepted. The farmers will get a milk cheque once a month for all the milk delivered, provided it has not spoiled. The cheque is credited to the farmer's account at the sacco (credit union).

Slide 49 - A farmer is waiting for the paper work to be completed after delivering the milk.

Slide 50 - Kenya does not have bank machines in rural areas. The farm wife, who usually does the banking, waits outside until it is her turn.

Slide 51 - Homeward bound - there are few pickup trucks in rural areas, so farmers can expect to carry on their backs or heads whatever they buy in town.

Slide 52 - Three happy and healthy farm children!

Lesson VI - How does *Farmers Helping Farmers* assist farmers in Kenya?

Estimated time to complete: 1 class

Theme: Through a web quest activity, students will become aware of how a local non-governmental organization (NGO), *Farmers Helping Farmers*, assists farmers in Kenya.
Answers are included after the activity sheet.

Materials:

Access to FHF web-site http: //www.farmershelpingfarmers.ca/
Activity sheet: Farmers Helping Farmers Web Quest

Student Instructions:

1. View the Farmers Helping Farmers web-site to find the answers to the questions on the activity sheet: Farmers Helping Farmers Web Quest.

Name: _____

Farmers Helping Farmers Web Quest

1. In what year was Farmers Helping Farmers awarded the Agriculture Institute of Canada's International Award? _____

2. A mature Macadamia nut tree seedling can produce an annual crop worth how much? _____

3. What materials were used to make a low cost bio-gas generator on the farm of Mrs. Geru in the Embu District? _____

4. In what year did the first UPEI pre-service teachers travel to Kenya to practice teach in the twinned schools in Kenya? _____

5. How much can a Kenyan coffee picker earn in a day —if he/she works very hard? _____

6. In what year did the Kenyan government allow Kenyan children to attend primary school free of charge? _____

7. What percentage of Kenyan students will have the opportunity to attend secondary school? ____

8. In what year was the Dairy Laboratory at the Wakulima Self-Help Dairy Group officially opened? _____

9. What kind of grass was used to make silage on farms in the Mukurwe-ini District of Kenya? _____

10. How much does a finished bag of silage typically weigh? _____

11. Approximately how many students attend Ruuju school? _____

12. What P.E.I. company donated seeds for the Ruuju School Project? _____

13. Design two questions about other interesting things you found on this web-site that were not mentioned above. (Make sure you also put the answer to your question.)

    Question 1:

    Answer: _____

    Question 2:

    Answer:_____

(ANSWERS)

Farmers Helping Farmers Web Quest

1. In what year was Farmers Helping Farmers awarded the Agriculture Institute of Canada's International Award? **1999** - background, first paragraph

2. A mature Macadamia nut tree seedling can produce an annual crop worth how much? **$100 Canadian dollars** -Muchui Women's Group Tree Nursery, Project Impact

3. What materials were used to make a low cost bio-gas generator on the farm of Mrs. Geru in the Embu District? **A 10 metre length of plastic silage tubing, two pieces of sewer pipe, and an outlet pipe to collect the biogas -**Embu Dairy, Biogas Generator, paragraph 3

4. In what year did the first UPEI pre-service teachers travel to Kenya to practice teach in the twinned schools in Kenya? **2004** - Karibu Two Easts School Twinning Project, Project Impact, paragraph 3

5. How much can a Kenyan coffee picker earn in a day —if he/she works very hard? **Between seventy to eighty Kenyan shillings, slightly more than 1 Canadian dollar per day** - Global Classroom Initiative, Why is Fair Trade Coffee Important? Paragraph 3

6. In what year did the Kenyan government allow Kenyan children to attend primary school free of charge? **December, 2002** - Global Classroom Initiative, Universal Primary Education in Kenya, paragraph 6

7. What percentage of Kenyan students will have the opportunity to attend secondary school? **54% (2005 estimate)** - Global Classroom Initiative, Universal Primary Education in Kenya, paragraph 6

8. In what year was the Dairy Laboratory at the Wakulima Self-Help Dairy Group officially opened? **2006** - Support to the Wakulima Dairy Self Help Dairy Group, Dairy Laboratory at Wakulima

9. What kind of grass was used to make silage on farms in the Mukurwe-ini District of Kenya? **Napier grass** - Support to the Wakulima Dairy Self Help Dairy Group, Silage Making Kenyan Style paragraph 3

10. How much does a finished bag of silage typically weigh? **500 kg** - Support to the Wakulima Dairy Self Help Dairy Group, Silage Making Kenyan Style paragraph 4

11. Approximately how many students attend Ruuju school? **420** - The Rujuu School Project, Background

12. What P.E.I. company donated seeds for the Ruuju School Project? **Vesey's Seeds** -The Rujuu School Project, Project Impact

LEVEL 2 - Project Activities

Anticipated Completion Time: The amount of time required will depend upon the extent of research completed by individual students or groups and the number and length of the student presentations. (Teachers may select from activities suggested for individual students, groups, or complete an activity with the entire class.)

Required Resources/Materials:

Internet access

Materials for preparation of visual displays
(for making transparencies, digital presentations, brochures, posters, etc.)

Farmers Helping Farmers web-site

CD of Kenyan agricultural scenes that may be used by students in presentations
Slide show "Farming in Kenya"

***Teacher Note: Some of these activities are more difficult than others. This is done in recognition that even more capable students have varying levels of ability.**

Most challenging - Activities 1, 3, and 6

Challenging - Activities 4, 5, 8, 9

Less challenging - Activities 2, 7, 10

The most challenging activities will require substantial research and/or personal contacts with experts in P.E.I. for satisfactory completion.

In Class Activities and Teaching Strategies:

The following is a series of activities that may be used to allow students the opportunity to explore/compare/contrast aspects of Agriscience between P.E.I./Canada and a developing country, using Kenya as the example.

A. Students will perform research, using a variety of sources, to ascertain the similarities and differences in agricultural topics between the two locations or to explore the global situation in relation to a particular topic.

B. Using the information learned about Kenya and P.E.I., or a global situation, students will create an end product that may take many forms/combinations, such as a digital presentation, brochure, poster, written report, or video. Each student/group will be required to 'teach' their peers by sharing their newly acquired knowledge.

Activity 1 - Human development trends 2005

Beginning with the following website, http://hdr.undp.org/en/reports/, find the Human Development Reports for Canada and Kenya.

Study the site carefully, learning about the Human Development Index which is used to compare countries around the world.

TASK: Prepare a presentation which describes the Human Development Index, and compare Kenya and Canada's Human Development Index ratings in areas such as life expectancy, adult literacy, school enrolment, income, gender disparity, and other factors.

As part of your presentation, describe what conditions you believe would exist in desirable living spaces.

Additional sources of information - starting points for gaining knowledge

Global issues education- 60 second tours and in-depth views of global issues - rich/poor gap, population, health, governance, food and water security, environment, energy, economy, conflict, possible futures.

http://www.facingthefuture.org/

Taking IT Global - extensive web-site with very short videos on each issue, a short article on each issue, additional articles for further study, and country studies (A youth-oriented site).

http://www.takingitglobal.org/understanding/

Short summaries and additional references to projects/studies for the following global issues: population change, food security, gender, governance, poverty, human rights, global economy, governance, aid, conflict and emergencies, tourism.
http://www.eldis.org/

Farmers Helping Farmers – website
http://www.farmershelpingfarmers.ca/

Articles and letters from Farmers Helping Farmers volunteer work teams in Kenya.
http://farmershelpingfarmers.blogspot.com/

COUNTRY INFORMATION

Information by country
http://www.unicef.org/infobycountry/index.html

Countries of the world - background information
http://www.theodora.com/wfb/abc_world_fact_book.html

also www.geographic.org

Canada and Africa - a contrast - lessons of comparison
http://www.canadiangeographic.ca/worldmap/cida/lessons/pdf/CG-CIDA_BC_6-8_Africa.pdf

GLOBAL AGREEMENTS

Universal Declaration of Human Rights
http://www.un.org/en/documents/udhr/

Rights of the Child Fact sheet
http://www.unicef.org/crc/files/Rights_overview.pdf

UN Millennium Development Goals
http://www.un.org/millenniumgoals/

INFORMATION ON KENYA

In-depth country guides -Kenya
http://www.worldtravelguide.net/kenya

Kenya statistics from UNICEF
http://www.unicef.org/infobycountry/kenya_statistics.html#14

Activity 2: Food exports and imports - P.E.I. and Kenya

What are the major crops produced in P.E.I. and in Kenya? How much is produced? What crops are exported from P.E.I. and Kenya? Where are they exported to? Log the food products that your family purchases at the supermarket. Where do the products come from? Research to find what foods that we eat come to P.E.I. from other places?

TASK: Find answers to the above questions comparing crops grown, exports, and imports to and from Kenya and P.E.I. Present these comparisons in an interesting manner to your peers.

Sources of information - starting points for gaining knowledge

General production statistics:

World -Production by country or crop

(On this United Nations Food and Agricultural Organization site (FAO), you can find the top countries in the world where specific raw materials are produced listed by country or by product.)

http://www.fao.org/es/ess/top/country.html?

PRINCE EDWARD ISLAND

P.E.I. crops

http://www.gov.pe.ca/af/agweb/index.php3?number=71208

Prince Edward Island Potatoes

http://www.peipotato.org/english/produce_whypeipotatoes.asp

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

KENYA

Farmers Helping Farmers web-site

http://www.farmershelpingfarmers.ca/

Articles and letters from various Farmers Helping Farmers volunteer work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

International Crop Research Institute for the Semi-arid Tropics
http://www.icrisat.org/

International Institute of Tropical Agriculture - Crop and Farming Systems
http://www.iita.org/cms/details/research_summary.aspx?a=86&z=63

Summaries of research papers/links
http://www.eldis.org/

Activity 3: Challenges that farmers face

1. Using the site www.canadiangeographic.ca/worldmap, compare the Human Development Index (HDI) trends for Canada and Kenya. What reasons can you give for the decrease in the Human Development Index for Kenya from 1990 to 2003? What happened to the HDI for Canada during that same time period?

2. Read the article, "AIDS/HIV and Food Security," found at http://www.fao.org/hivaids/ and, "HIV/AIDS and rural livelihoods," at http://www.id21.org/zinter/id21zinter.exe?a=10&i=r1tb2g1&u=44aea714

HIV/AIDS has dramatically affected the life of farmers in Kenya. However, it is not their only challenge. What are some other challenges Kenyan farmers face? What challenges do Canadian and Prince Edward Island farmers have?

TASK:
Prepare a report/presentation about the challenges that farmers currently face in P.E.I. and in Kenya being sure to refer to the HDI for both areas in your report.

Additional sources of information - starting points for gaining knowledge

KENYA
Main web-site
http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

Kenya - agriculture
http://en.wikipedia.org/wiki/Agriculture_in_Kenya

Review of Poverty in Kenya
http://www.kenya-advisor.com/poverty-in-kenya.html

Costs and benefits of eliminating child labour in Kenya
http://www.eldis.org/assets/Docs/18149.html

PRINCE EDWARD ISLAND
Agriculture on P.E.I.
www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

General - summaries of research papers/links

http://www.eldis.org/

Other sources of information/opinions

Learning about hunger in Canada
http://www.foodbankscanada.ca/

National Family Farm Coalition (American source but contains some useful information)
http://www.nffc.net/

Activity 4: Challenges to food production

Explore the issues of soil fertility, arable and available land, size of farms, land ownership, water access, and access to labour in P.E.I. and Kenya. Compare and contrast Kenya and P.E.I. in these areas.

TASK: Prepare a presentation in which you compare and contrast P.E.I. and Kenya in terms of a minimum of three of the above topics.

Sources of information - starting points for gaining knowledge

Internet Quiz - How much water does it take to grow a hamburger?
http://ga.water.usgs.gov/edu/sc1.html

Global water outlook to 2025

http://www.ifpri.org/sites/default/files/pubs/pubs/fpr/fprwater2025.pdf

The Millennium Development Goals related to water
http://pacinst.org/press_center/the_worlds_water_2004-2005/

Africa – water
http://thewaterproject.org/

The case of Mt. Kenya water crisis
http://www.irinnews.org/report.aspx?reportid=34512

Stories from Kenya- related to water
http://www.peacecorps.gov/wws/educators/enrichment/africa/

A Teaching Resource on World Hunger and Agriculture
http://www.iearn.org/projects/food/CD-ROM_sample/index.htm

Farmers Helping Farmers main website
http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

Population and feeding the world, land ownership
http://www.globalissues.org/EnvIssues/Population/Hunger/Land

P.E.I.

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

Soil/water conservation P.E.I.
http://www.gov.pe.ca/af/agweb/index.php3?number=69251&lang=E

Soil management P.E.I.
http://www.gov.pe.ca/agriculture/index.php3?number=1012070&lang=E

Soil erosion P.E.I.
http://www.edu.pe.ca/agriculture/agenvhigh/full.pdf

Irrigation P.E.I.
http://www.gov.pe.ca/roundtable/index.php3?number=69430
http://www.gov.pe.ca/roundtable/index.php3?number=69437

Farming the public right-of-way P.E.I.
http://www.gov.pe.ca/roundtable/index.php3?number=69415&lang=Ehttp://www.gov.pe.ca/roundtable/index.php3?number=69380&lang=E

Water quality P.E.I.
http://www.edu.pe.ca/agriculture/agenvhigh/full.pdf

Agriculture on P.E.I.
www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

General Web-sites

Overview and related links for a variety of global issues including biodiversity, genetically engineered food, human population, natural disasters, nature and animal conservation global warming, climate change, and global dimming.
http://www.globalissues.org/EnvIssues/

The world's water - includes maps of global access to water and sanitation, as well as many data charts (plus the introduction and opening chapter of "The World's Water 2004- 2005")
http://www.worldwater.org/2004-2005.html

Population and feeding the world
http://www.globalissues.org/EnvIssues/Population/Hunger.asp

Summaries of research papers/links
http://www.eldis.org/

Activity 5: Soil conservation/desertification/deforestation

While desertification (increase in deserts worldwide) is not a problem for Prince Edward Island, soil conservation and deforestation are issues of concern.

TASK: Using the sources below as starting points, explore at least two of the above topics to compare the extent to which these are issues in Kenya and P.E.I. In addition, search out possible solutions to these issues that are already in place or being considered.

Additional sources of information - starting points for gaining knowledge

PRINCE EDWARD ISLAND

P.E.I. Department of Agriculture, **Agriculture Information Desk**, at 368-4145 or toll-free 866-734-3276.

Soil erosion P.E.I.
http://www.gov.pe.ca/af/agweb/index.php3?number=71766

Tillage and soil erosion P.E.I.
http://www.gov.pe.ca/af/agweb/index.php3?number=1012070

Forest resources P.E.I.
http://www.gov.pe.ca/roundtable/index.php3?number=69382&lang=E

Sustainable agriculture P.E.I.
http://www.peisland.com/agrtour/intro.html

Farm profiles - sustainable agriculture P.E.I.
http://www.peisland.com/agrtour/profiles.html

Agriculture on P.E.I.
www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

P.E.I. Soil & Crop Improvement Association
www.soilcc.ca/ggmp/gg_fact/pdf/PEI%20NMP%202004%20c.pdf

KENYA

Farmers helping Farmers main web-site

http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

Developing Farm Radio
http://www.farmradio.org/

Sustainable Villages- projects in community development using appropriate technology
http://www.sustainablevillage.com/

Environment -Kenya
http://www.unpei.org/PDF/kenyaPEI-WWF-Bondo-Muranga-Meru.pdf

General

Conserving biodiversity for development
http://www.ilri.cgiar.org/

Biodiversity facts and figures/articles
http://www.scidev.net/ms/biofacts/

Biodiversity basics
http://www.biodiversity911.org

UN Convention to combat desertification
http://www.unmillenniumproject.org/index.htm

Summaries of research papers/links
http://www.eldis.org/

The Earth Charter - Seeds of Change - education for a sustainable future
http://www.earthcharterinaction.org/invent/details.php?id=476

Activity 6: Trade - Access to markets

Read the article "Why is Fair Trade Coffee Important?" found at http://farmershelpingfarmers.blogspot.com/search?q=fair+trade. This report was written by a member of a Farmers Helping Farmers educational team (Global Classroom Initiative) researching in Kenya in 2006. Using this article as a starting point, explore the challenges that farmers in developing countries have in marketing what they produce.

Research market access in P.E.I using the sources and contact information listed below and any other resources you can find.

TASK: Prepare a report or presentation on market access and marketing challenges for P.E.I. and Kenya.

Sources of information - starting points for gaining knowledge

KENYA/Trade or markets in general as a global issue:

Farmers Helping Farmers main web-site
http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

The Trade Justice Movement is working toward making trade and business fair to everyone in the world.
http://www.tjm.org.uk/

Distribution of wealth, etc.
http://en.wikipedia.org/wiki/Distribution_of_wealth

Trade related issues -causes of poverty, Third World Debt, Free Trade, corporations, Consumption and Consumerism, Sustainable Development, Fair Trade
http://www.globalissues.org/TradeRelated/

Food and trade
http://www.oxfam.org.uk/coolplanet/kidsweb/food.htm

Fair Trade
http://www.tenthousandvillages.ca/

The world bank - economic prospects/projects, features etc. by country
http://www.worldbank.org/

Poverty - causes
http: //www.globalissues.org/TradeRelated/Poverty.asp

Human development reports by country
http://hdr.undp.org/en/countries/

International trade/socio/economic data - statistical data locators
http://w3.unece.org/pxweb/

Source for statistical data
http://www.rba.co.uk/sources/stats.htm#internat

"Milking it" -Small farmers and international trade
http://www.oxfam.org.uk/education/resources/milking_it/milkingit/

UN Food and Agriculture Organization-understanding food insecurity, the human costs of hunger, economic costs of hunger, food security in an urban future, supermarkets and small farmers, web casts, related news stories, fact sheets, links to additional information
http://www.fao.org/newsroom/en/focus/2004/51786/index.html

Economy - Kenya
http://www.jambokenya.com/jambo/kenya/econ01.htm

Summaries of research papers/links
http://www.eldis.org/

PRINCE EDWARD ISLAND

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

Why P.E.I. potatoes?
http://www.peipotato.org/english/produce_whypeipotatoes.asp

Agriculture on P.E.I.
www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

Activity 7: Learning about new farming techniques

TASK: Using the resources below, compare and contrast how farmers in Kenya and in P.E.I. learn new farming techniques. What types of training are available to Kenyan/P.E.I. farmers? What training methods/ techniques are used? How are the training techniques similar /different in each region?

Additional sources of information - starting points for gaining knowledge

PRINCE EDWARD ISLAND

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

Agriculture and the Internet
http://www.gov.pe.ca/photos/original/af_computer_sur.pdf

Programs and services P.E.I.
http://www.gov.pe.ca/af/agweb/index.php3?number=69578&lang=E

Farm-Net training
http://www.gov.pe.ca/agriculture/index.php3?number=1036768&lang=E

Agriculture on P.E.I.
www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

KENYA

Developing Countries Farm Radio Network is a Canadian-based, not-for-profit organization working in direct partnership with approximately 250 radio broadcasters in more than 35 African countries to fight poverty and food insecurity.
http://www.farmradio.org/

Community development and radio
http://www.ned.org/cima/CIMA-Community_Radio-Working_Group_Report.pdf

Farmers Helping Farmers main web-site
http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

Education for rural people
http://www.fao.org/sd/erp/index_en.htm

Activity 8: Diversification of crops P.E.I./Kenya

TASK: Using the resources below and any others you can find, prepare a presentation on the importance of crop diversification in both P.E.I. and Kenya. In addition, report on what is being done in both places to encourage diversification.

Sources of information - starting points for gaining knowledge

KENYA

Farmers Helping Farmers main web-site
http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

Information on Kenya - history, geography & environment, people & society, fact file, Oxfam in Kenya
http://www.oxfam.org.uk/coolplanet/kidsweb

FAO - Sustainable Development Department - by detailed topic
http://www.fao.org/sd/index_en.htm

Summaries of research papers/links
http://www.eldis.org/

PRINCE EDWARD ISLAND

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

Managing landscape and biodiversity P.E.I.
http://www.gov.pe.ca/roundtable/index.php3?number=69384&lang

Enhanced Environmental Farm Plan P.E.I.
http://www.peifa.ca/index.php?option=com_content&view=article&id=65&Itemid=66

P.E.I. Soil & Crop Improvement Association
http://www.peiscia.ca/

Activity 9: Impact of farming to the economy and community

What is the impact on the family, community, or the economy of a successful small farm in Kenya? Using the web-blogs and the Farmers Helping Farmers web-site, research to determine the impact that even a one cow farm has on both that family and the community.

What impact does agriculture in P.E.I. have on the economy of this province?

TASK: Prepare a presentation on the impact of farming on the development of an area.

Sources of information - starting points for gaining knowledge

UNDP Drylands Development
http://www.ke.undp.org/
www.undp.org/drylands/iddp.html

SOS Sahel - Dryland farming projects in Kenya
http://www.sahel.org.uk/kenya.html

Desert Margins Program - Africa
http://www.dmpafrica.net/index.htm

Interactions between ecological issues and social and economic development
http://www.albaeco.com/sdu/

Farmers Helping Farmers main web-site
http://www.farmershelpingfarmers.ca/

Articles and letters from various FHF teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

Prince Edward Island

P.E.I. Department of Agriculture, **Agriculture Information Centre**, at 368-4145 or toll-free 866-734-3276.

Agriculture on P.E.I.

www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

Activity 10: A typical farmer in P.E.I . and Kenya

What is it like to be a farmer in P.E.I. and in Kenya?

Use the slide show "Farming in Kenya" as a starting point. Through interviews with Farmers Helping Farmers members who have worked in Kenya, interviews with Prince Edward Island farmers and internet research, consider the way of life, working conditions, daily routine, role of women and family, use of equipment and technology, labour needs, and any other aspects that you find interesting.

TASK: Prepare a presentation which contrasts and compares the daily life of farmers in P.E.I. and Kenya.

Possible sources of information for gaining more knowledge

KENYA

Farmers Helping Farmers main web-site
http://www.farmershelpingfarmers.ca/

Articles and letters from various teams during work terms in Kenya
http://farmershelpingfarmers.blogspot.com/

The introduction of this document gives a good overview of stats for rural life in Kenya
http://www.farmafrica.org.uk/cms.php?page=34

Stories/photos/maps from Kenya & other countries- related to water
http://thewaterproject.org/water-in-crisis-kenya.asp

Stories from Kenya - related to water
http://www.peacecorps.gov/wws/educators/enrichment

http://www.peacecorps.gov/wws/educators/enrichment/africa/countries/kenya/kenyastories.html

International Livestock Research Institute - research articles, news clippings regarding the impact/ importance of livestock in relation to poverty, economic growth, health, and other global issues - slide shows on various topics.
http://www.ilri.org/

PRINCE EDWARD ISLAND

P.E.I. Department of Agriculture, **Agriculture Information Centrek**, at 368-4145 or toll-free 866-734-3276.

Agriculture on P.E.I.
www.gov.pe.ca/af/agweb/index.php3?number=71208&lang=E

Appendix G

Career Profile

The objective of this project is to allow you to explore a variety of careers and create a career profile to share your findings and enthusiasm with your classmates. The career profile must fulfill the criteria stated below. The intention is to expose you to a variety of careers via your own research and the research and profiles provided by your classmates. You can present your career profile in a variety of formats such as a Webpage, podcast, online video, poster or part of an agriculture expo.

This is a unique opportunity to create a project of your own design... take pride in your work and enjoy!

Career Profile Criteria

You must search for a course-related career that you find interesting and then create a career profile. For your career profile, you must:

1. describe the career (duties, responsibilities, time commitment);
2. explain how the career is relevant to agriculture;
3. identify the educational requirements;
4. identify essential skills that are required to be successful at this career;
5. provide a salary range;
6. identify opportunities for work and labour market conditions/issues;
7. provide a current job posting for this career;
8. list advantages/disadvantages of the career;
9. identify aspects of the career that you like;
10. contact someone currently employed in this career and choose one of the following options (Please Note: the individual whom you wish to contact and the associated questions you wish to ask must be identified and communicated to me prior to making contact):
    i. provide a voice or video recording of his/her comments and answers to your questions;
    ii. provide a written recording of his/her comments and answers to your questions;
    iii. invite the contact to be a guest speaker for the class (I must be notified of your intention to provide a guest speaker prior to your making the necessary arrangements).
11. include graphics to provide clarity or enhance the contents of the career profile;
12. attach references (use the appropriate format associated with each reference type);
13. acknowledge those who have assisted you with information or have provided guidance.

Career Profile Rubric:

Career Profile	4	3	2	1	
Content	Student shows a full understanding of the topic.	Student shows a good understanding of the topic.	Student shows a good understanding of parts of the topic.	Student does not seem to understand the topic very well.	
Accuracy	All facts in the presentation are accurate.	99-90% of facts are accurate.	89-80% of facts are accurate.	Fewer than 80% of facts are accurate.	
Graphics and Pictures	Graphics go well with text and there is a good mix of text and graphics.	Graphics go well with text, but there are so many that they distract from the text.	Graphics go well with text, but there are too few and the presentation seems text heavy.	Graphics do not go with the text or appear to be randomly chosen.	
Spelling, Grammar and Organization	There are no spelling or grammatical errors. Presentation is very well organized.	There are minor spelling or grammatical errors, but presentation is well organized.	There are multiple spelling or grammatical errors OR the presentation lacked organization.	There are multiple spelling and grammatical errors. Presentation lacked organization.	
Quality	Assignment is of very good quality.	Assignment is of good quality.	Assignment is of fair quality.	Assignment is of very poor quality.	
Works Cited	There are more than two sources, cited correctly.	Sources used, but not cited properly.	Only one source is used.	No works are cited.	
Number of Questions Asked	Five or more questions were asked.	Four questions were asked.	Three questions were asked.	Fewer than three questions were asked.	
Relevance of Questions	All questions are relevant and give insight into the career.	Some questions are relevant and give insight into the career.	Some questions are relevant, but give little insight into the career.	Questions are not relevant and do not give insight into the career.	
Creativity of Questions	All questions are creative and provide information not easily found in research.	Some questions are creative and provide information not easily found in research.	A few questions are creative and provide information not easily found in research.	Questions lack creativity and do not provide information that can't be easily found from other sources.	

Mark /36

Appendix H

Prince Edward Island's Fresh Water Resource

An island is surrounded by water. Our island is no exception. On a warm sunny day, the waves caress the coastline, providing ample opportunity for swimming, fishing, and boating. However, this water contains salt, not suggested for drinking. Not to worry, we have an abundance of the fresh stuff as well.

We are blessed with approximately 112 cm of precipitation a year. Of this amount, about 50 cm is evaporated. Some is absorbed into the soil, some is transpired by the plants, and some eventually finds its way to the ocean. The important 20 cm left finds a home in a cozy sandstone aquifer. Why is this important? Because P.E.I. relies on groundwater for 99% of its fresh water for human consumption - the highest percentage reliance on groundwater in Canada.

As mentioned, P.E.I. has sedimentary rock as bedrock. This bedrock is porous, resulting in an aquifer. It is also fractured in places, allowing for ease of movement by water through the aquifer (2 cm to 1 m per day). These sedimentary rocks, 70% of which are sandstone, vary in depth from 1500 to 2500 m before you hit the igneous. The most permeable portion is the upper 7.5 m, although some productive zones have been found at depths of 150 m. Covering this bedrock is a thin overburden of sand, sandy till, and clay. The water table, which is the biggest amount of stored water in the aquifer, is between 0 and 60 m below the ground level, with the average depth being 10 to 20 m.

P.E.I. has a population of about 140,000 people. Of these, 35,000 get their fresh water from 41 municipal wells. Wells replenish quickly on P.E.I. due to usually abundant precipitation and porous ground. Some municipal wells yield 75 litres/second. The majority of Islanders rely on private wells (some as shallow as 10 m) for fresh water. Some have yields as low as 0.5 litre/second. Water softeners can come in handy on P.E.I., as the water is generally hard.

Unfortunately, this marvellous liquid asset of nature is threatened at times. Listed below, in no particular order, are the leading villains in the battle for water purity:

- above and below ground petroleum storage tanks
- petroleum spills
- agricultural chemicals and wastes (e.g., nitrates, pesticides, manure)
- sewage disposal systems
- inappropriate well construction and maintenance
- road salt runoff
- sea water intrusion
- waste disposal sites.

Our thin overburdened and porous bedrock may allow for quick well recharging, but it also makes us susceptible to groundwater contamination. As a result, the P.E.I. government in recent years has passed legislation giving water protection a top priority.

Several laws and actions have been taken:

- Over the last 20 years, water level monitoring wells have been established. Data from these is available for public perusal.
- Regardless of fault, owners of contaminating materials are responsible for removal of contaminated materials and ground including responsibility for appropriate financial compensation.
- Groundwater near major land sites is constantly monitored.
- 33% of P.E.I. landmass is improved farmland (second only to Saskatchewan). Selected testing of private wells for pesticides and nitrates occurs regularly.
- All public water supplies (municipalities, campgrounds, schools, etc.) are tested on a regular basis.
- All registered underground petroleum tanks have been replaced or inspected.
- Salt water intrusions can be a problem, especially near coastal areas. In Summerside, a 100 m well was flooded with salt water, causing the city to put down a new well to reach fresh water.
- Salt water intrusions can be good; more and more people involved in aquaculture are taking advantage of the intrusions.

Surface water on P.E.I. consists of ponds, streams, rivers, and estuaries. Our pioneers used these resources for human consumption, but as the Island became more populated, this became less and less appropriate. Today, they are used primarily for food, livelihood (shellfish industry), and pleasure. The greatest threats to surface water are

- Siltation and sediment loading (from agriculture runoff)
- Bacterial contamination (sewage disposal)
- Nutrient enrichment (fertilizer runoff, fish kills)
- Resource use conflicts (farmers vs. fishermen vs. tourists etc.)

An unusual example of the last issue occurred when people attempted good things. Farmers bordering a river made a wild life sanctuary for Canada geese. The geese became so numerous that the bacteria count in the river rose, threatening the oyster, quahog, and mussel industry for fisherman.

As we have seen, P.E.I. has an abundant fresh water supply, but it is vulnerable to contamination and must be constantly monitored.

Appendix I

Personal Water Use Activity

Questions for discussion:
Where does our water come from?
What happens to the water that goes down the drain?
Why is water important to people?
Why do you think we should be saving water?
What water saving ideas did you learn from the Water Share Web Site?

Responses to seek:
Concept of natural and engineered systems
Concept of water treatment and pollution
Awareness of diverse uses and values
Awareness of social impact of individual behaviour
Opportunities for taking personal responsibility

PROCEDURE:

1. Ask students to name all of the ways that they use water in a typical day. List these on the board. Show students the gallon jug of water, and ask them to estimate how many gallons of water they use in a typical day. Use some metric containers to make comparisons between gallon and litre measures.

2. Have students write down on a piece of paper the different water uses listed on the board. Tell them that over the next 24 hours they are to keep track of the ways they use water by noting them on the paper. For example, one student might flush the toilet 5 times, take a 10 minute shower, brush her/his teeth 3 times, and water the garden for 15 minutes.

3. The next day, show students the chart (with Water Saving Methods covered). Tell students that these are the average amounts of water for some typical water uses at home. Point out that some of the averages may seem high, but that is because people let the water run to get hot or cold before they use it. For example, we may not drink 1/4 of a gallon every time we get a drink of water, but we probably use 1/4 of a gallon.

4. Have students use this information to estimate the number of gallons of water they used in the 24-hour period.

5. Lead a discussion about the class's findings:

   - How much water did you estimate you personally used in the 24-hour period?
   - People in Canada use approximately 100 gallons of water per person, per day for domestic purposes. How does your usage compare with the average?
   - Imagine that you did not have plumbing in your home but had to carry water from a well. How do you think your water usage would change?
   - What simple, routine steps could we take to reduce the amount of water we use in a day?

6. Uncover the Water Saving Methods column of the chart and talk about the methods listed there. How hard would it be to actually follow each of these methods?

7. Have students log their water usage for another 24 hours, this time trying out as many water-saving methods as they can.

8. Ask students to calculate their water usage and compare the two days. Lead a discussion about the results:

- How much did your water consumption change from the first 24-hour period?
- What were the biggest reasons for the change?
- For which tasks was it easy to save water?
- For which tasks was it hard?
- If you were allowed only 25 gallons of water per day, how would you use your 25 gallons? How would you cut back?
- Choose three different water saving methods that you could use routinely. How much water would you save in a month if you were to apply these methods consistently?

Water Saving Method Chart (Without Usage)

Task	Average Uses	Water Conserving Method
Bathing	Full tub	Low level
Showering	Water running	5 -minutes with low-flow showerhead
Flushing toilet	Old regular tank	Tank with displacement device/ Ultra Low Flush
Washing hands/face	Tap running	Half-full bowl
Getting a drink	Tap running	Pitcher in fridge
Brushing teeth	Tap running	Wet brush, rinse
Washing clothes	Top water level	Adjusted water level
Shaving	Water running	Half-filled bowl
Watering outside	2/3 of a large water bill	½ of a smaller water bill
Cleaning driveway or patio	Hosing off	Sweep with broom
Washing car	Water running	Bucket, sponge, choke nozzle
Cooking 3 meals	Washing dishes by hand	Tap running
Sponge wash and dish pan drip	Automatic dishwasher	Full cycle
Short cycle		
Other	You estimate	

Water Saving Method Chart (With Usage)

Task	Average Uses	Water Conserving Method
Bathing	Full tub	Low level
	40 gallons	**15 gallons**
Showering	Water running	5 -minutes with low-flow showerhead
	60 gallons per 10 minutes	**12 gallons total**
Flushing toilet	Old regular tank	Tank with displacement device/ Ultra Low Flush
	7 gallons	**4.5 gallons** **2 gallons**
Washing hands/face	Tap running	Half-full bowl
	2 gallons	**½ gallon**
Getting a drink	Tap running	Pitcher in fridge
	1/4 gallon	**1/16 gallon**
Brushing teeth	Tap running	Wet brush, rinse
	10 gallons	**½ gallon**
Washing clothes	Top water level	Adjusted water level
	40 gallons per load	**25 gallons per load**
Shaving	Water running	Half-filled bowl
	20 gallons	**1 gallon**
Watering outside	2/3 of a large water bill	½ of a smaller water bill
	10 gallons per minute	**about half the watering time**

Cleaning driveway or patio	Hosing off	Sweep with broom
	10 gallons per minute	**0 gallons**
Washing car	Water running	Bucket, sponge, nozzle
	10 gallons per minute	**5 gallons**
Cooking 3 meals	**10 gallons**	**10 gallons**
Washing dishes by hand	Tap running	Sponge wash and dish pan drip
	30 gallons	**5 gallons**
Automatic dishwasher	Full cycle	Short cycle
	15 gallons	**7 gallons**
Other	You estimate	

Appendix J

Soil Texture Lab

A comparison of the water holding capacity of a sandy soil with a clay soil
(course texture vs. fine texture)

Materials Required:

2 Styrofoam cups

2 beakers to set the cups in

2 beakers containing 200 ml of water

2 beakers containing sand

2 beakers containing clay

Procedure:

1. Fill one cup ½ full of sand and one cup ½ full of clay. Label the cup with sand A and the cup with clay B. Take a pen and put 3 holes in the bottom of each cup. Make sure the holes are all the same size. Set each cup on top of the beaker.

2. At the same time, pour 200 ml of water into each cup.

Results:

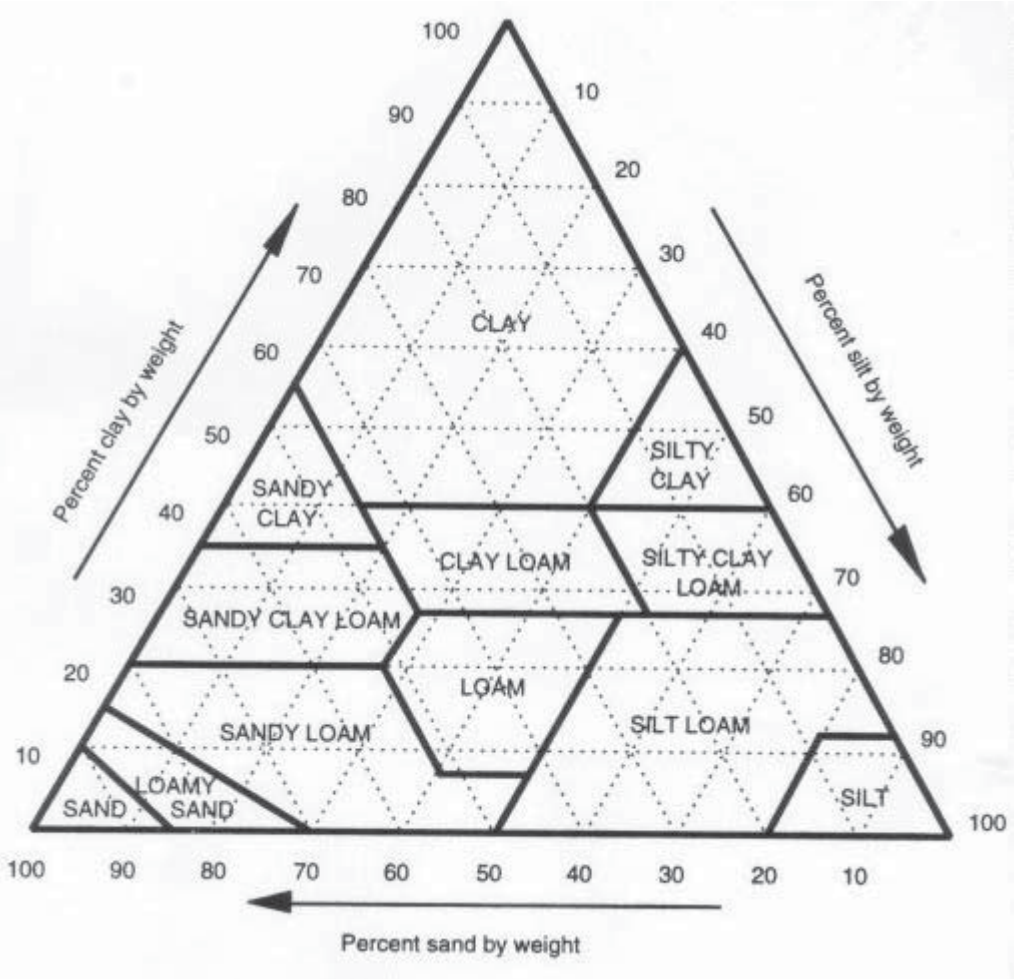
1.

A. Which soil type had the most water come through into the beaker below?

B. Are these the results you would expect?

C. Why or Why not?

2. Compare the colours of the two liquids. Explain the results.


100
90
80
70
60
50
40
30
20
10
Percent clay by weight
Percent silt by weight
Percent sand by weight
CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
LOAMY SAND
SAND
SILT

Appendix K

Soil Labs: Pore Space, Water Holding Capacity, and Capillarity

In a soil sample, a certain percentage of its volume is occupied by air. This is called pore space and it is found between the solid soil particles. In moist soil, some pore space is filled with air and some is filled with water. The amount of pore space varies from one type of soil to another. In the following exercise, you will determine the pore space of your sample.

MATERIALS: 2 graduated cylinders
stirring rod
soil sample

PROCEDURE:
A. Fill one of the graduated cylinders to the 55ml mark with soil.
B. Pack the soil by tapping the cylinder bottom quickly for ½ minute on your hand.
C. Record the volume of the soil.
D. Pour 70 ml of water into the other cylinder.
E. Pour the measured soil into the water.
F. Stir with a stirring rod to let all the air escape and then let stand for 5 minutes.
G. Record the volume of the mixture.

CALCULATIONS: When the soil was added to the water, water filled the pore spaces.
Calculate the percentage of pore space using the following equations:

A. (volume of soil + volume of water) -
(volume of the soil and the water mixture) = Pore Space Volume

B. Percentage of Pore Space = $\frac{PoreSpaceVolume}{SoilVolume}$ X 100

ASSIGNMENT: Write up the experiment giving the purpose, materials, procedure, observations, and results. Include the answers to the following in your report:

1. What soil type would have the greatest pore space? Why?
2. Why is air necessary in the soil?
3. Why is water necessary in the soil?
4. How is the water removed from the soil under normal conditions?
5. How could we increase the pore space?
6. How is suitable pore space maintained under natural soil conditions, i.e.; in uncultivated fields?
7. Why is it that the soil is difficult to dig when digging a post hole and yet when you put in the post and fill in the soil around it, often there isn't enough soil to refill the hole?

The water holding capacity of soil is mainly dependent upon two things - how much humus is in the soil and the size of the soil particles. However, some soils can absorb their own weight or more in water. Ideally, the water content should be only 60% -80% of the soil's capacity. If soils contain less than 60% of their capacity for water, there is not enough water for the cellular needs of many organisms. If soils contain more than 80% of their capacity of water, there is too little oxygen available for the growth and activity of many micro-organisms.

MATERIALS: can with both ends open
filter paper
rubber band
soil sample

PROCEDURE:
A. Weigh the can with the attached filter paper. Record the weight.
B. Place the soil in the can and reweigh it.
C. Slightly moisten the filter paper on the end of the can.
D. Weigh the completed apparatus. Record the weight.
E. Set the can (filter paper end down) in the water so that the lower half is immersed. Leave it until next lab day.
F. Remove the can from the water. Transfer to the rack and let dry for 30 minutes.

CALCULATIONS:
A. Weight of the dry soil
B. Weight of dry soil + can + wet filter paper
C. Weight of damp soil + can + filter paper

ASSIGNMENT: Write up the experiment giving purpose, materials, procedure, observation, and results. Include a diagram of the assembled apparatus and answer the following questions:
1. How does the particle size determine the water holding capacity of the soil?
2. Which soil has the best water holding capacity? Why?
3. Can the water holding capacity of the soil be increased? How?
4. How could you decrease the water holding capacity of a soil?

Percolation of water into the soil carries water with its dissolved and suspended materials into the depths of the soil. Evaporation dries out the upper layers of the soil. In areas where there is little rainfall, this should mean that few organisms can survive in the upper layers of the soil in low rainfall areas.

MATERIALS:
ring stand and clamp
rubber band
large beaker
graduated cylinder or glass tube
soil sample
filter paper

PROCEDURE:
A. Seal off one end of the tube by fastening filter paper to it with an elastic band.
B. Slowly add 200 grams of soil to the tube.
C. Attach the tube to a clamp which is supported by a ring stand.
D. Slowly lower the tube until the base is just below the water surface.
E. Measure the height to which the water rises in the soil at 30 second intervals. Make your measurements from the base of the tube in millimetres.
F. Continue measuring until the water reaches the top of the soil.

ASSIGNMENT: Write up the experiment giving the purpose, materials, procedure, observations, and results. Include a diagram of the assembled apparatus and answer the following questions: (be sure to state the soil type)

1. What is capillarity?
2. Why is it important for plant growth?
3. How does soil texture affect capillarity?
4. How would soil structure affect capillarity?
5. If you had two gardens, one in which the soil was mostly sand and the other with mainly clay soil, which one would you have to water more often? Why?
6. How do you think a hard pan would affect capillarity?
7. If there was a problem with poor capillarity in the soil, how could we improve it.
   A) if the capillarity rate was too high?
   B) if the capillarity rate was too slow?

Appendix L

Earthworm Lab

Eco-Enrichers

Worms:

Although many people rarely think of worms as more than fish bait, they are actually very valuable to the soil. But the earthworm has all but been forgotten in modern agriculture. So much of what the earthworm used to do for free is now done by tractors and chemicals. Many of these modern farming practices decrease the abundance of earthworms. Cultivation of the land, as well as pesticide and fertilizer applications, can adversely affect earthworm populations. If soil does not have a high number of earthworms, they can return if conditions are improved. They are certainly a valuable component of any soil. Here are some of the advantages of having earthworms:

- Earthworms churn the soil and make it porous for maximum plant growth.
- The maze of tunnels created by earthworms increases the soils ability to absorb water.
- Earthworms neutralize soil pH with their castings or manure. Soil that comes out of an earthworm in this form is closer to neutral pH, regardless of whether existing soil is above or below pH 7.
- Earthworms bring up minerals and make plant nutrients more available.
- Earthworm burrows stimulate the growth of nitrogen fixing bacteria which are very important to plant growth.
- The gut of an earthworm mixes, conditions, and inoculates plant residues, turning it into free manure.
- Earthworms are a good indicator of healthy soil. Soil with earthworms tends to have less plant-eating invertebrates than soil without earthworms.

It is obvious that earthworms are always working to make the soil better. They do this not only for their own survival but for the healthy survival of their primary food source, the residues from crops. They are truly a farmer's best friend.

In this lab exercise, students will gather soil and combine it with some type of organic matter. Worms are then added to this mixture. Analysis will be done on the soil before the worms are added and after they have a chance to work the soil. This will give students an idea of the valuable role that worms play in an ecosystem.

Appendix M

Empirical Grouping

Goal

Investigate the empirical method of grouping.

Think About It

You have had experience in forming groups, but much of this was done by instinct and was subjective. Is there some methodology that can be applied in order to obtain consistent, objective results?

Procedure

Read the instructions carefully and follow the procedure. Then answer the questions in the space provided.

1. Obtain an envelope from your teacher. It contains a variety of common objects.
2. Select one characteristic that is common to some of the objects, and group them according to that characteristic.
3. Record the characteristic and the items that share it.
4. Repeat steps 2 and 3 for at least ten different characteristics.
5. Examine all the groupings you made, and determine which objects appeared together most often.
6. List these as natural groups.

Questions

1. What characteristic did you use to group the majority of the objects? Why did you choose this characteristic? Explain.
2. What other characteristics could you have used to group your objects? Explain why you decided against two of the other possible characteristics you could have used to group your objects.
3. Which characteristics were least effective in grouping your objects? Why?
4. Which characteristics were most effective in grouping your objects? Why?
5. Explain the importance of grouping objects according to similar characteristics. Can you see an application in the classification of living organisms? Explain.

Empirical Grouping – Teacher's Notes

Tips

- Fill large envelopes with common objects such as a ruler, paper clip, screw, string, bottle top, chalk, rubber stopper, dried bean, cork stopper, eraser, pencil, sticky-note paper.
- Use varieties of size as well as colour.
- Some students may suggest using a computer for the final analysis and should be encouraged to do so.

Answers

1. Groups will vary, but the artificial ones will be based on single characteristics and tend to be larger, whereas the natural ones will be based on several criteria and have only extremely similar members. Some students may realize that the class itself is an artificial group.
2. Students will have a variety of different characteristics used to group their organisms. Two possible characteristics not to use include length and shape since some of the objects will show differences in shape and length and be difficult to classify as such.
3. The two least effective characteristics will likely be those of shape and colour as many of the objects may be available in several shapes and colours (i.e., pencils, pens, erasers).
4. The characteristics that are likely to be most effective will include categories such as writing utensils, objects used to hold things together, and other such categories. These categories group objects together with the greatest number of similarities.
5. Grouping objects according to similar characteristics is important when you wish to identify an object clearly. The same is true in the classification of living systems. Those organisms that have the greatest similarities are grouped together so that in mentioning one organism, one can know the majority of characteristics of that organism.

Appendix N

Creating a Dichotomous Key

If you find an insect you have never seen before, how could you discover its identity? Many field guides help you match up the characteristics of your specimen with those of similar organisms using a **dichotomous key**. This identification key uses a series of paired comparisons to sort organisms into smaller and smaller groups. In this investigation, you will learn how to make your own keys to identify specimens.

Pre-lab Questions

- What characteristics do all insects have in common?
- Name two characteristics that scientists use to tell different insects apart.

Problem

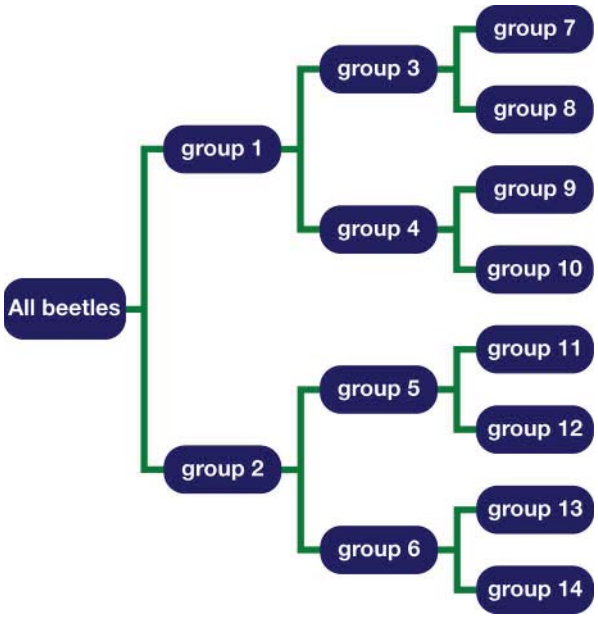
How do you make a dichotomous key?

Prediction

Predict which characteristics of insects will be most useful in creating an identification key.

Materials

illustration of 18 beetles
paper
sample dichotomous keys
pencil



Procedure

1. Copy the diagram of a dichotomous tree shown here onto a separate piece of paper.
2. Study the illustration of 18 beetles shown on the next page.
3. Select one characteristic and sort the beetles into two groups based on whether they have the characteristic or not.
4. List each beetle's number under either Group 1 or Group 2 on your diagram.
5. Record the characteristic that identifies each group.
6. Select another characteristic of each subgroup, and repeat steps 4 and 5 for the next level down on your diagram.
7. Continue to subdivide the groups until you have 18 groups with one beetle in each.

8. Using the characteristics shown on your diagram, construct a dichotomous key that someone could use to identify any beetle from the original large group. To do this, create a series of numbered steps with the first step showing the first characteristic you used. At each step, offer two choices for classifying the beetle based on a single characteristic. For example, you may have used the characteristic "antennae longer than front legs" as your first dividing characteristic. Your first numbered step in your key would be (1a) antennae longer than front legs. Use the sample keys provided by your teacher to help you.
9. Exchange your key with a partner. Use your partner's key to classify a beetle, and record all the characteristics of the species you chose.

Post-lab Questions

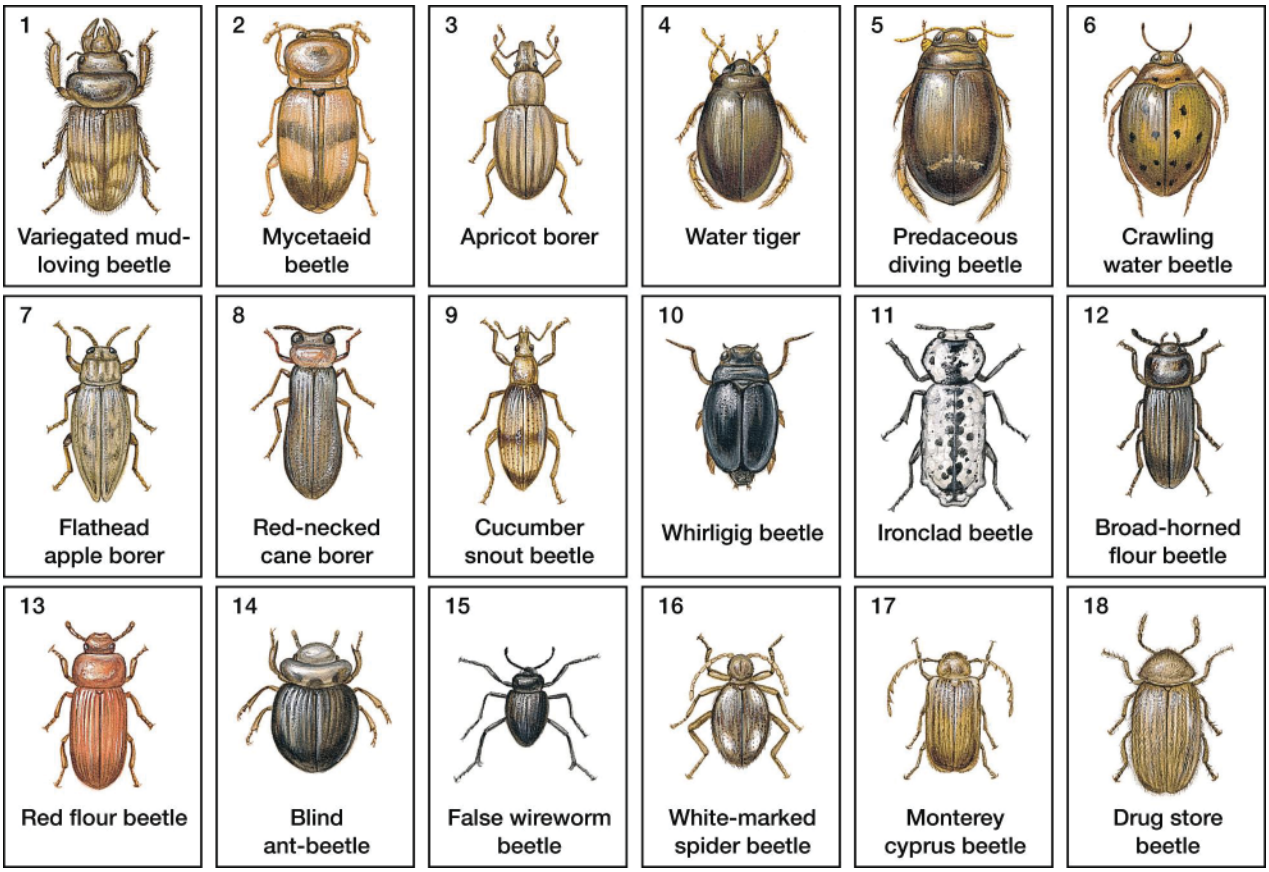
1. Did your partner produce a dichotomous key identical to yours? Explain why or why not.
2. Which beetle characteristics were not useful for creating your key? Explain why not.

Conclude and Apply

3. Why does a key offer two choices at each step and not more than two?
4. Use print or electronic resources to find the two-word species name for each beetle shown below.

Exploring Further

5. Your teacher will provide you with several different "mystery" beetles. Use your dichotomous key and see if you can identify what species the beetles are. You may be unable to completely identify your beetle using your key. If this is the case, how far could you go with your key? Visit the library or the Internet and get a field guide to beetles. Use this to identify the mystery beetles. What characteristics would you have needed in your key in order to fully identify them?



Appendix O

Plant Structures and Taxonomy

1. a) Distinguish between taproot and fibrous roots.

   b) Give two examples of taproots that we use as food.

   c) Name two plants with fibrous roots.

   d) Give an advantage of each type of root.

2. Give the purpose of the following parts of the root:

   a) root cap

   b) area of cell division

   c) area of cell elongation

   d) xylem

   e) phloem

   f) area of cell maturation

3. Define stem.

4. Describe the following types of stems and give an example of each:

   a) woody

b) herbaceous

c) bulbs

d) corms

e) rhizomes

f) tubers

5. Name the two internal parts of the stem which are the same as the root.

6. Distinguish between the terminal bud, the vegetative bud, and the flowering bud.

7. a) What is the function of the leaf?

b) Distinguish between a simple leaf and a compound leaf.

8. Define the following:

a) photosynthesis

b) chloroplast

c) stoma

d) guard cells

9. Give the formula for photosynthesis.

10. What are the three functions of the flower of the plant?

11. Describe the importance of the following parts of the flower:

a) stamen

b) filament

c) anther

d) pollen

e) pistil

f) stigma

g) style

h) ovary

i) petals

j) ovules

k) sepals

12. Define pollination.

13. After fertilization, the pistil enlarges and becomes the _____.

14. What is the purpose of the fleshy part of the fruit?

15. Name four ways fruit and/or seeds may be moved.

16. Explain the difference between a vegetable and a nut.

Plant Structures and Taxonomy Answer Sheet

1. a) Distinguish between taproot and fibrous roots.

   Taproot- root that is one main root, grows straight
   Fibrous - hair-like, numerous, spreads sideways

   b) Give two examples of taproots that we use as food.
   carrot, parsnip

   c) Name two plants with fibrous roots.
   grass, grain

   d) Give an advantage of each type of root.
   Taproot- able to survive drought conditions
   Fibrous - anchors the plant well, holds soil better

2. Give the purpose of the following parts of the root:
   a) root cap -penetrates soil for growth
   b) area of cell division - cells multiply and begin to grow in both directions
   c) area of cell elongation - cells get longer and specialized
   d) xylem - carries water and nutrients to leaves
   e) phloem- carries food from the leaves to other parts of the plant
   f) area of cell maturation - cells mature and root hairs develop

3. Define stem - part of plant that supports leaves

4. Describe the following types of stems and give an example of each:
   a) woody - tough outer bark, able to survive cold conditions
   b) herbaceous - green and soft, unable to survive cold conditions
   c) bulbs - shortened stems surrounded by modified leaves
   d) corms - thickened, compact and fleshy
   e) rhizomes - thick stems that run below ground
   f) tubers - thickened underground stems that store carbohydrates

5. Name the two internal parts of the stem which are the same as the root.
   xylem and phloem

6. Distinguish between the terminal bud, the vegetative bud, and the flowering bud.
   Terminal - area at the tip of the stem
   Vegetative - produces stem and leaf growth
   Flowering - produces flowers

7. a) What is the function of the leaf?
   To make food
   b) Distinguish between a simple leaf and a compound leaf.
   Simple -single leaf from stem
   Compound - 2 or more leaves coming from a common point on the stem

8. Define the following:
   a) photosynthesis - process of manufacturing food
   b) chloroplast - organelle in the leaf where photosynthesis is carried out
   c) stoma - opening in the epidermis that allows for gas exchange
   d) guard cells - cells which open / close the stoma

9. Give the formula for photosynthesis.
   $6CO_2 + 6\,H_2O = C_6H_{12}O_6 + 6O_2$

10. What are the three functions of the flower of the plant?
    To produce the seeds, to produce fruit, and to continue the species.

11. Describe the importance of the following parts of the flower.
    a) stamen - male part of the flower
    b) filament - supports the anther
    c) anther - manufactures the pollen
    d) pollen - male reproductive cell
    e) pistil - female part of the flower
    f) stigma - receives the pollen
    g) style - tube connecting stigma to the ovary
    h) ovary - contains the ovules
    i) petals - brightly coloured to attract insects
    j) ovules - female reproductive cells
    k) sepals - protective device for the developing flower

12. Define pollination.
    union of the pollen with the stigma

13. After fertilization, the pistil enlarges and becomes the fruit.

14. What is the purpose of the fleshy part of the fruit? To attract animals and humans to the seeds, helping to spread them over a range of areas

15. Name four ways fruit and/or seeds may be moved
    wind, water, animals, and humans

16. Explain the difference between a vegetable and a nut.
    Vegetable can be any part of the plant which is edible, i.e,. root, leaves, flowers, or stems
    Nut is the fruit

Appendix P

Plant Physiology

Physiology:

The study of how plant organs (stems, roots, leaves, flowers, fruits, and seeds) function and the chemical processes required to live, grow, and reproduce.

Photosynthesis:

The trapping of light energy to convert it to chemical energy in the form of simple sugar.

Respiration:

All living cells take in oxygen and give off carbon dioxide by converting simple sugars into chemical energy.

** **Photosynthesis and respiration are processes which are opposite to each other.**

Photosynthesis	**Respiration**
Food is produced	Food is broken down
Energy is stored	Energy is released
Occurs in cells with chloroplasts	Occurs in all cells
Oxygen is released	Oxygen is used
Water is used	Water is produced
Carbon Dioxide is used	Carbon Dioxide is produced
Occurs in sunlight	Occurs in sunlight and darkness

Transpiration:

Plants lose water vapour through evaporation in the leaves. This process requires areas in contact with soil, air, and water. Osmosis (taking in water through a semi-permeable membrane from an area of high concentration to an area of low concentration) is critical to transpiration.

Plant Nutrition:

Plants need 16 essential nutrients.
Three are found in the atmosphere and water: Carbon (C), Hydrogen (H), and Oxygen (O).

Six of these are relatively large and are called macronutrients. They are Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), and Sulfur (S).

Seven micronutrients are needed in small or trace amounts. They are Boron (B), Copper (Cu), Chlorine (Cl), Iron (Fe), Manganese (Mn), Molybdenum (Mo), and Zinc (Zn).

Plants are also affected by the soil ph. The two types of soil ph are acidity (0 - 6.5) and alkalinity (7.5 - 14). The optimum or best range for most plants to grow in is between 6 – 7.

Plant Physiology

1. What are the major parts of the cell?

2. What is meant by physiology?

3. What is the most important chemical process in the atmosphere?

   Explain the process.

4. What are chloroplasts?

5. What is chlorophyll?

6. What 3 factors vary the food making process?

7. What is respiration?

8. Compare the differences between photosynthesis and respiration (point form).

9. What is transpiration?

10. Name five functions of water in a plant.

11. What environmental conditions affect transpiration?

12. What process does the root use to get nutrients into the root cell?

    Explain how this works.

13. What is the job of the pores in the soil?

14. What is the difference between plant nutrition and plant fertilization?

15. What is the optimum pH range for many plants?

16. How many essential nutrients are required for a healthy plant?

17. What is meant by acidity?

    What is meant by alkalinity?

18. What structures in a plant are used to store manufactured food?

1. What are the major parts of the cell?
   Cell wall, vacuole, chloroplast, cytoplasm, nucleus, (granules)

2. What is meant by physiology?
   The study of how organs function and how chemical processes help it live, grow, and reproduce.

3. What is the most important chemical process in the atmosphere?
   Photosynthesis

   Explain the process.
   Light energy is converted to chemical energy by making simple sugar. Chlorophyll and chloroplasts do the work and are necessary.

4. What are chloroplasts?
   Small membrane-bound bodies inside cells that contain chlorophyll

5. What is chlorophyll?
   Green material inside chloroplasts used in photosynthesis

6. What 3 factors vary the food making process?
   Light intensity, temperature, and concentration

7. What is respiration?
   Process where all living cells take in oxygen, breakdown simple sugars, and give off CO_2

8. Compare the differences between photosynthesis and respiration (point form).
   Almost complete opposites - photosynthesis food produced, energy stored, O_2 released, H_2O used, CO_2 used - needs sunlight and done in plants with chloroplasts
   respiration - food used, energy released, O_2 used, H_2O produced, CO_2 produced, - in dark and light, done in all plant cells

9. What is transpiration?
   Process where plants lose water through evaporation. Occurs primarily in the leaves through the stoma. Keeps a sucking motion in the plant that brings water to the leaves for photosynthesis.

10. Name the functions of water in a plant. (5)
    - carries nutrients to the leaves
    - used in photosynthesis process
    - helps control temperatures through transpiration
    - provides support through turgor pressure
    - dissolves nutrients to be carried

11. What environmental conditions affect transpiration?
Humidity, wind and air movement, temperature

12. What process does the root use to get nutrients into the root cell?
Osmosis

Explain how this works.
Water passes through a semi-permeable membrane carrying nutrients because a solution with a higher concentration of solutes will move to an area of lower concentration of solutes

13. What is the job of the pores in the soil?
Store air, water, and nutrients; permits root penetration

14. What is the difference between plant nutrition and plant fertilization?
Nutrition - availability and type of basic chemical elements in a plant
Plant fertilization - process of adding nutrients to the soil or leaves through the environment

15. What is the optimum pH range for many plants?
6 - 7

16. How many essential nutrients are required for a healthy plant?
16

17. What is meant by acidity?
Sourness of soil

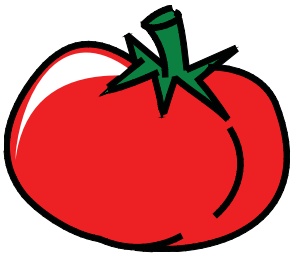
What is meant by alkalinity?
Sweetness of soil

18. What structures in a plant are used to store manufactured food?
Roots, stems, seeds, and fruits

Appendix Q

Dining on DNA

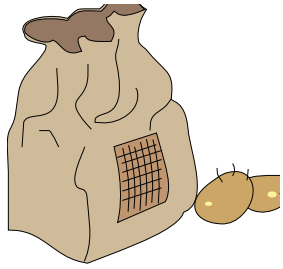
Risky Business or Stupendous Solutions?



THE FLAVR SAVR TOMATO

In the United States, tomato lovers spend 4 billion dollars on tomatoes every year (this includes tomatoes for salads, pastes, sauces, ketchups, and soups). American consumers expect to be able to purchase fresh tomatoes all year long, so during cold months tomato growers have a hard time keeping up with demand. Over the winter, tomatoes grown in southern states are picked while green and shipped to northern states. The tomatoes are then reddened and ripened in containers filled with ethylene gas. Northern consumers complain because ethylene-ripened tomatoes do not have the "backyard summertime" flavor of those in grocery stores during warmer months. Another problem is that because the tomatoes are picked early, they do not take up enough nutrients from the soil and sun in order to gain vine-ripened flavour and texture. What's more, ethylene-ripened tomatoes start rotting in 4-7 days, so many tomatoes spoil before being sold. Pectin, a naturally occurring fibre substance, is what gives tomatoes their firmness and keeps tomatoes from getting mushy.	Tomatoes have a gene (section of DNA) that codes for an enzyme called polygalacturonase. Let's call it "polyG" here for simplicity. PolyG actually chews up the pectin in the tomato and the end result is a softer, mushier tomato. A company called Calgene, Inc. genetically engineered a tomato by changing the gene that codes for polyG. Basically, they "turned off" the gene that codes for the polyG enzyme so that the tomato does not soften as quickly and can stay on the vine longer to gain delicious flavour. These new, genetically altered tomatoes were named Flavr Savr tomatoes. How did the scientists "turn off" the polyG gene? They introduced an "antisense" version of the polyG gene into the tomato plant cell. An antisense gene is basically an inverted or mirror image copy of the original gene. When the antisense gene is introduced into the gene, it attaches like a puzzle piece to the original polyG gene and therefore does not allow the polyG gene to code for the polyG enzyme. The end result is a tomato that stays firm even as it continues to ripen.

POTATO



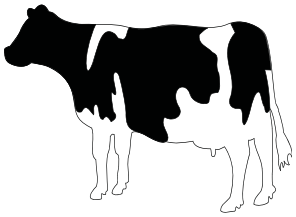
POTATO

PLANT

PESTICIDE

Many different types of bacteria find their homes on the leaves, stems, and fruit of plants. These microbes must often compete for their nutrients (food) with other plant pests such as insects or fungi. How do they compete? They provide a substance called a toxin which is harmful to their opponents, insects, and fungi. As scientists observed this competitive relationship between the plant pests, some came up with the idea to allow the plant to defend itself by producing this toxin all on its own. How did they do it? Let's explore the background in a little more detail. There is a specific bacteria known as *Bacillus thuringiensis* or Bt for short. Bt produces a substance which is toxic to many insects. Scientists identified the Bt genes responsible for the production of this toxin and transferred these genes into certain crop plants such as potatoes, corn, and cotton.	Now these plants which have been genetically engineered are able to produce the toxin on their own and protect themselves against the damaging insects. The toxin produced directly by the plant is called a "plant pesticide". Many people who support this research feel that by enabling plants to protect themselves through producing plant pesticides, the use of conventional or chemical pesticides will be reduced. The US Environmental Protection Agency has approved some limited use of the Bt plant pesticide. Also, they have determined that the use of the Bt plant pesticide will not pose an unreasonable risk to the health of people or other organisms which are not targeted by the plant pesticide.

Risky Business or Stupendous Solutions?

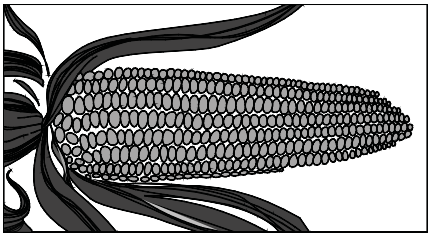


RECOMBINANT

BOVINE

SOMATROTROPIN

Bovine Somatrotropin is a protein hormone which is naturally produced in dairy cows. It is also known as BST. BST plays a role in some vital functions of the cow such as growth and milk production. In the early 1980's, scientists at a biotechnology company called Genetech isolated the genes that code for the production of BST in cows. By inserting these genes in bacteria, scientists were able to produce large quantities of BST in the laboratory. This form of BST which is produced through genetic engineering is called recombinant BST or rBST. The next step was to see how the rBST affected the cows. It was found that when rBST is given (via injectors) to lactating cows, milk production is increased by about 10%. Since this discovery, two companies (Monsanto and Eli Lilly) have developed a commercially available form of rBST to be used by dairy farmers.	The US Food and Drug Administration (FDA) has approved the use of rBST in dairy cows. The FDA reported that rBST does not change the composition of milk and proved no threat to individuals who consume the milk. According to research conducted on rBST and cows supplemented with rBST, • The concentration of BST in the milk of cows treated with the usual doses of rBST is not higher than the concentration of untreated cows. • When people ingest BST orally or receive an injection of BST, BST has no biological activity in these people. • BST is a protein and is digested like other proteins in the human digestive tract.



PEANUT

PROTEIN

IN CORN

Peanuts are high in protein but are also high in fat. In order to utilize the protein in peanut and avoid the fat, scientists and nutritionists have suggested putting the genes that code for peanut protein into corn. Corn that contains the peanut protein will have a higher protein content than normal corn. A higher protein corn has tremendous potential in our country and in third world countries as well. In our country, corn is used in processed food like cereals, breads, and chips. Increasing the protein content in corn would therefore increase the nutritional value of these processed foods. In third world countries, malnutrition is a big problem. Because corn is a staple crop in most of these countries, a high protein corn could help combat protein calorie malnutrition world-wide.	The condition of protein calorie malnutrition in people is called kwashiorkor (kwash-ee-or-kor). Now for the controversy! Yes, it's true that peanuts are high in protein, yet this peanut protein causes an allergic reaction in some people. So if the gene coding for the peanut protein is transferred into another food, such as corn, how is that person to know that s/he should avoid eating the corn? Other biotechnologists argue that genetic engineering techniques can actually be used to reduce the presence of allergy causing proteins in food since the scientists can isolate the gene coding for the allergen and reverse it or cut it out so that protein will no longer be made.

HERBICIDE - RESISTANT SOYBEANS

How do modern farmers deal with weed problems? One solution is to use chemical herbicides. Herbicides are chemical substances used to destroy plants or limit their growth. One such herbicide is called Roundup. Roundup has a compound called glyphosate in it. Glyphosate is called a broad spectrum herbicide because it negatively impacts many different types of plants (for example, board-leaf plants and grasses). Therefore, Roundup will not only harm the pesky weeds, it may also harm the desired crop plant. So, scientists from the company Monsanto identified a gene which enables a plant to tolerate Roundup.

They transferred this gene into a soybean plant and then, through traditional plant breeding methods, created many of these Roundup resistant soybean plants. The name given to the plants are Roundup Ready soybeans. Now, farmers are able to apply Roundup to their fields to get rid of the weeds yet do not have to worry about harming their soybean crop.

Those who advocate the use of this application of biotechnology note that Roundup is a herbicide that is easily degraded in the environment and that by making the crop plants resistant to Roundup, the end result will be less overall volume of herbicides used. Individuals opposed to this technology fear that the genes for herbicide-resistance will be somehow passed to the weeds.

Risky Business or Stupendous Solutions?
Please answer all of the following questions as they apply to your specific food biotechnology application.

Food Safety Concerns:

1. An allergen is any substance that can cause an allergic reaction in a person. Does this application of biotechnology pose any problems in terms of introducing an allergen to the food? Explain.

Nutrition Quality:

2. Does this application of biotechnology enhance or take away from the nutritional quality of the original food? Explain.

World Hunger:

3. Does this application of biotechnology have the potential to impact world hunger? How?

Environmental Issues:

4. Will this application of food biotechnology:

   a. Increase the use of chemical pesticides? _____
   b. Decrease the use of chemical pesticides? _____
   c. Not impact chemical pesticide use? _____

   Explain your answers:

5. Biodiversity is a term which is used often when discussing whole ecosystems. Biodiversity refers to the variability of animals, plants, and microorganisms within a specific ecosystem. Does the introduction of the genetically altered product you read about pose any environmental risks in terms of biodiversity?

Economics:

6. Is this application of biotechnology needed from an economic point of view? Explain.

7. Does this application of biotechnology have the potential to have positive or negative economic impacts on:

   a. The farmer? Explain.
   b. The food processor? Explain.
   c. The consumer? Explain.

Aesthetics:

8. Will this application of biotechnology change the appearance of the food to make it more marketable (desirable to the consumer)? How?

Social Issues:

9. Might this application of biotechnology present problems to consumers due to religious or moral beliefs? Explain.

10. Now list five potential risks and five potential benefits of this application.

Potential Risks:

a. _____

b. _____

c. _____

d. _____

e. _____

Potential Benefits:

a. _____

b. _____

c. _____

d. _____

e. _____

11. How might we minimize the risks and maximize the benefits of this technology?

_____

_____

_____

_____

_____

12. Prioritize your list of Potential Risks (rate the risks on a scale from 1 to 5, with 1 being most risky and 5 being least risky).

1. _____

2. _____

3. _____

4. _____

5. _____

13. Prioritize your list of Potential Benefits (rate on a scale from 1 to 5, with 1 being the most beneficial and 5 being the least beneficial).

1. _____
2. _____
3. _____
4. _____
5. _____

14. Assess the priorities and state why you approve (or disapprove) of this application of biotechnology.

_____

_____

15. Take a group vote to decide whether the group approves or disapproves the application.

Number who approve? _____
Number who disapprove? _____

16. Discuss your reasons for supporting or opposing the application.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Risky Business or Stupendous Solutions?
Teacher Answers:

Students will answer questions in the following categories according to the application of biotechnology they have read. Some general answers are below.

Food Safety Concerns:

1. Does this application of biotechnology pose any problems in terms of introducing an allergen to the food? Explain.

The alteration of the genetic makeup of some plants may produce unforeseen health risks through the introduction of an allergen into a plant which previously had no allergen. People who are allergic need to be made aware that the "new" food does contain a potential allergen.

Nutrition Quality:

2. Does this application of biotechnology enhance or take away from the nutritional quality of the original food? Explain.

Genetically altering foods can have a big impact on certain foods. Foods can be more nutritious, already nutritious foods can be made tastier, and perishable foods can be given a longer shelf-life. On the other hand, concern has been voiced that genetically altering foods may decrease the beneficial nutrient composition of that food.

World Hunger:

3. Does this application of biotechnology have the potential to impact world hunger? How?

At present, there are 7.0 billion people inhabiting Earth. By 2030, the population of Earth is projected to increase to 8.5 billion people. Many people question if we will have the capability to feed an extra 1.5 billion mouths (plus the ~1 billion people who presently do not have enough to eat). Food biotechnology may be part of the solution by increasing the crop yields or being able to increase nutrient composition of food.

Environmental Issues:

4. Will this application:
   a. Increase the use of chemical pesticides? b. Decrease it? or c. Not impact its use?

A. In some cases, the goal is to reduce the need of pesticides by enabling plants to kill any pests that endanger them.
B. Biological control, a method to apply bacteria and viruses directly on the plants to produce toxins, may lessen pesticide use.
C. Pesticide, herbicide, and fungicide tolerant crops are created so chemicals can be applied on the entire field. This has the potential to increase the need for "new" pesticides as in the case of Roundup Ready soybeans. The crop rotation of fields presents a problem as the Soybeans will not be destroyed if Round up Ready wheat is planted the following year. There is a potential for less to be used as the pesticide has killed all plants in the field over time.

5. Does the introduction of this transgenic product pose any environmental risks in terms of biodiversity?

When an organism's genetic makeup is affected, the organism can either do something or not do something it did before. When the organism's abilities change, it always affects the environment. The question is does it hinder or help the environment.

Also, the affects of genetic engineering threatens the diversity of species on Earth. Therefore, the number of types of plants available lessens and more become extinct. It is always felt that diversity within the environment gives the ecosystem resilience.

Economics:
6. Is this application of biotechnology needed from an economic point of view?

A biotechnology which promises to decrease world hunger would boost the economy. Also, increasing crop yields where needed may be a boost. However, should there be a surplus in the market, an increase in production could be a problem for the economy.

7. Does the application have a positive or negative impact for a
   a. farmer b. food processor c. consumer?

Some applications will have an enormous impact on a specific industry.
Positive impacts: 1) creation of a whole new industry in an area, 2) creation of a more affordable food supply.
Negative impact: 1) downfall of an existing industry, 2) creation of an exclusive product to drive prices up.

Aesthetics:
8. Will this application change the appearance of the food to make it more marketable? How?

A longer shelf-life gives food the appearance of "fresh" and that is desirable to the consumer.

Social Issues:
9. Might this application present problems to consumers due to religious or moral beliefs?

A transgenically altered food can cause religious and moral debate. For example, some people eat kosher food prohibiting them from eating pork products. Therefore, should a pig's genetic material be injected into another product, this causes a problem. Also, others believe it is "playing God" to alter the genetic makeup of organisms.

10. List five potential benefits.

A. Foods could be more nutritious
B. Food more tasty
C. Longer shelf-life
D. Decrease in the number of food poisoning incidents by increasing the detection of food borne pathogens
E. Waste management: Enzyme bioreactors are being developed to pre-treat components of disposable service ware to allow for their removal through the sewer system rather than through the solid waste disposal or convert them to biofuel for operating generators.
F. Reduce the need for pesticides
G. Make plants grow faster
H. Make crops draught tolerant
I. Non-food materials can be made from food products, i.e., plastics made from potatoes

Potential Risks:

A. Allergic reactions, i.e., peanuts, shellfish
B. Religious or moral beliefs opposed to eating certain foods
C. Marker genes are injected along with the desired gene to show scientists the gene transfer is successful. Very often the marker gene is antibiotic resistant and it is through this resistance that scientists can tract the injection. Although highly unlikely, some people feel they may become antibiotic resistant.
D. Environmental concerns: Possibility of "test" plants getting into the wild and taking over
E. Fear that introduced genes will adversely affect the other genes in the organism
F. Ethical concerns: "playing God" - it's not man's place

11. How might we minimize the risks and maximize the benefits?

We could minimize the risk by enforcing strict labelling requirements for genetically altered foods and a strict approval process.

We could maximize the benefits by keeping careful watch on preliminary testing. Genetically altered food may help eliminate hunger world-wide.

NOTE: The remaining questions express the results of each group's discussion and consensus building.

Appendix R

Detemining Plant Genotypes

Determining Plant Genotypes

In this investigation, you will design and conduct experiments to determine the genotypes of tobacco plant seeds. You will use two batches of seeds that yield slightly different characteristics in the plants. One batch of seeds will produce some seedlings that are green and some that are white (albino). The other batch will produce some seedlings that are green, some green-yellow, and some yellow. Work in a small group to design your experiments. Then obtain your teacher's approval before completing the investigation.

Problem

How can you determine the genotype of a tobacco seed based on the phenotype of the seedling?

Hypothesis

Each group is responsible for formulating a testable hypothesis of how the plant phenotypes reflect their genotypes. The hypothesis will form the basis of your experimental design.

NOTE: Be careful not to mix seeds from the two batches. Wash your hands following this investigation.

Materials

2 different batches of tobacco seeds
flats, small pots, or plastic cups
growth medium (vermiculite or sterilized potting soil)
magnifying lens or dissecting light microscope
water
labels

Experimental Plan

1. Brainstorm several methods you could use to test your hypothesis, using the materials listed here.
2. As a group, select one method for your experimental design.
3. Your experimental design should include the collection of qualitative and quantitative data.
4. Your plan should consist of a series of easily identifiable and understandable steps that could be duplicated by another group without the need for additional information or clarification.

Checking the Plan

Review your plan among the members of your group and with your teacher. Possible questions include:

1. What types of data will you collect?
2. What is/are the dependent and independent variable(s)? Does your experiment include any control variables? What variables might you wish to control?
3. What is the duration of the experiment and what data will you collect during this time?
4. Have you prepared a table for collecting your data?
5. Has your plan been approved by your teacher?
6. Have you applied/used all necessary safety precautions?

Data and Observations

Each group is responsible for carrying out their own data collection. Record your observations in your table. Each group is also responsible for analyzing their results. Use a graph or chart to present your results.

Analyze

1. Suggest possible genotypes (combinations of alleles) for the different phenotypes observed (for example, GG might indicate homozygous dominant for green).
2. Why is it not possible for the genotypes of the different batches of tobacco plants to be determined through an investigation of the seeds alone?
3. Identify each of the variables you considered in designing your experiment. Explain how consideration of each variable was necessary in order to obtain valid scientific results.
4. Determine the method of inheritance for the batch of seeds that produced green and/or white tobacco seedlings. Explain.
5. Describe how you determined the genotypes of the individual seeds using an example from each of the seed batches.

Conclude and Apply

6. Determine the method of inheritance for the batch of seeds that produce green, yellow-green, and/or yellow tobacco plants. How is this method different from the method you described above? Does this method of inheritance follow the principles laid out by Mendel? Explain.

Exploring Further

7. In this investigation, you looked at variations of a single trait — plant colour. How would you modify your experimental design to determine the genotypes of the seeds for two different traits?