STUDENT LAB TEMPLATE

Ecological Impacts of Rice Farming

Jim Serach, Lawrence Academy, Groton, MA 01450; modified by Dean Goodwin and Jeannette Adkins in conjunction with the Environmental Literacy Council Summer Lab Development Team 2004

Abstract

In this student-centered laboratory activity you will investigate the amount of rice production in a number of locations worldwide, and conduct an experiment to determine the moisture and ash content of different rice samples. You will investigate the links between rice production and the effects on the local and global environment.

Objectives

This activity allows you to:

- conduct an Internet research investigation to obtain data on rice production from different countries.
- perform an experiment to determine the water and ash content of a widely used food resource.
- make calculations and conversions relating to the obtained data.
- increase your understanding of the production and use of an important agricultural food supply and current agricultural techniques.
- evaluate the relationship of rice production to environmental consequences.
- assess the contribution of rice production to the local and global economy.
- interpret the experimental data as it relates to natural ecological systems.

Introduction

The demand for food continues to rise as the population grows. Methods used to produce food have an impact on the environment. As an environmentally conscious citizen, you are to determine the impact of one of the major worldwide food sources, rice. This investigation will increase your environmental literacy with regard to worldwide rice production and consumption.

This lab activity requires you to conduct research and perform an experiment in order for you to compile your data. The research involves using the Internet, library resources, and a primary lab investigation. Your teacher is not going to simply give out an instruction sheet for you to follow! You will be expected to provide input at various times throughout the investigation.

Background Research Information

Environmental science textbooks have chapters on food production and agricultural methods. You can search the Internet for useful websites. There are many good websites that will provide you will all the information you need for this activity; if you are having trouble, your teacher may be able to point you in the right direction!

Hint for getting started! Remember, you have to find out about rice production and yields in different countries. Your teacher will give you an example data table for you to complete. What other information would be useful to include in a data table relating to rice production? Why?

Materials

Your teacher will provide you with a selection of rice samples. These samples may come from different countries and may contain a number of varieties of rice. Your teacher will also supply you with the necessary equipment to conduct the experimental analysis.

Procedure

Your first task is to compile data on rice production and yields for various countries. Your teacher will facilitate in deciding which countries to investigate. Discuss with your group the types of data that you would expect to obtain or look for in your research. Your teacher will provide a sample data table that you may modify to suit your needs. Use the Internet and any other material that is available.

Before you undertake the lab investigation you need to brainstorm some factors that may play a role in determining the lab results. For example, the following questions could lead your pre-lab discussions:

- What are the major components of rice?
- What is the origin of each of the rice components?
- How many different varieties of rice are there?

Your teacher will provide you with a procedure for conducting the lab investigation that will be used to determine the water and ash content in your selected rice sample. Before performing the experiment you need to develop a working hypothesis for the lab exercise.

Lab Tips

There is always the potential for danger when working in a lab! Care should be taken when handling any lab equipment. **Make sure to wear safety goggles. Use tongs for handling the hot crucibles.** Remember that porcelain crucibles retain heat for an extended amount of time.

Data/Observations/Analysis

After completing the lab you will carry out some basic calculations in order to quantify the relative percentage of water and ash in your rice sample.

The final task in this lab activity is for you to link together the collected and experimental data in order to assess the impact that rice production has on the local and global environment. You should include also an economic perspective in your analysis.

At the conclusion of this lab activity, you will be evaluated on both an oral presentation to the class, and a written report on the analysis of your findings. Be creative! Choose what you think will be the best format to use in presenting your results to the class!

TEACHER LAB TEMPLATE

Ecological Impacts of Rice Farming

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Objectives

This activity allows your students to:

- conduct an Internet research investigation to obtain data on rice production from different countries.
- perform an experiment to determine the water and ash content of a widely used food resource.
- make calculations and conversions relating to the obtained data.
- increase your understanding of the production and use of an important agricultural food supply and current agricultural techniques.
- evaluate the relationship of rice production to environmental consequences.
- assess the contribution of rice production to the local and global economy.
- interpret the experimental data as it relates to natural ecological systems.

Why use this lab in the APES course?

Many students do not realize the local and global importance of food production in their lives and the lives of others, particularly those people living in less developed countries. The lab helps them to understand the interdependence of Earth systems, especially the cycling of matter. The activity provides a hands-on opportunity for Internet research and a correlation of the research to a traditional lab investigation. Completion of these activities allows for synthesis and evaluation of global systems as the students' link their data to environmental consequences. Examples include, global warming as a result of methane release from paddy fields, the profound effect that agricultural practices has on nutrient cycles, and the link between the economy and the natural environment. The activity helps students to become more familiar with a systems thinking approach when studying the environment. This can be an empowering concept for the students to grasp. The more links we can provide students in terms of needs of society versus environmental impact, the better prepared they will be as citizens of tomorrow. The lab activity covers an important section of the APES curriculum as described below.

Correlation to Topic Outline in Acorn Book

I B: The Cycling of Matter

1. water
2. carbon
3. major nutrients
    a. nitrogen

b. phosphorus
4. differences between cycling of major and trace elements

III A: Water
1. fresh: agricultural, industrial, domestic
IIIB: Minerals
III D: Biological
3. food and other agricultural products
IIIF: Land
2. agriculture and forestry

V A: First-order Effects (changes)
1. atmosphere: CO_2, CH_4, stratospheric O_3

VI E: Issues and options (sustainability).

Correlation to National Science Education Standards

Principles:
- Science is for all students.
- Learning science is an active process.

Teaching Standard A: Teachers of science plan an inquiry-based science program for their students. In doing this, teachers
- select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.

Teaching Standard B: Teachers of science guide and facilitate learning. In doing this, teachers
- focus and support inquiries while interacting with students.
- orchestrate discourse among students about scientific ideas.
- challenge students to accept and share responsibility for their own learning.
- encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

Teaching Standard C: Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers
- guide students in self-assessment.

Teaching Standard D: Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers
- structure the time available so that students are able to engage in extended investigations.
- create a setting for student work that is flexible and supportive of scientific inquiry.
- ensure a safe working environment.
- make the available science tools, materials, media, and technological resources accessible to students.

- identify and use resources outside the school.

Teaching Standard E: Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers

- display and demand respect for the diverse ideas, skills, and experiences of all students.
- enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community.
- nurture collaboration among students.
- model and emphasize the skills, attitudes, and values of scientific inquiry.

Assessment Standard A: Assessment must be consistent with the decisions they are designed to perform.

- assessments are deliberately designed.
- assessments have explicitly stated purposes.

Assessment Standard C: The technical quality of the data collected is well matched to the decisions and actions taken on the basis of their interpretation.

- the feature that is claimed to be measured is actually measured.
- assessment tasks are authentic.
- students have adequate opportunity to demonstrate their achievements.

Unifying Concepts and Processes: Standard: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

- systems, order, and organization.
- evidence, models, and explanation.
- constancy, change and measurement.

Science as Inquiry: Content Standard A: As a result of activities in grades 9-12, all students should develop

- abilities necessary to do scientific inquiry.
- understandings about scientific inquiry.

Science as Technology: Content Standard D: As a result of activities in grades 9-12, all students should develop an understanding of

- geochemical cycles

Science in Personal and Social Perspectives: Content Standard F: As a result of activities in grades 9-12, all students should develop understanding of

- natural resources.
- environmental quality.
- natural and human induced hazards.
- science and technology in local, national, and global challenges.

Introduction

An *ecosystem* may be loosely defined as the interaction between and among biotic factors, the various species involved, and abiotic factors, and the conditions and resources of the system. Modern ecosystem theory divides an ecosystem into two interconnected subsystems; an *energy subsystem* and a *material cycling (nutrient) subsystem*. Because of the *Second Law of Thermodynamics*, the energy subsystem is an open system; energy enters the system as light, is transferred between organisms via trophic relationships (each transfer resulting in some energy loss), and the energy ultimately leaves the boundaries of the system as heat. As a result, ecosystems require a constant source of energy.

The nutrient subsystem in an intact ecosystem functions to a large degree as a closed system. That is, materials such as water, nitrogen, phosphorus, potassium, and other nutrients tend to cycle within the boundaries of a given ecosystem. These materials are taken up, assimilated, and stored by living organisms and are returned to the system as metabolic wastes or when the organisms die. Decomposers and detritus feeders play a crucial role in releasing materials as forms that can once again be taken up by autotrophs.

Modern agriculture is an anthropogenic disturbance that has a profound effect on these nutrient cycles. Significant amounts of nitrogen, phosphorus, potassium and many other minerals (i.e., calcium, magnesium, iron) are removed from the soil by crops; these crops are harvested and shipped to markets. This output of nutrients is substantial and must be replaced by the input of fertilizers or other agricultural methods. Thus, our agricultural systems are open systems, with inputs and outputs beyond the boundaries of the system. (in this case, an agricultural field or rice paddy).

Group Size

This lab is very flexible in terms of student numbers. Individual students can perform it, but it also works well if students want to work in pairs or small groups. Also, each student or pairs of students could collect the data and then work in larger groups (of three or four) to analyze the results and make their presentations. The amount of time the teacher can set aside for this activity will determine the student group size that is used.

Lab Length

This activity requires two to three periods to introduce the topic, conduct research and brainstorm ideas regarding collection of the data and the completion of the traditional lab experiment. Students can collect research information on their own time, perhaps over the weekend or for homework during the week. The traditional lab exercise needs to be conducted during a designated lab period. After the data has been collected and analyzed, several class periods should be set aside for student discussion.

Preparation and Prep Time

Teachers need to familiarize themselves with resource information available on the Internet or in the school library. The school librarian may be able to assist in the student research activity. The main time commitment is putting together a selection of rice samples and setting up the equipment necessary for the completion of the lab.

Materials/Equipment

Students should have access to the Internet for the research component.

For the lab experiment you will need: rice samples; crucible; crucible tongs; ring stand; safety goggles; drying oven (75^{o} C); desiccator; balance; Bunsen burner; clay triangle.

Students should be encouraged to work out the mathematical computations without the use of a calculator if they are able; they could check their work with a calculator afterwards. (Remember calculators are not allowed on the APES examination, and as the calculations are fairly simple, this would be good practice for the exam!)

Suppliers

Rice samples could be purchased from the supermarket or a gourmet/speciality food store. Look for rice that is produced from a number of locations worldwide. Providing the students with a diverse sample collection could enhance the level of discussion and lead to better awareness of global implications concerning rice production.

Safety and Disposal

Students should be reminded about the potential dangers of heating any material in a ceramic crucible. They should be careful when handling any hot equipment. During the rice combustion process the students must wear safety goggles. The ash residue can be disposed of in the trashcan.

Teaching Tips

After being presented with the task in hand, students brainstorm such questions as "What do we know?", "What do we need to know?", and "How do we find out what we need to know?" These can be given as homework or as in-class assignments. Students share their answers with each other and work together on a research team in order to find out the answers to the questions they have raised. Research can be performed on the Internet or through the library. Students can call or e-mail any organization that they feel may be able to provide them with information. Some teachers may find it useful to assist the students, at appropriate times, by facilitation of concept-mapping strategies on the board

Both class and homework times are utilized for the completion of this lab activity. Students teach each other about their findings in their particular research area. The time taken for this project depends on the teacher and the depth of coverage. I also give the students assignments to discuss the issue with family members, and report feedback to the class. During this student-centered approach, the teacher acts more of a facilitator and guides the class through the process. Students actively participate in presenting their research findings to the class.

In addition to linking rice production to methane release and global climate change, other environmental consequences such as increased incidence of malaria can also be mentioned. Invariably, these topics come up during student discussions, which provide a good opportunity for the teacher to help the students to make more connections between rice production and the effects on the environment.

The questions and analysis student handout that follows, provides a number of critical thinking questions relating to this activity. In 3 (a), I have selected the year 1999 for the comparison of data. The actual year chosen can be flexible. For example, it could depend on when the latest global data on rice production becomes readily available. It is often of interest to repeat this analysis for a number of different years to ascertain any trends.

A further extension that may be valuable to undertake is to analyze the costs involved in rice production. This could focus on a particular country, or on one aspect of rice production for a country, such as the cost of fertilizer used in the production process. This provides the opportunity to link economics to a study of the environment. Another thought provoking analysis that promotes lively discussion is to compare the rice consumption per capita for developing and developed countries.

Depending on the humidity in your location, some teachers may wish to use a desiccator in the cooling and weighing of the crucibles, in order to prevent the rice from regaining moisture. This may not be a problem if the lab is air-conditioned or if you do not have such humidity considerations. It would be prudent, in the interests of accuracy, to have the student complete the weighing section expediently, and not leave the crucibles in the open lab over lunch!

If you do not have a drying oven readily available do not despair! A simple and cheap drying oven can be made from a Styrofoam ice chest. Insert a 100 W bulb through the lid and put the lid onto the Styrofoam ice chest containing the crucibles. A thermometer or thermocouple can be used to monitor the inside temperature. Vent holes can be cut into the lid if needed. Make sure the lamp housing does not get so hot as to melt or damage the Styrofoam! This set-up can be left overnight to dry out the rice and is a good substitute for the real thing!

Allow the students as much flexibility as possible in how they analyze and present their results to the class. PowerPoint, handouts, or posters can be used to supplement their talks.

Possible Assessments

Tasks that were given as homework can be checked as part of the student's ongoing homework grade for the class. A student's performance on the lab activity can also be assessed using any of the following parameters:

- Discussion/in-class participation/written assignments/research data/oral presentations and the lab report, test/quizzes on the material.
- Each student receives an individual score for his or her research portfolio, and a group or individual grade for the class presentation.

- Students can be quizzed on, for example, information from the student presentations, and any student produced handouts, data from the lab activity, and any facts presented from research.

When performing inquiry-based units with the students, it is important that they are made aware beforehand of how the teacher will be evaluating their work.

Sample Rubric for Assessment

A checklist is used for evaluating discussions and oral reports. All members of the class, including the teacher, complete this form. In this way, students evaluate each other's performance and learn what constitutes effective communication. A sample rubric is given below. Handout materials that contain hints for making a good presentation, and copies of the following scoring rubric, are provided at the end of the lab section.

ORAL REPORT EVALUATION

PRESENTER'S NAME: _____

TITLE OF REPORT: _____

Student shows:	Low- - - - - - - - - - - - - - - - - - High				
1. knowledge of subject	1	2	3	4	5
2. voice projection	1	2	3	4	5
3. eye contact	1	2	3	4	5
4. use of visual aids	1	2	3	4	5
5. creativity and enthusiasm	1	2	3	4	5
6. ability to remain focused	1	2	3	4	5
7. response to questioning	1	2	3	4	5
8. evidence of thorough research	1	2	3	4	5
9. ability to present the material clearly	1	2	3	4	5
10. ability to summarize all views on the topic	1	2	3	4	5

EVALUATOR'S NAME:_____ TOTAL SCORE:_____

References/Resources

Several books and articles that are available for the students to reference are:

Lucien M. Hanks, Rice and Man: Agricultural Ecology in Southeast Asia, University of Hawaii Press, Honolulu, 1992.

Agnes C. Rola and Prabhu L. Pingali, Pesticides, rice productivity, and farmers' health: an economic assessment, International Rice Research Institute, Manilla, 1993.

Heinz-Ulrich Neue, “Methane Emission from Rice Fields”, *BioScience*, 43 (7): 466-73, 1993. For a full text see www.ciesin.org/docs/004-032/004-032.html

Philip Johansson, “Stairway to Sustainability”, *Earthwatch*, September 1998, 28-37.

Some useful websites are:

General information
http://www.fao.org/rice2004/en/rice-us.htm
http://www.irri.org/science/ricestat/index.asp
http://www.knowledgebank.irri.org/#
http://www.boardofstudies.nsw.edu.au/multimedia/rice/riceprofile.html
http://www.ers.usda.gov/Briefing/Rice/background.htm
http://www.disasterrelief.org/Disasters/001213riceyields/
http://www.isb.vt.edu/articles/may0402.htm
http://www.cgiar.org/irri/Riceweb

Nutrition
http://www.fao.org/rice2004/en/rice2.htm
http://www.fao.org/rice2004/en/f-sheet/factsheet3.pdf
http://www.irri.org/science/ricestat/pdfs/Table%2016.pdf
http://www.knowledgebank.irri.org/factsheets/default.htm#Health_and_Nutrition/Health_and_Nutrition.htm

Environment
http://www.fao.org/rice2004/en/rice4.htm
http://www.agric.nsw.gov.au/reader/science-and-research
http://www.disasterrelief.org/Disasters/001213riceyields/
http://www.isb.vt.edu/articles/may0402.htm
http://www.enviroliteracy.org/article.php/439.html

Science-Biotechnology
http://www.fao.org/rice2004/en/rice8.htm
http://www.fao.org/rice2004/en/f-sheet/factsheet6.pdf
http://www.agric.nsw.gov.au/reader/science-and-research
http://www.enviroliteracy.org/subcategory.php/5.html
http://www.enviroliteracy.org/subcategory.php/5.html
http://www.enviroliteracy.org/article.php/213.html

Economics
http://www.fao.org/rice2004/en/rice9.htm
http://www.fao.org/rice2004/en/f-sheet/factsheet4.pdf
http://www.irri.org/science/ricestat/pdfs/Table%2023.pdf
http://www.ers.usda.gov/Briefing/Rice/trade.htm
http://www.ers.usda.gov/publications/so/view.asp?f=field/rcs-bb/

International Production of Rice
http://www.fao.org/rice2004/en/world.htm
http://www.irri.org/science/ricestat/pdfs/Table%2034.pdf
http://www.irri.org/science/ricestat/pdfs/Table%2030.pdf

http://www.irri.org/science/ricestat/pdfs/Table%2010-feb.pdf

The following sections include a typical student research data table format; a lab procedure that can be used as a student handout; a questions and analysis for both the student and teacher; a set of sample data; a student handout on presentation tips and a sample presentation scoring rubric.

Ecological Impacts of Rice Farming

Typical Student Research Data Table

Country	Production ('000 t)	Area ('000 ha)	Yield (t/ha)	Mineral Removal (kg)	Area planted with modern varieties (%)
Southeast Asia Totals					

Ecological Impacts of Rice Farming: Analysis of Rice Sample Experiment

Purpose: *The purpose of this laboratory exercise is to demonstrate and quantify nutrient and water loss in the production of paddy rice.*

Materials Needed:

rice samples	drying oven (100^{o} C)
crucible	desiccator
crucible tongs	balance
ring stand	Bunsen burner
safety goggles	clay triangle

Procedure:

1. Determine the mass of a clean crucible. Record this in the data table.

2. Fill the crucible ¾ full with your chosen rice sample and weigh the crucible and rice together. Calculate and record the initial mass of the rice sample.

3. Place the crucible and sample into the drying oven and dry at 75^{o} C for at least 24 hours or until constant mass is achieved.

4. Remove the crucible from the oven and allow it to cool for a few minutes. (Your teacher may require you to cool the crucible in a desiccator before weighing.) Weigh the dried sample and record the mass of rice in the data table.

5. Place the crucible and dried rice sample into a triangle set up on a ring stand. Place a Bunsen burner beneath the crucible. Carefully adjust the ring so that the bottom of the crucible is in the inner cone of the Bunsen burner flame. Incinerate the sample until only ash remains in the crucible. *Wear your safety goggles while your sample is being incinerated!!*

6. Remove the crucible from the flame and allow it to cool. (Your teacher may require you to cool the crucible in a desiccator before weighing.) Weigh the ash sample and record its mass in the data table.

7. Calculate the percent water and percent ash in your sample.

8. Repeat for three trials and calculate mean percent water and mean percent ash.

Ecological Impacts of Rice Farming: Analysis of Rice Sample Experiment

Data Table

Trial	Mass of Crucible (g)	Mass of Crucible + Rice (g)	Initial Mass of Rice (g)	Mass of Dried Rice (g)	% Water	Mass of Ash (g)	% Ash
1							
2							
3							
				Means			

Ecological Impacts of Rice Farming

Questions and Analysis (25 pts total)

1. Explain the change in mass (1 pt each)
    a. after 24 hours in the oven

    b. after incineration

2. What are probably the major components of the ash that remains? What is their ultimate source? (4 pts)

3. a. Using the data from your research, calculate the yield (tones/ha) of the rice in 1999 for five selected Southeast Asian countries, and for Asia as a whole. (4 pts total)

b. Use the production data and the amount of ash you found above in this experiment to calculate the amount (kg) of minerals removed from the soil in those five selected Southeast Asian countries, and for Asia as a whole. (4 pts total)

4. Describe the effects on the rainforest ecosystem when rice is cultivated, harvested, and exported from tropical Southeast Asia to the United States. (2pts)

5. Predict some ecological and technological effects of harvesting and export on the rice agricultural system and soil fertility. (3 pts)

6. Assess the sustainability of rice farming in a country such as Japan, making any suggestions, both pro and con, that you would give to the farmers. (2pts)

7. Assess and evaluate any environmental problems that you think may be associated with rice farming in developed and developing countries. (2pts)

8. Suggest reasons and explain why different countries may have different productivity (yields) of rice. (2pts)

Ecological Impacts of Rice Farming

Questions and Analysis: Teacher Notes (25 pts total)

1. Explain the change in mass
   a. after 24 hours in the oven

   The heat evaporated the water that was stored in the "dried" rice.

   b. after incineration

   Combusting the rice oxidized the organic material to CO_2 and it was driven off.

2. What are probably the major components of the ash that remains? What is their ultimate source? (4 pts)

   The major components of the ash are minerals such as K^+, Ca^{2+}, Mg^{2+}, and Na^+ from the soil where the rice was grown; some may have been added as inorganic fertilizer.

3. a. Using the data from your research, calculate the yield (tones/ha) of the rice in 1999 for five selected Southeast Asian countries, and for Asia as a whole. (4 pts total)

   Sample calculation: See data table

   Divide production (tonnes) by area (hectares) farmed.

   Include units.

b. Use the production data and the amount of ash you found above in this experiment to calculate the amount (kg) of minerals removed from the soil in those five selected Southeast Asian countries, and for Asia as a whole. (4 pts total)

Sample calculation: See data table

Multiply % ash by the number of tonnes produced.

Multiply by 1000 (1000kg/tonne) to get kilograms.

Include units.

4. Describe the effects on the rainforest ecosystem when rice is cultivated, harvested, and exported from tropical Southeast Asia to the United States. (2pts)

This type of agriculture requires the clearing of land for open paddies. Furthermore, the water and minerals are lost from the system. In other words, this changes the natural, closed water and nutrient cycle to an open one that requires inputs of water and minerals.

The diversion of water into paddies and canals could effect local surface water flow patterns and reduce evapotranspiration. Extensive land modification occurs in constructing terraces.

5. Predict some ecological and technological effects of harvesting and export on the rice agricultural system and soil fertility. (3 pts)

As above-conversion to an open system leads to loss of soil nutrients with the exported crop. These nutrients must be replaced artificially through the addition of fertilizers. Flooded paddy fields also have anaerobic soils which leads to the release of methane (a greenhouse gas) and loss of nitrate from the soil (it is reduced to nitrogen gas under anaerobic conditions).

Fertilizer production, and intensive mechanized agriculture, requires large inputs of energy (fossil fuels) and capital.

The use of genetically-modified high yield varieties may lead to other, yet undiscovered consequences, and monoculture makes crops more

susceptible to insect pests. This leads to the need for chemical pesticides and all their external costs.

6. Assess the sustainability of rice farming in a country such as Japan, making any suggestions, both pro and con, that you would give to the farmers. (2pts)

See above concerns about the unsustainability of open-system agriculture.

Can be made more sustainable by: recycling of crop residues as fertilizers; adopting IPM techniques to minimize the need for chemical pesticides; using more rice varieties in a system; minimize the time the paddies are under water; draining fields and planting nitrogen-fixing cover crops in the fallow season; creating/exploiting a market for organically grown rice.

7. Assess and evaluate any environmental problems that you think may be associated with rice farming in developed and developing countries. (2pts)

High energy use/consumption of fossil fuels (CO_2 production); CH_4 release by anaerobic paddies; problems associated with GM crops; pesticide residues lead to water pollution (surface water and groundwater); nutrient loads from artificial fertilizers lead to eutrophication downstream and in coastal waters; workers' health; increase in mosquitoes and arthropod-borne diseases; developing countries may face biodiversity loss due to deforestation.

8. Suggest reasons and explain why different countries may have different productivity (yields) of rice. (2pts)

More developed countries like Japan and Korea can afford modern, high-yield varieties; artificial fertilizers and pesticides; mechanized harvesting and planting, and fuel.

Ecological Impacts of Rice Farming

Typical Student Data Table Obtained from Research

Country	Production ('000 t)	Area ('000 ha)	Yield (t/ha)	Mineral Removal (kg)	**Area planted with modern varieties** (%)
Cambodia	3,800	1,740	2.2		11
China	200,499	31,720	6.3		100
Indonesia	49,534	11,624	4.3		77
Lao PDR	2,103	718	2.9		2
Japan	11,469	1,788	6.4		100
Pakistan	6,900	2,400	2.9		42
Thailand	23,272	10,000	2.3		68
Asia	**540,621**	**138,503**	**3.9**		**74**

*from http://www.cgiar.org/riceprodasia.htm

Ecological Impacts of Rice Farming: Analysis of Rice Sample Experiment

Typical Student Data Table from Experiment

Trial	**Mass of Crucible (g)**	**Mass of Crucible + Rice (g)**	**Initial Mass of Rice (g)**	**Mass of Dried Rice (g)**	**% Water**	**Mass of Ash (g)**	**% Ash**
1	19.94	33.25	13.31	12.24	8.04	2.43	19.85
2	20.40	32.07	11.67	10.60	9.08	2.13	20.09
3	21.24	32.89	11.65	10.76	7.63	2.15	19.98

Means	8.25	[redacted]	19.97

Ecological Impacts of Rice Farming

Tips for Presentation of Results

Each student or student group will give a short oral presentation of his or her findings. It should be no more than 10 minutes long. You can use a format of your choice including poster, PowerPoint, overhead transparencies and handouts. You will have a few minutes at the end of each presentation to answer questions from the class. During the talk the other students in the class will take notes that will be used later on a quiz from the materials presented. This will also help each student to think of questions to ask. After each presentation every member of the class, including myself, will fill out an evaluation report. Your grade for the oral presentation will be the average of all the class scores. I will go over the evaluation form with you prior to the first presentation. Remember that your final research report and the presentation will constitute your grade for the lab activity so do a good job.

Hints for making a good presentation

What works.....

- using visuals on an overhead projector
- handouts-one for each member of the class
- posters with large print
- staying calm
- video clips, slides, photographs, computer use, PowerPoint
- good eye contact
- speaking slowly and clearly, projecting your voice as if you were speaking to the person furthest away from you
- knowing the material
- having an opening and closing statement
- preparing in advance
- being enthusiastic-after all you did the research
- explaining scientific terms/data-maybe using analogies to help people understand better
- knowing the vocabulary that you use

What does not work.....

- only having one handout and passing it around the class
- mumbling
- winging it
- reading directly from your notes
- not knowing your topic thoroughly
- not talking loud enough
- monotone voice
- having no visual materials to enhance your talk

Advice.....

- do not say 'um', 'er', 'uh'....
- plan in advance
- bring enough handouts for everyone in the class including the teacher
- speak in complete sentences
- do not stress out-you are the expert
- do not rush-take your time
- use visual aids
- stick to the subject

speak loud and clear
be enthusiastic
do not spend all the talk looking at your feet!

Ecological Impacts of Rice Farming

Rubric for Presentation Evaluation

(Print the page, photocopy and cut to produce two forms)

ORAL REPORT EVALUATION

PRESENTER'S NAME: _____

TITLE OF REPORT: _____

Student shows:	Low- - - - - - - - - - - - - - - - - - High				
1. knowledge of subject	1	2	3	4	5
2. voice projection	1	2	3	4	5
3. eye contact	1	2	3	4	5
4. use of visual aids	1	2	3	4	5
5. creativity and enthusiasm	1	2	3	4	5
6. ability to remain focused	1	2	3	4	5
7. response to questioning	1	2	3	4	5
8. evidence of thorough research	1	2	3	4	5
9. ability to present the material clearly	1	2	3	4	5
10. ability to summarize all views on the topic	1	2	3	4	5

EVALUATOR'S NAME:_____ TOTAL SCORE:_____

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