Lesson A1–2

Conducting Agricultural Research

Unit A. Research

Problem Area 1. Scientific Investigation in Agriculture

Lesson 2. Conducting Agricultural Research

New Mexico Content Standard:

Pathway Strand: Problem Solving and Critical Thinking

Standard: **IV:** Solve problems using critical thinking skills (e.g., analyze, synthesize and evaluate) independently and in teams.

Benchmark: **IV-A.** Formulate ideas, proposals, and solutions to handle problems.

Performance Standard: **1.** Formulate ideas and proposals to solve problems. **2.** Analyze and evaluate ideas, proposals, and solutions to manage a variety of problems.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain the steps in conducting research in agriculture.
2. Discuss the general safety precautions that should be followed in conducting agricultural research.

List of Resources.

The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Osborne, Edward W. *Biological Science Applications in Agriculture.* Danville, Illinois: Interstate Publishers, Inc. 1994 (Chapter 1)

Other Resources. The following resources will be useful to students and teachers:

Cooper, Elmer L. and L. DeVere Burton. *Agriscience: Fundamentals & Applications.* Albany, New York: Delmar. 2002 (Chapter 2)

Herren, Ray V. *The Science of Agriculture: A Biological Approach.* Albany, New York: Delmar. 2002 (Chapter 1)

Lee, Jasper S. and Diana L. Turner. *Introduction to World AgriScience and Technology*. Danville, Illinois: Interstate Publishers, Inc. 1997 (Textbook and Activity Manual, Chapter 2)

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheet

Terms.

The following terms are presented in this lesson (shown in bold italics):

Dependent variable
Experiment
Hypothesis
Independent variable
Replication
Scientific method
Treatment
Variable

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Ask students to think about building a picnic table. How do you go about building a picnic table? Do you just start cutting boards and pounding nails? No, you follow a step by step procedure to make sure that the

final product is exactly what you wanted. The same is true in agricultural research except for the fact that we don't always know what the final product will be. A simple step-by-step procedure must be followed.

Summary of Content and Teaching Strategies

Objective 1: Explain the steps in conducting research in agriculture.

Anticipated Problem: What are the steps in conducting research in agriculture?

I. The process of scientific inquiry, or the ***scientific method***, is a carefully controlled, systematic process for discovering the unknown. This process is used in all aspects of research. The scientific method helps to ensure that conclusions reached through study are valid and reliable. When conducting experimental research, all factors except the factor or variable under investigation are controlled, or held constant. As a result, any observed results are in fact due to the single variable being examined. There are seven basic steps in the scientific method. They are: (1) identify the problem, (2) formulate the hypothesis, (3) design and conduct experiments, (4) collect data, (5) analyze the data, (6) draw conclusions, (7) make recommendations.

A. The first step in conducting agricultural research is identifying the problem to be investigated. This most often is best stated in the form of a question. The research problem should grow out of your areas of interest and personal experience in agriculture. By choosing a problem in the researcher's area of interest, it will allow the experimentation process to be more enjoyable and more relevant to the researcher.

B. The next step in the process is to predict the results of your experiment. This prediction is called a hypothesis. A ***hypothesis*** is a tentatively accepted theory that explains the relationship between two variables. Generally, hypotheses should indicate the nature of the relationship between variables. The researcher should utilize background knowledge and experience in this area to formulate the hypothesis. Once the hypothesis is made, it is subjected to a test that attempts to isolate the important factors. This test is called an ***experiment***.

C. The third step in the scientific method is to design and conduct the experiment. Factors to consider in the design of the experiment include observation and measurement procedures, control measures, and selection of variables. A ***variable*** is a characteristic by which an object of phenomenon may be described. Variables change from time to time and may have more than one value. An ***independent variable*** is the characteristic that the researcher believes will affect another variable. Researchers manipulate an independent variable by managing its presence in the experiment. The manipulation of the independent variable is known as the ***treatment***. The ***dependent variable*** is the characteristic that will be observed. It is expected to change as a result of the independent variable. Measurement of the dependent variable is critical to the success of the experiment. During this phase of the experiment, the researcher must determine the most precise

and appropriate way to measure the affect of the independent variable. It is critical that the design of the experiment match the stated hypothesis. This means that the researcher must make sure that the experiment answers the question stated in the first two steps of the scientific method. The research design should also provide for replication. ***Replication*** is the exact duplication of the experiment. This allows the results to be verified across numerous trials, resulting in greater confidence in the results. After all design procedures have been followed, then it is time to conduct the experiment.

D. The next stage in the experiment is the data collection step. The researcher should consistently and precisely follow the previously determined methods outlined in the experiment design in the measurement and collection of data. A pattern or format of collecting and recording data should have been developed in the design stage of the experiment. Data summary charts are usually used to record experimental data. These charts should be as simple as possible, yet provide for all data to be completely and consistently recorded.

E. Once the data is collected, the next step of the process is ready to be completed. This step is to analyze the data. In this stage, data that was collected during the experiment is analyzed to be used later to draw conclusions. The research will follow the procedures outlined in the experiment design stage in organizing the data. This can be a very exciting stage of the research process because results of the experiment become evident.

F. Once the raw data has been organized into a useable form, the researcher can now use that information to draw conclusions. The researcher must answer the question, "Was my hypothesis correct?" This is done by looking for patterns in the data or by interpreting calculations that were performed on the data. During this process, the researcher must also determine if there is any evidence to suggest that the data might be inaccurate or in any way misrepresent what actually happened in the experiment. At this point any limitations of the experiment must also be noted.

G. Depending upon the nature of the experiment, the researcher may then be able to formulate recommendations based on the findings of the experiment. Findings should be explained in detail through conclusions, written discussion, and recommendations. Results of this experiment should be compared to results obtained from similar experiments. Finally, based upon the results of the completed experiment, the researcher should identify new research questions to explore through further experimentation. Through this continuing cycle of questioning, experimentation, further questioning, and further experimentation, agricultural research is done.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the steps in conducting research in agriculture. Chapter 1 in Biological Science Applications in Agriculture is recommended. Use TM: A1–2A and TM: A1–2B to aid in discussion on this topic.

Objective 2: Discuss the general safety precautions that should be followed in conducting agricultural research.

Anticipated Problem: What are the general safety precautions that should be followed in conducting agricultural research?

II. Working in an agriscience research laboratory is much like working in other agricultural laboratories; a number of general safety procedures must be followed to prevent personal injury. The following practices should be followed when conducting experiments in the agriscience laboratory.

A. Wear protective clothing, including an apron, gloves, and approved safety goggles.

B. Handle and dispose of all chemicals according to manufacturers' storage and disposal directions.

C. Be careful with scalpels, knives, dissecting needles, and other sharp instruments, especially when working around others.

D. Locate adequate workspace for your experiment. Place all equipment away from the edges of tables and lab counters.

E. Be aware of your surroundings (flammables, electricity, obstructions, etc.) as you conduct your experiment.

F. Place all materials and instruments in their designated storage areas at the end of the laboratory period.

G. Keep the work area clean and free of clutter.

H. Work carefully with glass instruments and lab supplies. Use holding racks and containers designed to be used with breakable items.

I. Keep flammable materials away from fire and sparks.

J. Never leave hot liquid or glassware unattended.

There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the general safety precautions that should be followed in conducting agricultural research. Chapter 1 in Biological Science Applications in Agriculture is recommended. Use TM: A1–2C to aid in discussion on this topic.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at end of textbook chapters may also be used in the review/summary.

Application. LS: A1–2A

Evaluation. Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student performance on classroom participation, laboratory assignments, and written tests or quizzes.

Answers to Sample Test:

Part One: Matching

1 = f, 2 = a, 3 = h, 4 = e, 5 = d, 6 = b, 7 = c, 8 = g

Part Two: Completion

1. manufacturers'
2. summary charts
3. problem

Part Three: Short Answer

(1) identify the problem, (2) formulate the hypothesis, (3) design and conduct experiments, (4) collect data, (5) analyze the data, (6) draw conclusions, (7) make recommendations

Sample Test Name _____

Test

Lesson A1–2: Conducting Agricultural Research

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Dependent variable
b. Experiment
c. Hypothesis
d. Variable
e. Independent variable
f. Replication
g. Scientific method
h. Treatment

_____ 1. The exact duplication of the experiment.

_____ 2. The characteristic that will be observed.

_____ 3. The manipulation of the independent variable

_____ 4. The characteristic that the researcher believes will affect another variable.

_____ 5. A characteristic by which an object of phenomenon may be described.

_____ 6. A test that attempts to isolate the important factors of a hypothesis.

_____ 7. A tentatively accepted theory that explains the relationship between two variables.

_____ 8. A carefully controlled, systematic process for discovering the unknown.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. Handle and dispose of all chemicals according to _____ storage and disposal directions.
2. Data _____ _____ are usually used to record experimental data.
3. The first step in conducting agricultural research is identifying the _____ to be investigated.

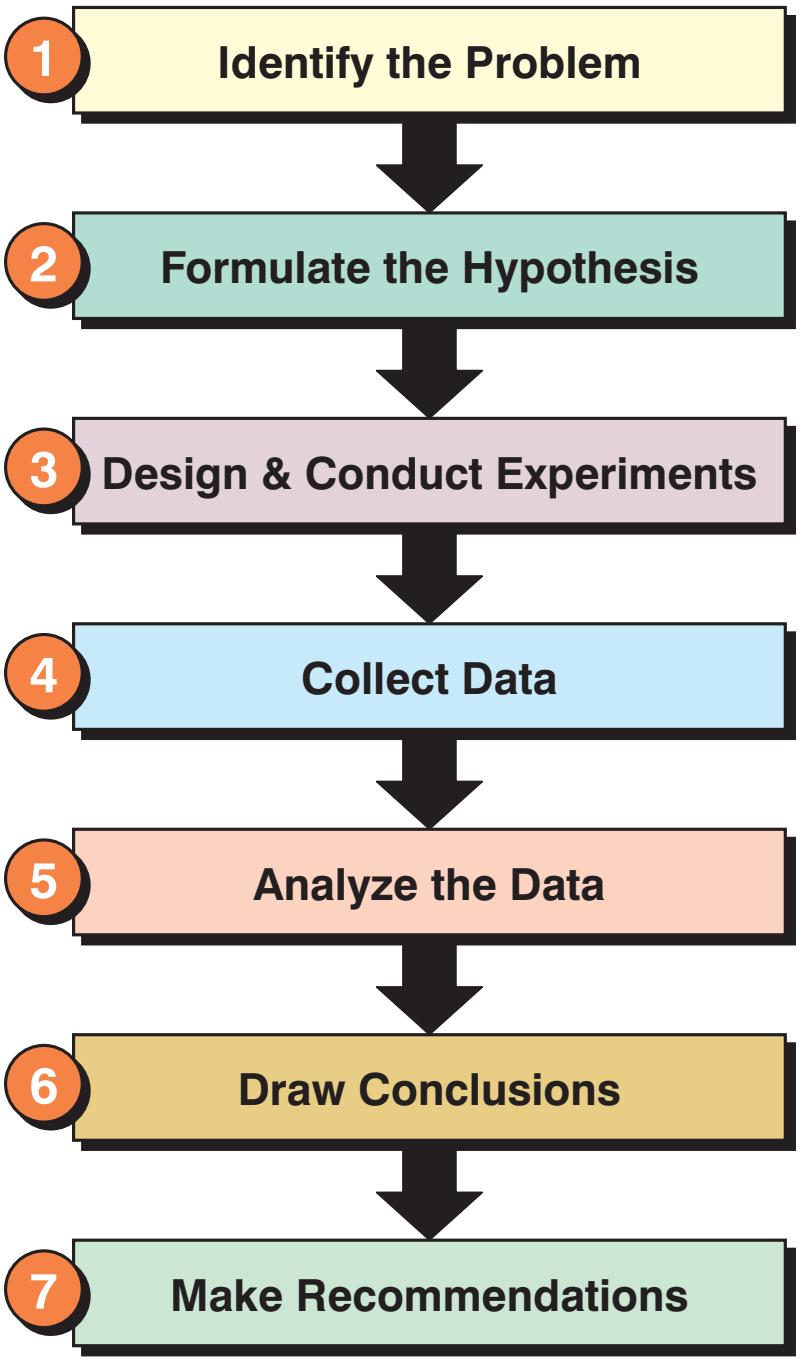
Part Three: Short Answer

Instructions. Provide information to answer the following question.

Identify the seven steps in the scientific method.

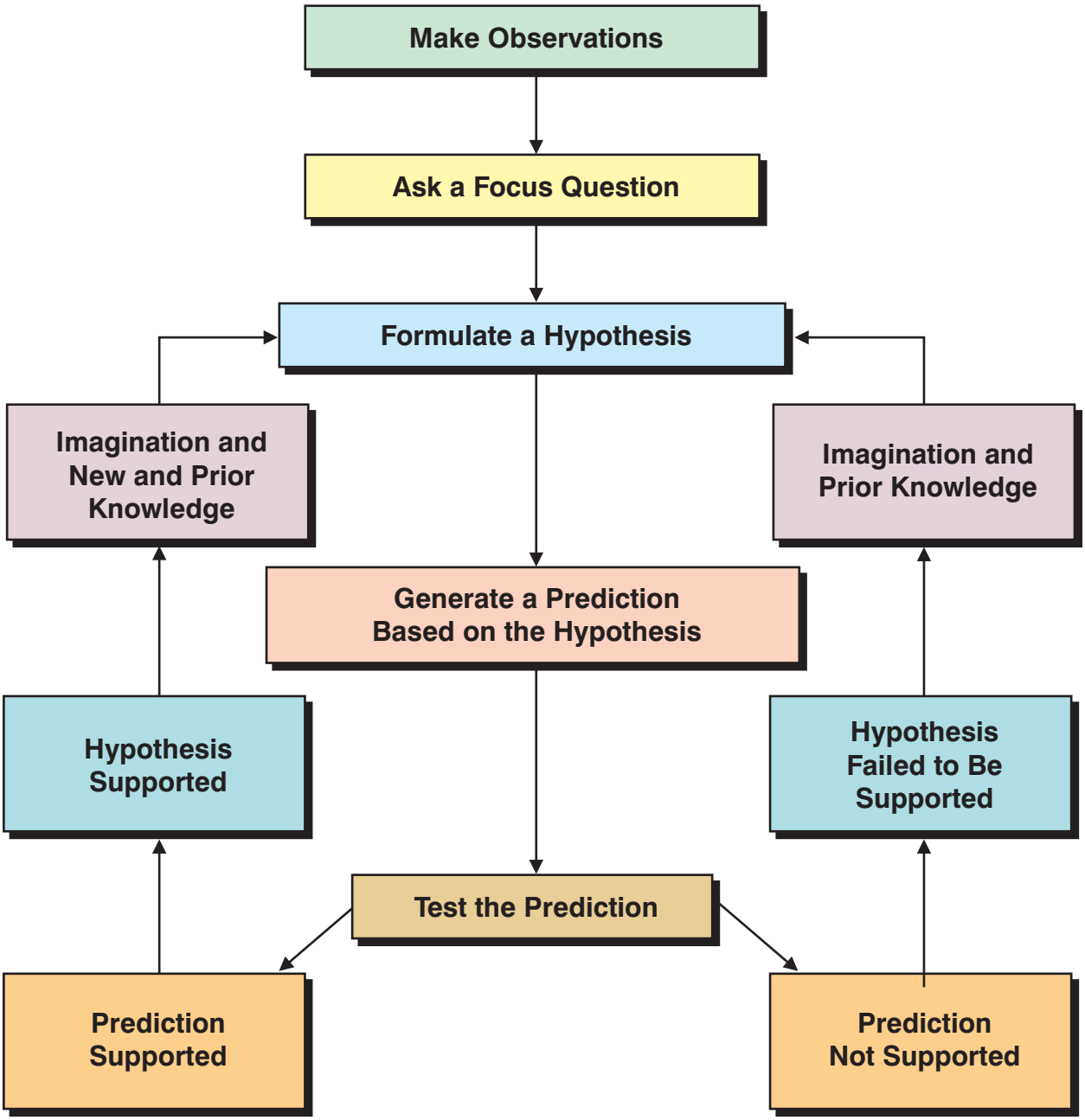
TM: A1–2A

SEVEN STEPS IN THE SCIENTIFIC METHOD



TM: A1–2B

HYPOTHESIS TESTING



AgriScience Laboratory and Safety Skills

OBJECTIVES:
- ☑ To practice the basic rules of safety in the agriscience laboratory
- ☑ To locate all safety equipment in the laboratory and know its use
- ☑ To apply safety concepts through laboratory activities
- ☑ To learn the basic rules for fieldwork

A. Safety Skills

Safety should always be very important in the agriscience laboratory. It is important that students learn the safety rules and apply them when working in the laboratory. Beside the appropriate description you will find safety icons (pictures) that will be used in future activities to alert you to safety precautions that should be used.

Important general safety rules are:

1. Read through the procedures of each laboratory activity before you begin the activity so that you understand what to do. Never perform a lab activity unless your teacher is present to supervise. Pay special attention to safety cautions and follow your teacher's instructions exactly.
2. Never run, push, play, or fool around in the laboratory.
3. Locate and learn to use all laboratory safety equipment including the fume hood, fire blanket, fire extinguisher, and eyewash station. Also locate the nearest exit to use in case of an emergency.
4. Keep your work area clean and uncluttered. Always clean your equipment and work space after you finish a lab activity.


gas precaution

5. Turn off all electrical equipment, water, and gas that is not in use, especially at the end of the class period.
6. Dress properly for the laboratory:
   a. Do not wear loose-fitting sleeves, bulky coats and sweaters, or open-toed shoes.
   b. Tie back long hair.


eye safety

   c. Wear safety goggles when using chemicals, hot liquids, lab burners, or hot plates and at any other time your teacher instructs you to do so.


clothing protection

   d. Wear a lab apron when using chemicals, hot materials, or anything that might stain or damage your clothing.
   e. Wear plastic gloves to handle specimens or corrosive or irritating chemicals or to protect from bacteria or fluids from plants or animals.

Using Heat and Fire Safety


fire safety

1. Never leave a hot plate, lit bunsen burner, or other hot object unattended.
2. Never reach or lean over a hot object, exposed flame, or hot plate.
3. Use heat-resistant gloves or special equipment to move hot objects.


explosion danger

4. Always point the end of an open container that you are heating away from yourself and others. (Never heat a closed container—it might explode.)
5. Use only Pyrex glassware or an equivalent type for heating.

Using Chemicals Safely


poison

1. Some substances in the laboratory are poisonous. Never smell, eat, or drink anything in the laboratory unless instructed to do so by your teacher and the experiment instructions.
2. Always wash your hands before leaving the laboratory area, especially if you have handled chemicals, plants, or animals of any kind.
3. Never return unused chemicals to the stock bottles. Use the designated droppers or transfer methods indicated by the teacher.

Using Laboratory Equipment Safely

1. Never use chipped or broken glassware.


hand safety

2. Keep your hands away from the sharp or pointed ends of scalpels, scissors, etc. Always cut away from yourself and others.
3. Do not force glass tubing or thermometers into rubber stoppers or twist the glass once it is in place. Ask your teacher for instructions.
4. Do not use direct sunlight as a light source on a microscope mirror. Direct sunlight can damage your eyes. Many microscopes have a substage light.

Working Safely with Specimens/Animals


animal safety

1. Treat live animals gently. Follow directions for proper care. Be aware that animals can injure you or spread disease.
2. Do not cut into a specimen while holding it in your hand. Use a wax-filled dissecting pan to properly mount and support the subject.
3. Work with containers of microorganisms only under the close supervision of your teacher.
4. Dispose of live or preserved specimens as directed by your teacher.


plant safety

5. Some plants can be harmful if eaten or touched. Follow your teacher's instructions carefully. Use a field guide when collecting specimens.

Using Electrical Equipment Safely

1. Check your equipment for broken or frayed cords on plug-ins.
2. Make sure the area around the electrical equipment is dry and free of things that might catch fire. Touching electrical equipment with wet hands can cause a shock.


electrical safety

3. Place electrical cords out of the way so that people will not easily trip over the cords or cause the equipment to fall. Turn off all equipment before leaving the laboratory.

Performing Field Study/Trips Safely

1. Make sure you understand the objectives of the fieldwork, noting all potential safety hazards and the appropriate responses.
2. Make sure your plans fit the experience/training of your group members and the area for the field trip. Don't overestimate!
3. Physical handicaps and medical conditions must be allowed for when your plans are made.
4. Make sure you carry a first-aid kit and have a person in your group who has training in first-aid.
5. Wear clothing suitable for all weather conditions you may encounter. Carry any needed special equipment.
6. Be able to read a map and use a compass and have both with you, especially when planning activities that require hiking or movement over long distances.
7. Leave information with authorities on intended work locations and a travel schedule.
8. Check the weather forecast before departure; be alert to changes in the weather at all times; and do not hesitate to turn back if necessary.

Reporting Accidents

1. Tell your teacher about any accident, breakage, or spill that occurs in the laboratory or field.
2. If you get a chemical in your eyes or on your skin or clothing, wash it off immediately with running water while your lab partner notifies the teacher.
3. Clean up spills immediately under the supervision and instruction of your teacher.

 Name

Lab Sheet

Using Balances to Determine Mass

Materials:

Various common agriscience laboratory equipment (20 pieces)

Balance

Bubble gum

Procedures:

Agriscience Laboratory Equipment:

Place twenty different commonly used pieces of agriscience laboratory equipment around the room.

Have students identify each of the pieces of equipment.

Give students the correct answers. Have the students correct their papers.

Learning to Use Balances:

Weigh one piece of bubble gum. Record the mass.

Develop a hypothesis on the effect chewing will have on the mass of the bubble gum. Record the hypothesis.

Chew the bubble gum for 30 seconds. Using the wrapper as a weigh paper, determine the mass of the bubble gum. Record the mass.

Repeat step #3 until bubble gum has been chewed for 5 minutes.

Graph the results of your findings.

Evaluate hypothesis to see if it was correct.

Results:

Time	0:00	0:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00
Mass											