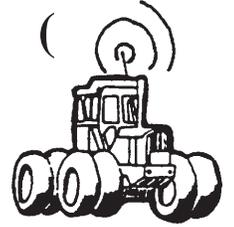


Activity 1



Mission Impossible

Activity: Students will use science process skills in solving modern agricultural problems which rely on recent advances in biotechnology.

Curriculum Fit: **Program Context: The Nature of Science, Technology**

- Biotechnology
- Applied genetics
- Transplants
- Transmitters
- Problem solving
- Remote sensing

Agriculture Concepts: Technology and capital intensity
Diversity of agriculture

Cognitive Level: Application

Materials Required:

- Problems (attached)
- Problem-solving format (attached)

Time Required: 20 minutes per item



Background — For the Teacher

Scientists use a problem-solving approach to develop state-of-the-art technology. Biotechnology involves the use in industry of artificially altered living organisms or their components (e.g. hormones). Powerful new genetic technologies which have been discovered and applied to agriculture play a major role in improving the speed, efficiency, and productivity of plants and livestock.

In terms of your Program of Studies for Division III Science, this lesson addresses Program Context. Students will use a scientific approach to solve some seemingly unsolvable problems. The enclosed format leads students to use such science process skills as interpreting data, formulating models, inferring and communicating. These help the student to understand the impact of biotechnology on the agricultural industry.

Any of the problems can stand on its own. Therefore you can use a version of this lesson whenever your students have some time available to devote to creative thought and to investigating the nature of modern technology. As an alternative, after you have used this lesson once with the whole class, you can set it up as a work station for students who finish other work ahead of time.

Some students may be able to write new problem and solution card sets based on newspaper or magazine articles about new developments in agriculture.

Procedure

Preparation

1. Make about 10 copies of the “Problem Solving Format” (attached).
2. Photocopy the Problem-Solution pages and cut out the individual cards.

NOTE

Pre-read the cards in case your students will need some background introduction.

3. If you are going to use this lesson frequently or set it up as a permanent work station you should mount each problem and solution step on an index card and plasticize them.
4. Mix the solution step cards up so they are at random.

Introduction

5. Divide your class into groups of 3.
6. Give each group a copy of the Problem Solving Format and explain that they are going to use this format to solve some modern agricultural problems.

The Activity

7. Have someone from each group choose a problem card.
8. Spread the solution step cards around the room while the groups consider their task.
9. Allow the students 5 minutes to find 4 cards that produce a logical solution to their problem.

Conclusion

10. Have one elected spokesperson from each group present the group’s solution to the class.

NOTE

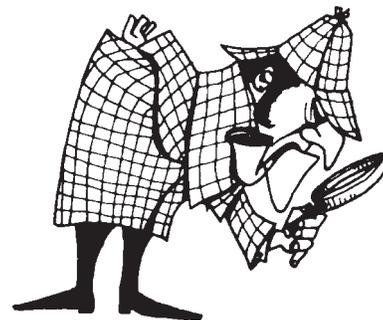
You can insert a single problem into any class, or you can devote an entire class to solving problems.

Related Activities

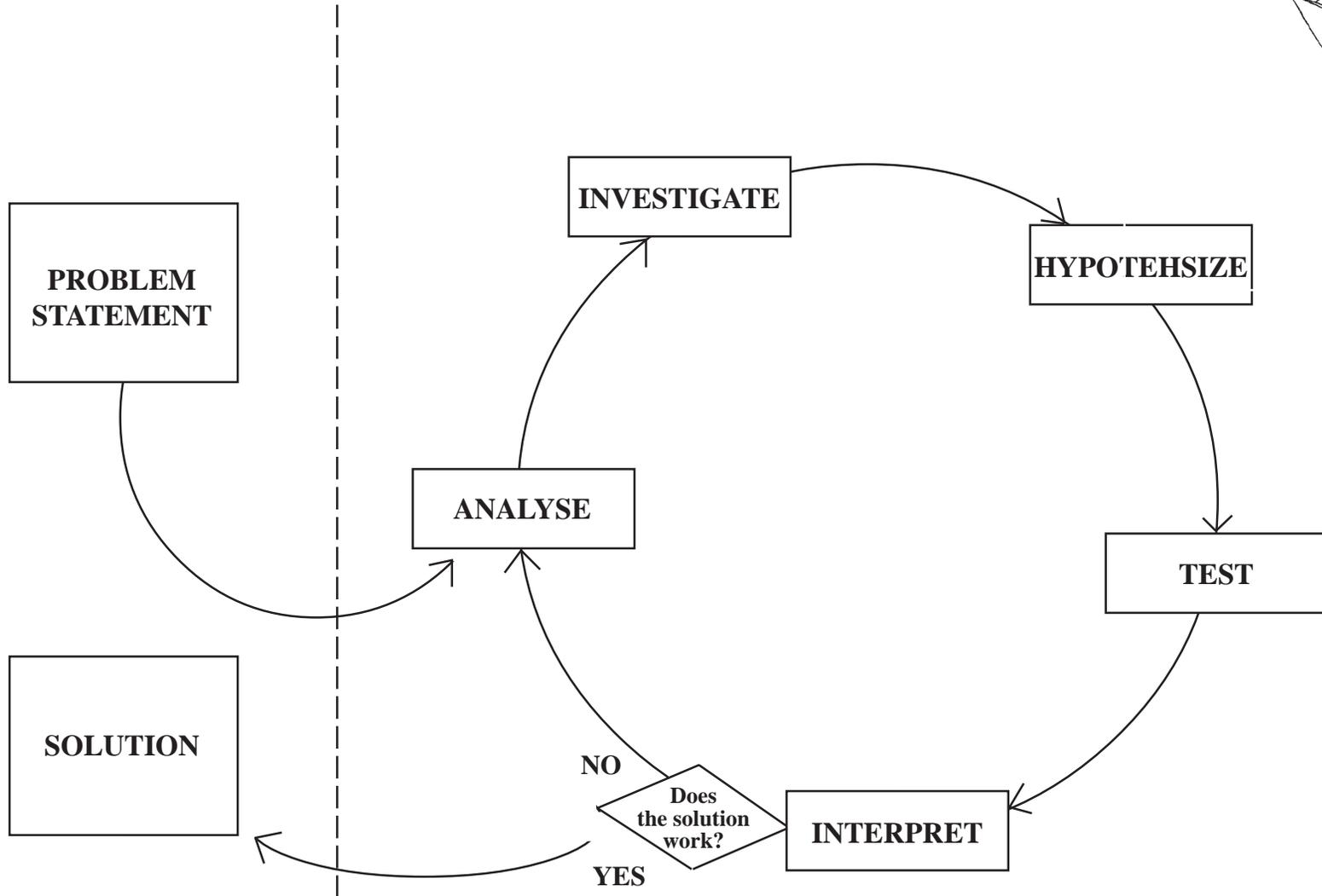
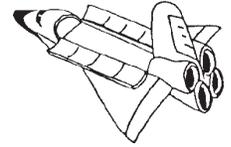
1. Visit or invite a guest speaker from a private or government laboratory that is involved in biotechnical research.

Outside Activities

1. Improving the Odds (video tape), Alberta Agriculture, Food and Rural Development.



Problem Solving Format





Agricultural research - a field test plot.



Agricultural research - hand pollinating plants.

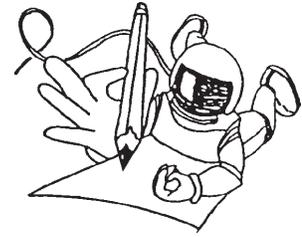
PROBLEM

Good day, Agent AgSci.

Your assignment is to deliver 1000 head of cattle to Australia in two days. You must remain with them at all times, and transport them in two pieces of aircraft carry-on luggage.

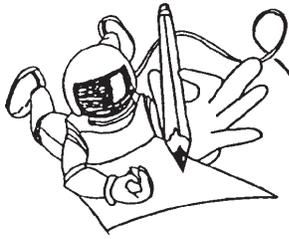
Thank you for having volunteered.

T.



Recovery, Storage and Transport of Embryos

1. Fertilized ova (calf embryos) can be removed from a cow and kept alive in a laboratory dish.
2. Collected embryos can be stored indefinitely by freezing them.
3. Frozen embryos can be transported in an insulated case kept cold with dry ice.
4. A veterinarian can implant a calf embryo into any mature cow.



PROBLEM

Good day, Agent AgSci.

Your assignment today is to provide consumers with tomatoes that have the flavor and texture of home-grown tomatoes all year round, even in the middle of winter. You must do this at a comparable cost and without changing shipping and storage requirements.

Thank you for having volunteered.

T.

Improving Quality of Tomatoes

1. Tomatoes are picked green so that they can be shipped long distances without being damaged. They are then treated with ethylene gas to soften them and make them red before reaching the supermarket. As a result, they are mushier and do not have the flavor of vine-ripened tomatoes.
2. If the natural ripening process could be slowed down, tomatoes could be left on the vine longer, yet still travel long distances without becoming overripe and damaged.
3. Biotechnology enables scientists to manipulate specific genes to produce specific results. Researchers have found a way to put a copy of a gene that causes softening into the tomato plant backwards, slowing down the rate of softening during natural ripening.
4. The *Flavr Savr* tomato is allowed to ripen on the vine before being picked. Vine-ripening produces the flavor and texture consumers associate with homegrown tomatoes. Since it softens at a much slower rate, the *Flavr Savr* can be shipped long distances to cold climates where it is not possible to grow tomatoes year round.

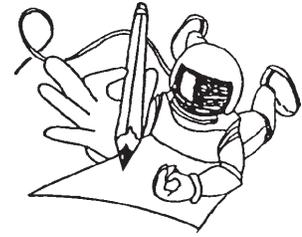
PROBLEM

Good day, Agent AgSci.

Your assignment today is to transport 10,000 artificially cloned tomato seedlings to Lyons, France. These tissue cultures are very fragile and must be kept moist throughout the trip.

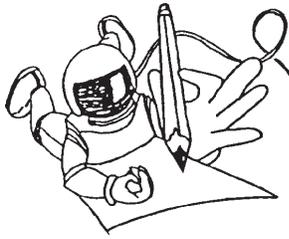
Thank you for having volunteered.

T.



Artificial Seed Capsule

1. To cushion the seedling cultures and protect them from drying, you need a coating that will contain a water supply but can be dissolved from the outside.
2. Water can be prevented from dissolving materials by trapping it in a gel. This is a material in which micro-droplets of water are surrounded by molecules of some other substance. It gets its name from gelatin which is the best known example.
3. Suspend the seedling culture in a gel; surround the gel with a water-soluble plastic coating; transport the resulting artificial seeds in any dry box.
4. When the artificial seeds are planted, soil water will dissolve the plastic and dilute the gel. This will free the seedling culture which can begin to grow.



PROBLEM

Good day, Agent AgSci.

Your new assignment is to help an Alberta farmer keep track of crop conditions on 17 widely separated quarter-sections. Information must be visual and relayed to him at his farm headquarters.

Thank you for having volunteered.

T.

Remote Sensing

1. The resource satellite Landsat circles the earth several times each day, and gathers data based on how much light is reflected by the earth's surface.
2. From this reflection, Landsat can record topography, local weather patterns, surface soil color, soil moisture, and vegetation.
3. The information Landsat gathers is stored and transmitted in computer language, but it is commonly displayed as a map with different conditions shown by different colors.
4. A series of Landsat recordings allow a farmer to assess the conditions, trends and rates of change for either crops or pastures.

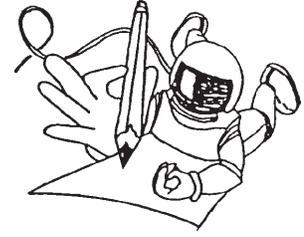
PROBLEM

Good day, Agent AgSci.

Your assignment today is to help a rancher trace the movements of a herd of cattle that pasture on open range in South-central Alberta. The information must be available at the ranch office, anytime of the day or night, and as soon as it is gathered.

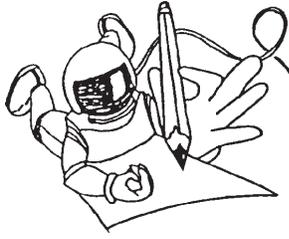
Thank you for having volunteered.

T.



Biomedical Telemetry Radio Waves Transmitter

1. Scientists have developed a tiny radio transmitter (1 cm in diameter, 3 cm long) that will emit a signal every 5 minutes for 5 - 10 years.
2. One of these transmitters can be fed to a cow like a pill, and once swallowed will remain in the animal's first stomach as long as it lives.
3. The signal from this transmitter can be picked up by an antenna on a hilltop, relayed to a receiver and decoded by a computer at the ranch office.
4. This radio/computer system can gather and separate information on the location, health and identity of up to 1000 head of cattle.



PROBLEM

Good day, Agent AgSci.

Your assignment today is to make it possible for a sandwich packager to extend the time his product can be stored in a refrigerated display case without going stale.

Thank you for having volunteered.

T.

Modified Atmosphere Packaging

1. Food spoils when oxygen inside a package combines with fatty products in the food to produce humidity.
2. Freezing, cooking, drying and salting all prevent spoilage, but all cause changes in the flavor or texture of the food.
3. Oxygen can be displaced by pumping nitrogen or carbon dioxide gas into the package. Either gas will stop the spoiling process, while also providing enough inside pressure to prevent air from leaking back in.
4. Modifying the atmosphere inside the package can increase the refrigerated shelf life of perishable food from 10 days to 35 days.

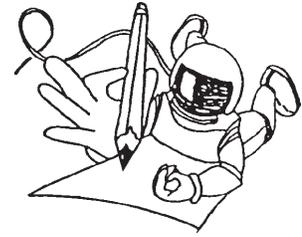
PROBLEM

Good day, Agent AgSci.

Your assignment is to find a way to determine whether cows are pregnant or not. Your method must work in the first month of their pregnancy.

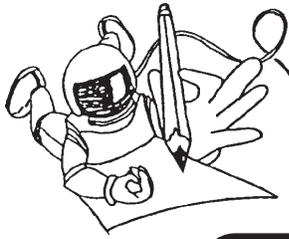
Thank you for having volunteered.

T.



Ultrasound Wave Transmitter

1. An ultrasound transmitter gives off high frequency sound waves. The waves travel in constant patterns until they reach a change in density. A density change reflects waves back toward their source.
2. When a cow is pregnant, body fluids accumulate in her reproductive organs so that their density increases.
3. An ultrasound machine that works like airport radar and submarine sonar, sending out waves and reading their echoes, should be able to detect pregnancy by identifying the fluid buildup that goes with it.
4. An ultrasound transmitter must directly touch the skin with no air gap. Shave the hair from a patch of abdominal skin, coat the transponder with mineral oil or petroleum jelly and hold it firmly in place.



NOTE

Somatotropin occurs naturally in milk. Injecting a cow with extra somatotropin will increase the production of milk, but will not raise the level of somatotropin in that milk. Research has shown that bovine somatotropin poses no health concerns for humans. The commercial use of somatotropin to increase milk production received approval in the United States in 1993. Approvals in Canada are still pending.

PROBLEM

Good day, Agent AgSci.

Your assignment today is to raise the milk output of healthy well fed dairy cows by 30%. This increase must occur within a month.

Thank you for having volunteered.

T.

Raising a Cow's Milk Production

1. When a cow has a calf, she begins to produce a hormone called somatotropin. Somatotropin continues as long as she is milked.

2. In all mammals, the hormone somatotropin causes new mothers to produce milk for their offspring.

3. Scientists can gather somatotropin from the blood of cows with new calves, and are synthetically able to make it in laboratories.

4. If a milking cow receives extra somatotropin by injection, her production of milk will increase. Laboratory tests have produced increases as large as 30%, but the average increase is about 17%.

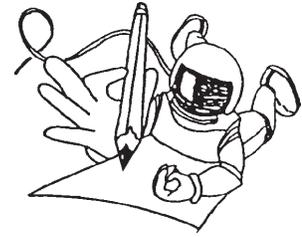
PROBLEM

Good day, Agent AgSci.

A part-time farmer needs your help. Your assignment is to ensure that his 50 ewes (female sheep) all have lambs in the same month next year.

Thank you for having volunteered.

T.



Synchronizing Lambing

1.

Ewes (female sheep) will only mate with rams during a condition called estrus (readiness for breeding).

2.

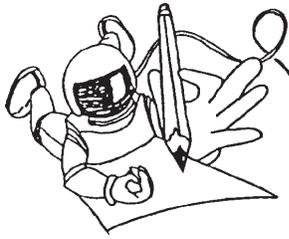
Estrus is started when the ewe begins to produce a hormone (body chemical) called PGF2.

3.

If a ewe is injected with synthetic PGF2, she will enter estrus within 48 hours.

4.

Lambs develop for 145 days between fertilization and birth.



PROBLEM

Good day, Agent AgSci.

Your assignment today is to obtain 2 genetically identical bulls for an Alberta farmer. He believes that having the same genes will make the bulls similar in their behaviour, therefore more predictable and therefore safer.

Thank you for having volunteered.

T.

Embryo Separation

1. In the first part of its life, an embryo grows by having each cell form an exact duplicate of itself. Thus one cell becomes two, those two become four, those four become eight and so on.

2. Up to a certain stage of development, cells that are separated from each other will develop as if they were separately fertilized ova.

3. Scientists can produce two animals with identical genes by splitting an embryo.

4. Embryos cultured in a lab can be implanted into a cow which then acts as a surrogate mother.

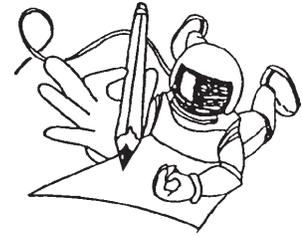
PROBLEM

Good day, Agent AgSci.

Alberta's wheat farmers cannot pay their fertilizer bills. Your assignment is to identify a way of increasing the supply of soil nitrogen to plants without using nitrogen fertilizer.

Thank you for having volunteered.

T.



Gene Transfer in Plants

1. Atmospheric nitrogen forms 78% of normal air, but is in a form that plants cannot use. Some soil organisms can convert atmospheric nitrogen into a form useful to plants.
2. Alfalfa, peas, clover and other legume plants form root nodules in which nitrogen-fixing bacteria called Rhizobium can live.
3. Adding Rhizobium bacteria to alfalfa pays back 30 times as well as adding nitrogen fertilizer.
4. Plant-breeding scientists can transfer the “root nodule” gene from alfalfa (or any of the legume family) into wheat embryos, enabling wheat plants to support their own Rhizobium colonies.

✓
DAN V

PROBLEM

Good day, Agent AgSci.

Your assignment for today is to arrange for some cattle to grow to full size without having their meat change from veal to beef.

Thank you for having volunteered.

T.

Increasing Yield of Veal Calves

1. The muscles of calves differ internally from the muscles in adult cattle. Calves' muscles yield veal, adult cattle muscles yield beef. Normally the muscles become adult in structure by the time a calf weighs 90 kg.

2. Some Piedmontese breed cattle have a gene called "double muscle" that causes their calves to be much larger than other breeds when their muscles change from veal-type to beef-type.

3. Scientists can produce animals with four parents instead of two by fusing two embryos together. The resulting animal is called a chimera (the "ch" is pronounced "k").

4. The chimera from fusing a Piedmontese embryo with a dairy breed embryo will remain calf-like in its muscle structure until it weighs 350 kg.

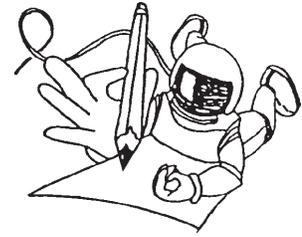
PROBLEM

Good day, Agent AgSci.

Your assignment is to ensure that next year Alberta's All Round Champion Cow (the AARCC) has 10 calves in the same month.

Thank you for having volunteered.

T.



Superovulation of Cows

1. The release of egg cells in cows is controlled by a hormone called FSH (follicle stimulating hormone).
2. A cow can be made to release several egg cells (ovulation) instead of her normal one by an injection of extra FSH.
3. A veterinarian can collect egg cells from a cow, fertilize them by artificial insemination and implant them into any mature cow.
4. Calves are born 275-290 days after fertilization.

