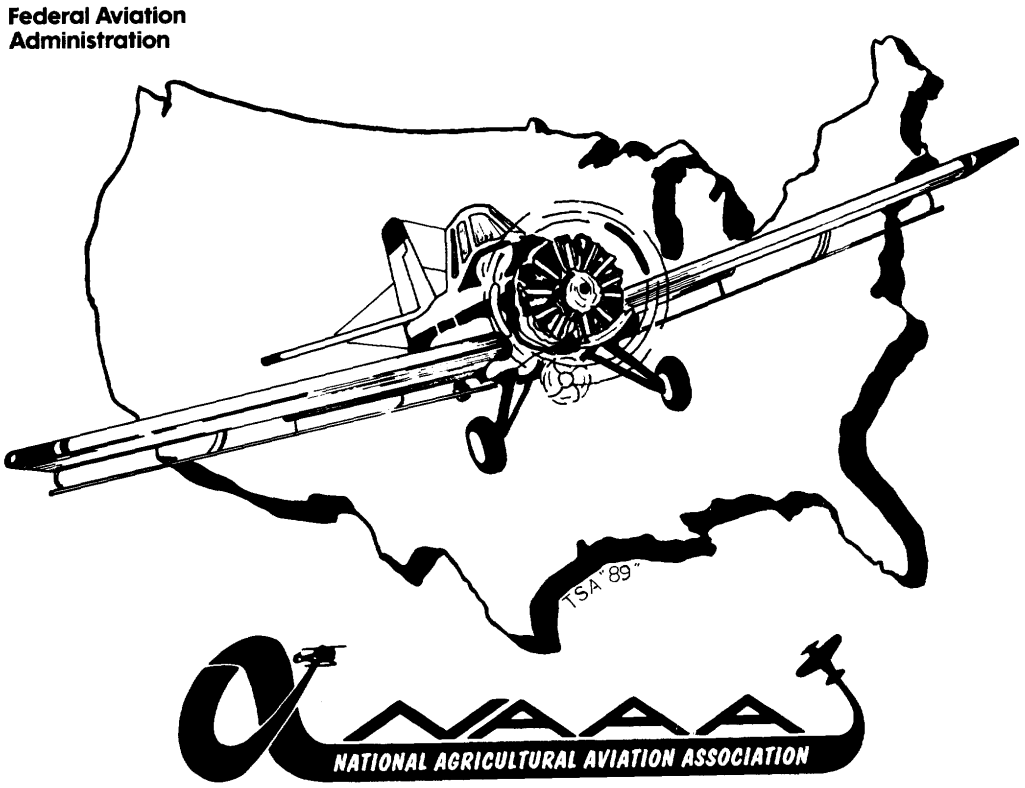
U.S. Department of Transportation
Federal Aviation Administration

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# *SECONDARY LEVEL*
# *EDUCATIONAL CURRICULUM GUIDE*

Suitable for social studies, language arts, mathematics, science, vocational agriculture classes as well as career education, grades 6-12.

AGRICULTURAL AVIATION
SECONDARY LEVEL EDUCATIONAL CURRICULUM GUIDE.

Agricultural AVIATION: Critical Assist for the World's Food Supply

Junior/Senior High Educational Curriculum Guide Presentation Outline

I. The intent and purpose of the agricultural aviation curriculum guide.
- A. To introduce the industry of agricultural aviation to educators and students.
  - 1. The history of agricultural aviation.
    - a. Why the industry evolved.
    - b. Who was involved in the early phase and where.
  - 2. The industry of agricultural aviation as it exists today.
    - a. The number of operations and people involved.
    - b. The service it provides.
  - 3. The future of agricultural aviation.
- B. To provide insight into the usefulness and importance of agricultural aviation.
  - 1. As an assist to growers in the economic production of food and fiber.
  - a. Application of pesticides, fungicides, insecticides, desiccants and fertilizer, as well as seeding.
  - 2. In federal, state and local government contract work.
    - a. From forestry work to mosquito control.
  - 3. In recreational, miscellaneous work.
    - a. maintain an aesthetic quality of life for Americans.
- C. To make people aware of the concern the agricultural aviation industry has for the safe application of approved products and the environment.
- D. To provide other educational agencies with accurate and current information about agricultural aviation.
  - 1. Presently being studied by educational programmers in the National Aeronautics & Space Administration, Civil Air Patrol and F ederal Aviation Administration.

II. The development of the curriculum guide.
- A. Developed by the Women of the National Agricultural Aviation Association.
  - 1. Assisted by educators.
  - 2. Developers are familiar with the industry.
  - 3. Approved by National Agricultural Aviation Association.
  - 4. Funded by National Agricultural Aviation Research & Education Foundation.
- B. Current information (1989).
  - 1. Intent is to update every two years through WNAAA/NAAA Public Relations & Education Committees.

III. Procedure for educators to follow.
- A. Become familiar with contents of guide.
  - 1. Utilize the information in the guide from all areas not just area of expertise.
  - 2. Obtain supplemental material off the resource listing which may be pertinent (refer to suggested supplemental material listed on section).
- B. Structure into already planned lessons.
  - 1. brings realism to the skill being taught.
  - 2. The students develop more interest if they realize the skill they are learning is necessary.
  - 3. Or, shows that people in the agricultural aviation industry could not successfully operate a business without the knowledge acquired while in high school.

IV. Contents
- A. Pretest.
  - 1. To assist educator in determining the students knowledge of the industry.
  - 2. A source of feed-back to developers.
- B. Social Studies
  - 1. Local and world affairs.
    - a. Current events which students formulate opinions on.
  - 2. History of agricultural aviation.
    - a. The who, what, why, when and where of its beginning.
  - 3. Influences of government

a. Government agencies which guide and regulate the agricultural aviation industry.

4. Careers in agricultural aviation
   a. An outline of the career of an Ag pilot.
5. Geography
   a. map reading skills using township naps.
   b. Activity sheet which requires the ability to utilize a township nap.

C. Language Arts
1. A list of suggested activities to do with students.
   a. many require skills necessary to operate an aerial application business.
2. Crossword puzzle and work search utilizing vocabulary words from the industry.

D. Mathematics
1. Problems related to grades 5-9 and higher math students.
   a. Presents realistic problems which Ag pilots/operators do daily (answers supplied).
2. Business math
   a. Problems pertaining to a real Ag aviation operation (answers supplied).

E. Science
1. Biology
   a. Thought/research questions related to the industry of agricultural aviation.
2. Earth sciences
   a. questions related to the industry in the area of meteorology, climatology, ecology and agronomy.
3. Chemistry
   a. questions formulated to show students the value of the knowledge learned in chemistry as related to the agricultural aviation industry.
4. Physics
   a. A practical application for the principles of flight.

F. Glossary
1. Common agricultural aviation terms with definitions.

G. Agricultural aviation facts and trivia
1. Interesting information about the industry.

H. Material and Resource Listing (under V.)

I. Critique of NAAA curriculum guide (under VI.)

V. Resources (pg. 36)

A. Utilize to enhance lessons for students.
1. Secure a speaker from the agricultural aviation industry to speak to the students.
   a. Allows students to hear information from the view point of a person in the industry.
   b. Provides for community/school interaction.

B. Supplements provide information beyond the scope of the curriculum guide.
1. Audio visual presentations.
2. The material available from agricultural avi ation support industries.

C. Provide source listing for media center to obtain information from.

VI. Feedback from educators after incorporating ideas from curriculum guide.

A. Provides Information for developers to use when changing guide.
1. Developers need to know usefulness, interest level of educators and students and areas where improvement is necessary.

B. Gives a sound basis to determine if the curriculum guide should be continued.

**AGRICULTURAL AVIATION:**
Critical Assist for the World's Food Supply

**CONCEPT**: The Agricultural Aviation industry is critical to the continued production of the world's food supply.

**INTRODUCTION**: Agricultural Aviation has become a necessity in the economic production of quality food. To aid in ensuring the existence of this industry, the National Agricultural Aviation Association was organized in 1967. Included in the organization's purpose is the objective of educating the public about this evolving industry in which 2,200 operators utilizing approximately 6,700 agricultural aircraft, are affecting the entire population of this country with their services in the areas of agriculture; federal, state, and local government; and recreational industry.

In agriculture, aerial applicators are assisting growers in crop production management by seeding and fertilizing; controlling diseases, insects and weeds, and applying growth regulants, desiccants and defoliants. For ranchers, aerial application is an economic method of controlling livestock insects and pasture weeds; managing grasshopper infestations on rangeland; and selective snow melting. The industry is also involved in feeding and relocating fish. As an agricultural support system, aerial applicators are aiding in the production of an abundance of high-quality food and fiber.

Under national, state or local government contracts, Ag aviators employ their aircraft to perform varied services which are essential to the nation's well being. Ag pilots are involved in: public health programs, including mosquito abatement; controlling fire, insects and disease in forests; eliminating cultivated and wild illegal plants; right-of-way brush control; and environmental clean-up such as oil spills. This aspect of agricultural aviation deals with maintaining the aesthetic, health, and safety standards to which the American public is accustomed.

Ag pilots and their aircraft are occasionally called upon to enhance the quality of leisure/recreational activities. They provide services to golf courses for snow removal, banner and glider towing operations, and air show promoters. These tasks are not necessities for living but involve other ways to utilize the pilots and aircraft of the industry.

Although agricultural aviation is a diverse industry, its primary purpose is to economically assist in the production of the world's food and fiber supply. With a better understanding of the role Ag aviators play in supplying food, perhaps the general public will realize how critical this industry is to their existence.

**SUGGESTED USAGE OF THIS CURRICULUM GUIDE:**

This guide contains current and accurate information about the agricultural aviation industry. The subject matter within can be utilized in the development of social studies, language arts, mathematics, and science skills. The materials are suitable for use with special education or gifted students. The uniqueness of the topic of agricultural aviation is that it can be approached from many angles: aviation, agriculture, pesticides, and environment. All areas should be considered so as to give students a complete and accurate view of aerial application and the role it has in providing food and fiber for everyone.

For all areas of study, it is appropriate to administer the Pre-Test in order to determine the students' knowledge of aerial application. The Pre-Test can be found at the beginning of the guide. Teachers are encouraged to add questions which are pertinent to the location-where the lessons are being taught. Once the students' knowledge 9f aerial application has been evaluated, use the information in all the sections of this guide including the glossary and materials from the-resource list to fill in areas of inadequate understanding.

Please complete and send the critique form. The National Agricultural Aviation Association relies on your evaluation to improve the educational guide. Your interest in the industry and your efforts to promote agricultural aviation as a critical assist to the continued production of the world's food supply are appreciated.

**TABLE OF CONTENTS**

**PRE-TEST QUESTIONS**

1. What does the term "agricultural aviation" mean?

_____

_____

_____

2. Are there pesticides stored in and around an average ho usehold? List as many as you can think of in your home.

_____

_____

_____

3. Explain how agricultural aircraft are different from other small planes.

_____

_____

_____

4. Name three different government agencies that influence the work of an agricultural aviator.
   (a)_____
   (b)_____
   (c)_____
5. What are three different uses for agricultural planes and pilots?
   (a)_____
   (b)_____
   (c)_____
6. Of all the crop protection chemicals commercially applied on U.S. agricultural land, what percentage is applied by Ag aircraft?
   (a) less than 15% (c) less than 25%
   (b) more than 60% (d) more than 75%
7. How many aerial application businesses are there in the United States?
   (a) 22,000 (c) 3,800
   (b) 6,700 (d) 2,200
8. In 1990 the cost of a new Ag plane in the U.S. can range from -
   (a) $1,000 to $10,000 (c) $50,000 to $120,000
   (b) $10,000 to $50,000 (d) $120,000 to $500,000
9. To achieve the same concentration of herbicide per acre as one teaspoon of sugar per bowl of cereal, you would have to apply the herbicide to the field at which of the following rates?
   (a)16 oz. per acre (c) 1,000 Bs. per acre
   (b)10 oz. per acre (d) 2.5 tons per acre
10. Match the following terms with their correct definitions.

| | |
|---|---|
| PESTICIDE | A substance used to control unwanted small gnawing mammals. |
| HERBICIDE | Any material used to prevent, retard or control a disease causing organism. |
| INSECTICIDE | A substance used to control insects. |
| FUNGICIDE | Any material used to prevent or control unwanted plants. |
| RODENTICIDE | A general term used to describe items which control a wide range of pests. |

**ANSWERS TO PRE-TEST**

1. Agricultural aviation is a term given to a support industry for agricultural growers. Service is provided by trained pilots, flying specialized aircraft, dispersing materials needed for production of high quality food and fiber.

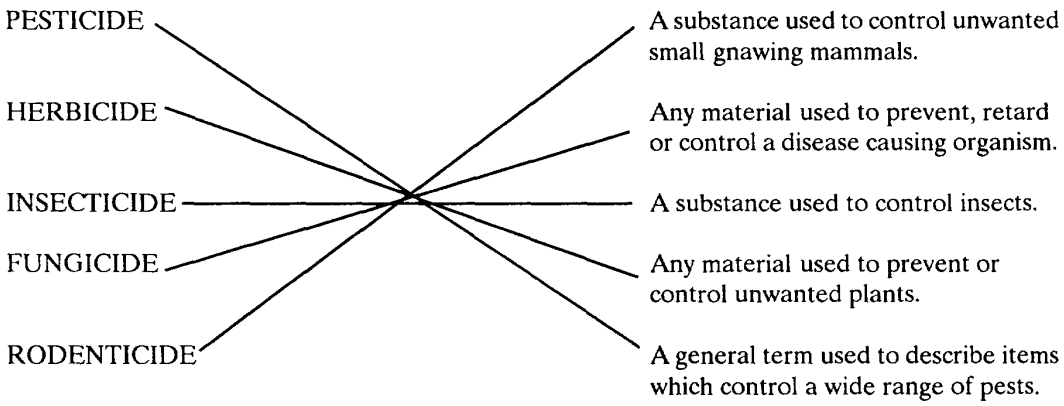
2. Possible products On the list could include: insect sprays and repellents, fly strips, flea powders, bathroom cleansers, chlorine tablets for swimming pools, weed and feed for lawns, roach motels, mouse and rat poison, etc.

3. Ag planes are restricted use aircraft. Most have only one seat and are not equipped for passenger transport. Ag aircraft are usually tail draggers. The main difference lies in the dispersal equipment: the hopper in which the product is carried is usually located behind the engine and in front of the cockpit; the majority of Ag aircraft have windmill driven pumps mounted under the fuselage to push liquids to the booms which are attached below the trailing edge of the wings; when applying dry materials, a spreader is fastened to the belly of the plane.

4. Refer to Social Studies activity, AG AVIATION AND THE GOVERNMENT on page 8 of this curriculum guide.

5. Refer to the introduction to this curriculum guide on page 1.

6. (b) more than 60%
7. (d) approximately 2,200 in 1990
8. (d) $120,000 to $500,000
9. (d) 2.5 tons per acre
10.



**OVERVIEW:**

The goal of this section is to demonstrate the importance of the role that Agricultural Aviation plays in a global sense. The realization of how lives would be changed if the Ag Aviation industry did not exist is a fabulous scenario to imagine.

Historically, agriculture has only known the benefits that aviation can bring about for less than a century. Due to the demands of a rapidly expanding population, we are fortunate to have the benefits that crop care by air makes available to the world.

The aerial application industry is very highly regulated. Rules and regulations from various government agencies are implemented in the day to day business of an agricultural aviation operation. The intent of the enclosed exercise is to bring an awareness to the student concerning governmental agencies and the way they are interrelated. The use of library research skills is necessary for completion of the activity.

Lessons in geography offer an excellent opportunity to correlate the lesson with the math and science sections of the guide. Correct interpretation of maps is a very important skill in aviation.

A career as an Ag Pilot is as demanding as it is exciting. We have provided a glimpse into the daily life of an Ag Aviator as well as a summary of the education requirements for this occupation. This lesson is organized in outline form in order to help the student to develop or increase skills of using an outline to learn about a topic.

**MATERIALS AND RESOURCES**

For this section we suggest contacting the following resources for additional material:
Numbers 4, 5, 7, 14-21, 24-26, 31, 41-46.

## LOCAL AND WORLD AFFAIRS

**SUGGESTED ACTIVITIES:**
Using items from a newspaper Or media broadcast, discuss how aerial applicators (whether applying water, slurry, pesticide, seed, fertilizer, etc.) affect the daily lives of the students.

Describe a scenario of a starving country. Have the students role-play the country's government. Decide how to help the situation using Ag Aviation.

Discuss what the food in the grocery stores would look like if Ag aviation were not a reality. Could you afford to buy the produce? Would you be satisfied with the appearance of the food?

Discuss the possible outcome of a large forest fire without the support of aircraft.

Discuss the benefits of municipal mosquito control.

Using recent magazine articles discuss the government's intervention in the eradication of drug producing plants. Analyze the unusual risks the aviator takes in performing this job.

Discuss the futuristic needs of a rapidly growing world population (estimated above 6 billion by the year 2000).

Investigate the economic pressures on agriculturally related industries.

Examine the use of chemical control methods on the locust plagues in Africa.

Research Ag aircraft manufacturers and determine why production and design development have decreased. Be sure to consider the influences that insurance and the overall agricultural economy have on the manufacturers.

Review the following historical events, and contemplate the possible differences that aerial application and agrichemicals could have made had they existed at the time.

1) In 1846, nearly one million people died in Ireland because a flight destroyed the potato crop, their primary food source. (Great Potato Famine)
2) In 1874, Rocky Mountain locusts devastated grain growing areas of the great plains from Texas to Canada.
3) In 1878, 5,000 people died in Memphis, Tennessee, and 4,000 died in New Orleans, Louisiana, from an epidemic of yellow fever.
4) In the late 1800's, major delays affecting the construction of the Panama Canal were attributed to large mosquito populations in the area; malaria and yellow fever were common place, and caused the deaths of thousands of workers.
5) In the 1930's, grasshoppers destroyed the crops in the great plains regions.

## A SHORT HISTORY OF AGRICULTURAL AVIATION IN THE U.S.

Shortly after the turn of the century, American farmers began to seriously consider the use of agricultural chemicals as a means with which to control insects, weeds and plant disease. Although there were available, chemicals that could control some of these problems, there was really no suitable way to apply them to the crops. In 1921, the Ohio Department of Agriculture fitted an airplane with a metal container and filled it with a powdered insecticide. Two U.S. Army pilots applied the chemical to trees that were being destroyed by moths. The experiment was so successful that the government moved airplanes and agricultural, scientists to the southern states, where cotton farmers were combating cotton boll weevils. In time, the epidemic was brought under control and America's most important fiber crop, cotton, was secure. Government programs continued to use airplanes to fight insect pests that were causing damage and destruction to America's forests.

During these early years, the aircraft were all modified military or civilian airplanes; the product dispersal systems were homemade. Although the work was exciting, it also proved dangerous to those who flew the early "crop-dusters" as both the men and their planes came to be called. The development of an airplane designed specifically for aerial application occurred in the 1950's. These Ag-planes gradually began to replace the converted aircraft of the previous three decades. At times there have been as many as twelve manufacturers of various types of Ag airplanes. Helicopters eventually joined the ranks of Ag aircraft, and are sometimes the best tool for the job.

Agricultural chemicals have also kept pace with advancements in technology, and have been influential in the growth of the agricultural aviation industry. In the 1930's aerial applicators arrived in the northern states to war against insect and disease pests which threatened fruit and vegetable crops. After World War II, the industry expanded into the western states where the development of new chemicals made possible the control of weeds and insects in cereal grain crops. Some of these new chemicals proved very useful in controlling various insects that carried diseases dangerous to humans. Countries that previously had no control over malaria and river blindness were provided with chemicals which helped save hundreds of thousands of lives and reduced the suffering of millions. All during the 1950's, crop production continued to rise and disease declined as a result of chemical controls.

In 1967, the National Agricultural Aviation Association was formed to help promote aerial application, and to provide a legislative voice. Individual states also formed agricultural aviation associations. These organizations work closely with government agencies, agrichemical companies, aircraft manufacturers and other support industries. Their combat efforts insure that our nation's food, fiber, and forest products can meet the needs of both our own domestic consumption and that of our export markets.

## AG AVIATION AND THE GOVERNMENT

The following agencies each have regulations, programs or services pertaining to the Agricultural Aviation industry. Select three of the agencies and research the answers to the following questions about each one.

1) When and for what purpose was the agency established?
2) What role does the agency play in the Ag aviation business?
3) What is the name and title of the person currently in charge of the agency?

FAA (Federal Aviation Administration)

EPA (Environmental Protection Agency)

OSHA (Occupational Safety and Health Administration)

NTSB (National Transportation Safety Board)

FDA (Food and Drug Administration)

IRS (Internal Revenue Service)

US Forestry Service

Department of Agriculture (federal and state level)

Department of Health (federal and state level)

Department of Labor (federal and state level)

Department of Transportation (federal and state level)

Agricultural Conservation and Stabilization Service

Soil Conservation Service

Small Business Administration

State Aeronautics Commission

State Land Grant Universities with Extension Services

Notes: Utilize the resources of the school and local public libraries for the information about these government agencies.

**A CAREER IN AG AVIATION**

I. Nature of the Work:
- A. An Ag Pilot's schedule is non-standard.
  1. Work is usually seasonal, in the summer months for most states.
  2. When working there are no weekends. Seven days a week for several weeks is not uncommon.
  3. Work for an Ag Pilot is not "nine-to-five". Sunrise-to-Sunset is a more accurate description. Some pilots fly night applications for various reasons.
- B. Specific Skills Necessary
  1. Low altitude, precision flying at maximum gross weight.
  2. Keen observation for obstacles, and crop identification.
  3. Quick reflexes.
  4. Comprehension of products being applied.
  5. Mechanical knowledge of aircraft used.
- C. Risk Considerations
  1. Low level flying.
  2. Exposure to agrichemicals.
- D. Rewarding not Glamorous
  1. Ag Pilots are playing a vital role in agricultural production.
  2. They are not the barnstormers of yester-year.

II. Where the Jobs are:
- A. Various locations in the United States.
  1. Seasons longer than 8 months/year.
     a. California and Southern States.
  2. Seasons of less than 8 months/year.
     a. All other regions of the U.S.
- B. Foreign Countries.

III. Wages and Benefits:
- A. Variable according to:
  1. Experience of Pilot.
     a. Low Ag-time $10,000-$15,000/yr.
     b. High Ag-time with good work record, $60,000-$80,000/yr.
  2. Location of Job (Seat).
     a. Short season = small income.
     b. Long season = more work = larger income.
     c. Economic condition of the area.
  3. Other skills.
     a. Pilots who are also aircraft mechanics can derive additional income for shop duties.
     b. Some pilots use their flying skills in other aviation related occupations, such as charter work, flight instruction, etc.

IV. Educational Requirements:
- A. Commercial Pilot License (FAA).
  1. Additional training in Ag Flying.
  2. Federal Aviation Regulations Part 137-rules pertaining to agricultural aircraft operations.
- B. Commercial Pesticide Applicators License (EPA).

V. Opportunities for Training:
- A. College (4 year and 2 year programs).
- B. Private Ag Aviation School.
- C. On the Job Training.

VI. Outlook for the future:
- A. There will always be a need for professional, well trained pilots.
- B. Insurance Complications.
  1. Necessary for Ag Pilots.
     a. Need experience to obtain.
     b. Can't get experience without it.
  2. Schools are currently negotiating with the insurance companies to develop amended policies.



Supplemental Sheet 1005 E Street. S.E., Washington, DC 20003 This. Information current 1990.

## GEOGRAPHY

Interpretation of maps is an important skill in the Ag aviation business. It is necessary for aerial applicators to be able to accurately read several types of maps: weather maps, aeronautical charts, infrared and aerial photo maps, and even simple sketches drawn by the customers. The most commonly used maps in the business are the general highway maps of the counties where the work is being done. A sample of this kind Of map is shown on the next page, using this map Ag pilot(s) can locate the field(s) to be sprayed.

When a farmer calls for service, he is asked to give the legal land description (legal, for short) of the field he wants treated. A legal land description is a description of a tract of land in legally precise terms, it explains the exact location Of the tract and the number of acres it contains. An acre is rectangular measure of land equal to 43,560 square feet, and there are 640 acres in a square mile, which is called a section. When working with rectangular land descriptions, square measure is expressed in terms of acres, and the location is expressed in terms such as S1/2 (south half), NW (northwest quarter), etc. as illustrated

Figure A

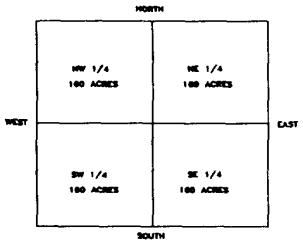
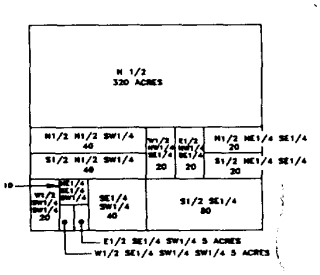



Figure B




Example: As you can see in figure A a quarter section is 160 acres (640+4 = 160). If a farmer described his field as the SW1/4 of the section and there were 160 acres then the pilot would know where to find the field and how to load his aircraft to do the job. Sometimes the legal is more difficult to interpret, such as the location of the 20 acre field in figure B with the description of W1/2, NW1/4, SEA of the section. The key to reading a longer legal is to read it from right to left, or backwards; start with SEA and locate the square 160 acres in the southeast corner of the section, then find the NW portion of the 160 acres (this would be 40 acres, 160 + 4 = 40), and from this parcel separate it into east and west halves, that leaves the 20 acre field you set out to identify.

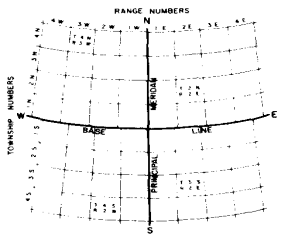
Now that the location of the field in the section is possible, how does the Ag pilot determine where the section is? He must first understand the township/section land survey system. When the new territories of the U.S. were surveyed many years ago', a township system was devised. A congressional township, in theory, is a square tract of land 6 miles square, containing 36 sections. All the sections are numbered and the pattern of numbering is the same in every township (figure C). Each township also has number identifiers, a township number (T), and a range number (R). The township number, is the number of rows or tiers of townships that a township lies in, either north or south of a base line. The range number is the number of rows or tiers either east or west of the principal meridian (figure D).

Figure C

| | | | | | |
|---|---|---|---|---|---|
| 6 | 5 | 4 | 3 | 2 | 1 |
| 7 | 8 | 9 | 10 | 11 | 12 |
| 18 | 17 | 16 | 15 | 14 | 13 |
| 19 | 20 | 21 | 22 | 23 | 24 |
| 30 | 29 | 28 | 27 | 26 | 25 |
| 31 | 32 | 33 | 34 | 35 | 36 |

How sections are numbered in a township

Figure D




Township and Range Numbers



Supplemental Sheet 1005 E Street, S.E.. Washington. DC 2000:3 This information current 1990.

With the exception of a few regions, the township survey system is the standard in most parts of the United States. When using this system, as in the following exercise, legal land descriptions show the section, township, and range that the property is located in.

**EARLY TO BED.. . EARLY TO RISE...**

**1. Locate "Golden Planes Ag Service" airstrip. The legal is, S 1/2 of section 5, T9S, R52W.**

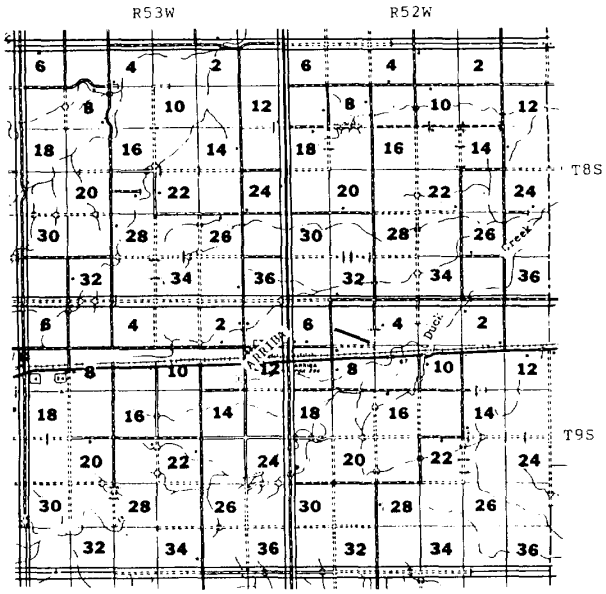
*At 9:30 pm., Pilot Bernie is awakened by a call from Grower Rich, requesting to it have his barley sprayed. Rich has an 80 acre field located on the N1/2 of SE1/4 of section 6, T8S, R53W.*

**2. Mark the location of Grower Rich's barley field.**

*Pilot Bernie notes that the chemical mixture for Grower Rich is the same as the one he will be applying in the morning on wheat for Grower Curtis on the N1/2 of N1/2 of section 17, T9S, R53W, 160 acres. The rate of application for the selected pesticide mixture is 1 gal/acre, so Bernie can combine the two loads his Air Tractor and complete both fields in one trip .*

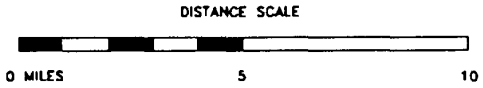
**3. Mark the location of Grower Curtis' wheat field.**

*At 4:45 a.m. Loader Greg prepares tie first load of the day. It is the 240 gallon mixture for Grower Curtis' and Rich's fields. Pilot Bernie will ferry to Grower Curtis' field first and treat it, he will drop paper flags to mark the field; meanwhile Flagger Ruthanne will drive the pickup to Grower Rich's field.*




**4. Bernie will have to fly a heading of _____to get to the wheat field. (Determine the answer by using the compass rose.)**

**5. _____miles, is the cross country distance the plane will have to fly to Grower Curtis' field.**




*The total application time for the first field is 25 minutes. During this time, Flagger Ruthanne will drive to Grower Rich's barley field.*

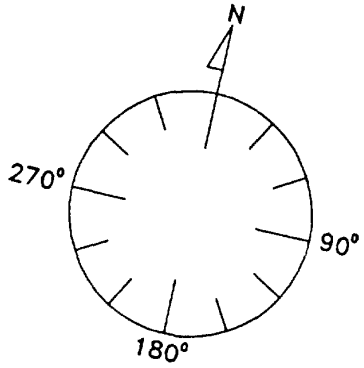
**6. Using the most direct route calculate the pickup's mileage from the airstrip to the northeast corner of the field. The distance would be _____miles.**

**7. Pilot Bernie arrives at the barley field shortly after Ruthanne. He flew _____miles between fields.**

*After finishing the second field, Pilot Bernie returns to the airstrip for fuel and another load. It is 6:00 a.m.*

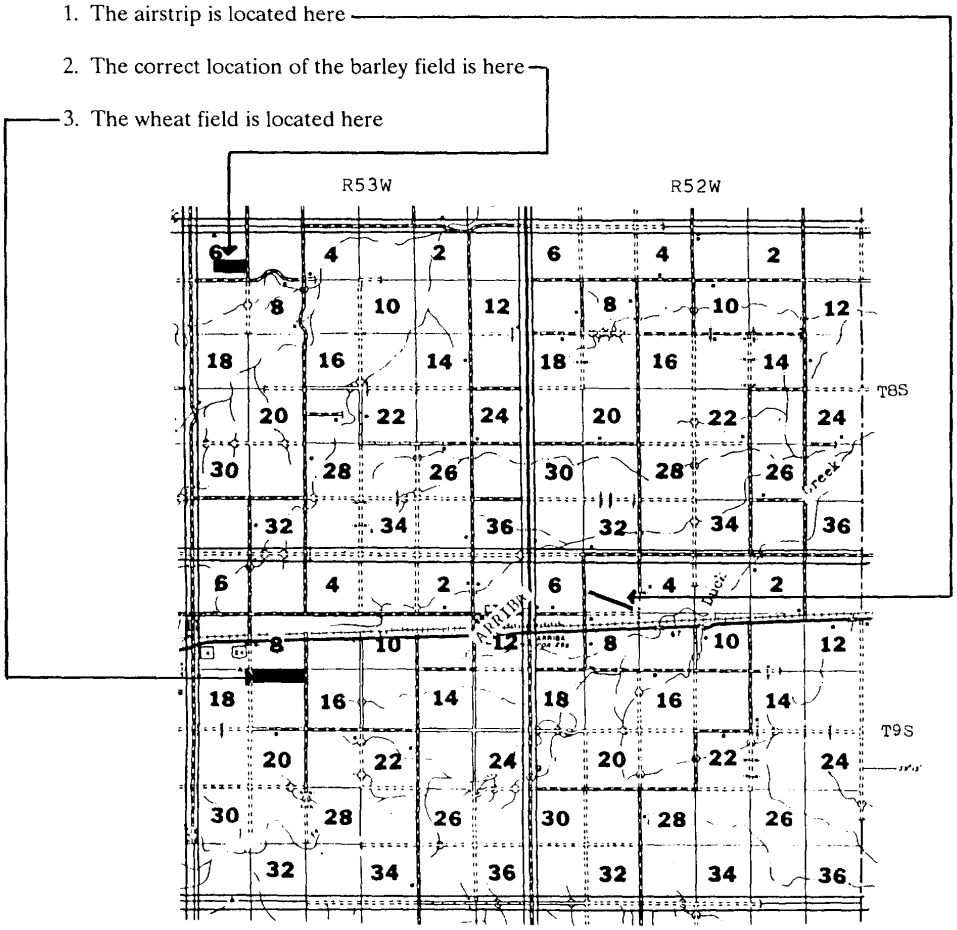
**8. His compass heading is _____**

**9. The cross country distance to the airstrip is _____ miles**.




COMPASS ROSE

**ANSWER KEY**




4. Approximate heading 240

5. 6 miles

6. 14 miles

7. 7 1/4 miles

8. Approximate heading 110

9. 9 1/4 miles

## LANGUAGE ARTS



**OVERVIEW:**

This section is directed to language arts teachers in junior and senior high school. The language arts activities which follow are all related to the agricultural aviation industry and will help your students develop and improve their skills in listening and speaking, reading comprehension and writing.

The members of National Agricultural Aviation Association want to furnish correct information regarding their chosen profession. We believe that a better informed adult population begins with providing schools and teachers with accurate information. To that end, we have prepared this language arts unit about the effect agricultural aviation has on the world's supply of food and natural fibers and maintenance of forested lands.

Teachers are encouraged to use these activities so they will best suit the students they are teaching. Levels of difficulty can be adjusted to the achievement levels of the students.
If software and computer time is available, we would suggest development of additional computer generated puzzles using the glossary words.

**MATERIALS AND RESOURCES:**

For this section we suggest contacting the following resources for additional materials:
Numbers 8, 14-26, 31, 41, 44.

**SUGGESTED ACTIVITIES:**

Improve correspondence skills by using the resource listing to have the class write formal letters requesting information, invite speakers, and/or make arrangements for a field trip. Follow up speaker engagements and field trips with thank you letters to the appropriate individuals.

Utilize the enclosed glossary of Ag Aviation terms in a vocabulary/spelling lesson. Implement drills in homonym recognition, word usage, and pronunciation acuity.

Show a video related to the topic of agriculture aviation (aviation, agriculture, agrichemicals). Follow up with a class discussion, determine the overall level of comprehension by asking specific questions. Have the students prepare a summary of the video. The summary may be used as a writing lesson or as a basis for an oral presentation. Preparation of the summary is to be preceded by construction of an outline of the key point(s).

Some students will have first hand knowledge of the benefits which are provided by Ag aviation. For example, they may be members of farming or ranching families which have used the services of an Ag pilot. These students should be encouraged to relate these personal experiences to the class in either an impromptu speech or a short story which is a personal narrative.

Invite a speaker to address the class on aerial application. At the conclusion of the speech, the students will interview the speaker with proper questions using vocabulary words from the glossary. If the speaker is unable to appear in person, conduct the interview in writing, or if possible by telephone conference.

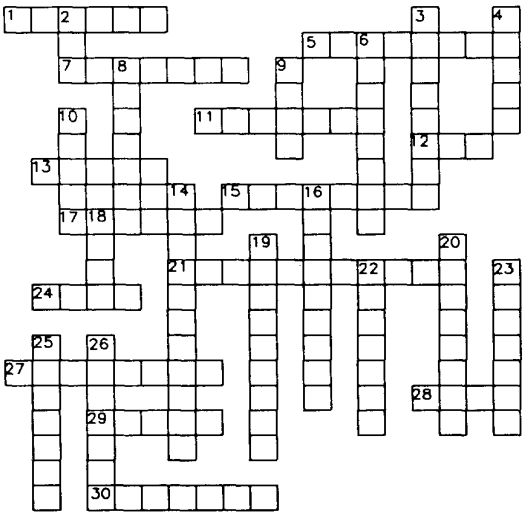
Discuss with the class the fact that many of the request & for aerial application services are over the phone and not in person. Occasionally the farmer will have to leave a message with a service or an answering machine. Have the class practice giving and receiving accurate messages.

Divide the class and conduct a debate on the risk/benefits of agricultural aviation.

Have the students give informative speeches to the class on the subject of aerial application. For suggestions for titles refer to the research paper list below. Use materials from the resource list to develop speech outlines.

Add the topic of Ag Aviation to the research paper list. Suggested titles are:
"The Benefits of Ag Aviation to My Community"
"Flying, Farming, and the Future"
"The History of Agricultural Aviation"
"Flying for Food"
"Agriculture’s Air Force"
"The Advancements in Ag Aviation"
"Pros and Cons of Pesticide Use"
"How Would You Promote Agricultural Aviation"
"Aerial Applicators, Stewards of the Land"

Send the essays to the National Agricultural Aviation Association in Washington, D.C. for possible publication in Agricultural Aviation, the official periodical of the NAAA.



**AG AVIATION UPS AND DOWNS**

**ACROSS:**

1. The tank on an Ag aircraft which holds the spray solution.
5. The streamlined body of an airplane to which the wings and tail are fastened.
7. Aircraft with single or paired wings at two levels.
11. State in which growth of seeds or other plant organs stop temporarily.
12. Ultra low volume.
13. The printed information attached to or on a pesticide container.
15. Evaporates at ordinary temperatures when exposed to air.
17. Building in which aircraft are stored or sheltered.
21. Any material used to control insects such as grasshoppers.
24. A plant growing where it is not desired.
27. Speed.
28. The amount of active ingredient or acid equivalent per unit ar ea.
29. Person who controls the plane.
30. A material added to pesticide to increase adherence.

**DOWN:**

2. Parts per billion, equals 1 pound in 500,000 tons.
3. The vertical distance from a given level to an aircraft in flight.
4. To fly aircraft from one location to another.
6. Compound that is absorbed and transacted throughout the plant or animal.
8. The distribution of the spray solution from an Ag aircraft.
9. The device on an Ag aircraft which produces the desired pressure for the spray solution.
10. The width of area covered by a pesticide application.
14. Adjusting the spray dispersal equipment to apply the desired rate of pesticide.
16. The process of stirring or mixing in a hopper, or mix tank.
18. A measurement of land totaling 43,560 sq. feet.
19. A chemical which causes the leaves to drop from a plant.
20. Ninety degrees from the horizon.
22. The portion of the inside of the airplane occupied by the pilot.
23. Person who marks the swaths for an Ag pilot.
25. A measurement of land, one mile square totaling 640 acres.
26. An instrument indicating direction.

**AG AVIATION BACK AND FORTH**

CAN YOU FIND THESE WORDS?

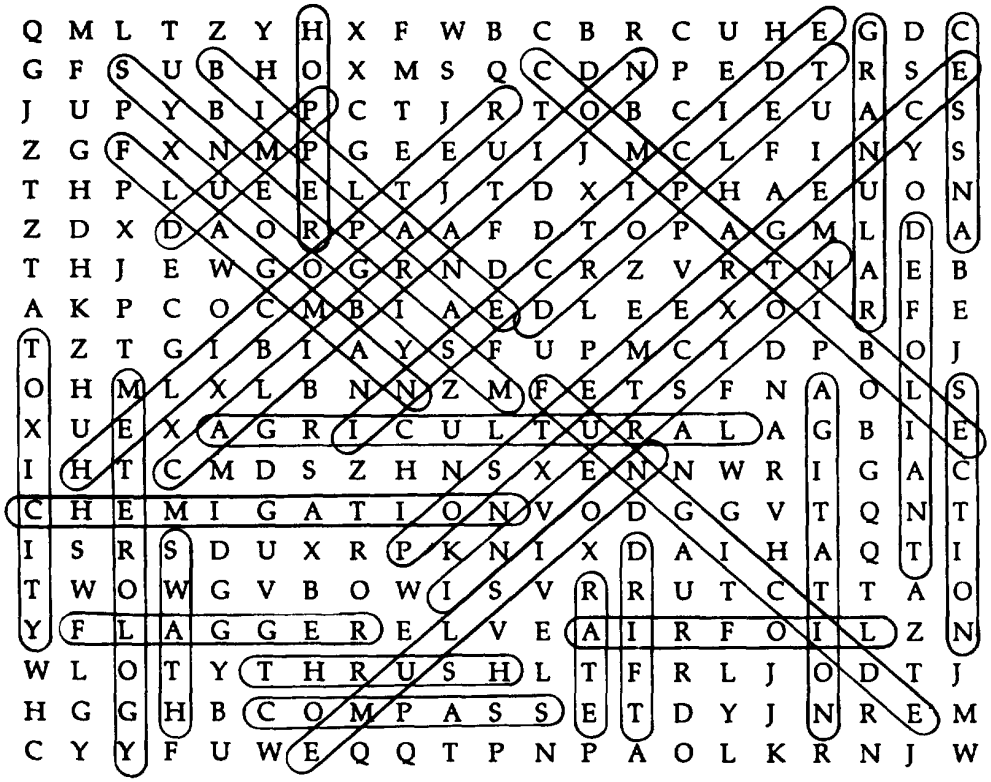
| | | |
|---|---|---|
| POST EMERGENCE | AGRICULTURAL | INSECTICIDE |
| CHEMIGATION | CALIBRATION | METEOROLOGY |
| HELICOPTER | COMPATIBLE | INVERSION |
| SYNERGISM | FUNGICIDE | AGITATION |
| DEFOLIANT | TOXICITY | GRANULAR |
| EMULSION | SECTION | FLAGMAN |
| DROPLET | AIRFOIL | BIPLANE |
| FLAGGER | COMPASS | THRUSH |
| CESSNA | HOPPER | SWATH |
| DRIFT | RATE | DUMP |

Q M L T Z Y H X F W B C B R C U H E G D C
G F S U B H O X M S Q C D N P E D T R S E
J U P Y B I P C T J R T O B C I E U A C S
Z G F X N M P G E E U I J M C L F I N Y S
T H P L U E E L T J T D X I P H A E U O N
Z D X D A O R P A A F D T O P A G M L D A
T H J E W G O G R N D C R Z V R T N A E B
A K P C O C M B I A E D L E E X O I R F E
T Z T G I B I A Y S F U P M C I D P B O J
O H M L X L B N N Z M F E T S F N A O L S
X U E X A G R I C U L T U R A L A G B I E
I H T C M D S Z H N S X E N N W R I G A C
C H E M I G A T I O N V O D G G V T Q N T
I S R S D U X R P K N I X D A I H A Q T I
T W O W G V B O W I S V R R U T C T T A O
Y F L A G G E R E L V E A I R F O I L Z N
W L O T Y T H R U S H L T F R L J O D T J
H G G H B C O M P A S S E T D Y J N R E M
C Y Y F U W E Q Q T P N P A O L K R N J W

## ANSWERS TO PUZZLES

**ANSWER KEY**

| **Across:** | | **Down:** | |
|---|---|---|---|
| 1. | HOPPER | 2. | PPB |
| 5. | FUSELAGE | 3. | ALTITUDE |
| 7. | BIPLANE | 4. | FERRY |
| 11. | DORMANT | 6. | SYSTEMIC |
| 12. | ULV | 8. | PATTERN |
| 13. | LABEL | 9. | PUMP |
| 15. | VOLATILE | 10. | SWATH |
| 17. | HANGAR | 14. | CALIBRATION |
| 21. | INSECTICIDE | 16. | AGITATION |
| 24. | WEED | 18. | ACRE |
| 27. | VELOCITY | 19. | DEFOLIANT |
| 28. | RATE | 20. | VERTICAL |
| 29. | PILOT | 22. | COCKPIT |
| 30. | STICKER | 23. | FLAGGER |
| | | 25. | SECTION |
| | | 26. | COMPASS |



# MATHEMATICS

**STORY PROBLEMS**



**OVERVIEW:**

The purposes for presenting this guide to mathematics instructors are:

1) As a tool to introduce and promote the agricultural aviation industry in a positive manner within an educational setting.

2) To provide the instructors with a chance to transfer the material taught in the classroom to a life situation. A working knowledge of mathematics is required to become a pilot; it is necessary prior to establishing an aerial application business; and it is an integral part in the daily procedures of an aerial applicator. The figures given in each example are current and realistic; this was done in order to give a true portrayal of the aerial application industry and production agriculture.

Various mathematical problems are supplied to demonstrate how agricultural aviation assists growers in producing maximum crop yields in the most cost effective manner. By working through these questions, the student will become familiar with some aspects of the routine of an aerial applicator. Each problem contains accurate information pertaining to the situation and asks real life questions; the student will use logic and mathematical processes to solve the problem. The examples are arranged by suggested grade level, but the problems for prior grades may be presented to the class. The students should be encouraged to attempt all story problems within their ability levels. Once the instructor is aware of what aerial application consists of, he/she can further expand on examples suited to the area of study.

This section is suitable for utilization by a substitute teacher.

**MATERIALS AND RESOURCES:**

For this section we suggest contacting the following resources for additional materials:
Numbers 14-18, 20, 25, 26.

**SUGGESTED FOR GRADE 6**

1. In the produce department of the grocery store, apples sell for .80 lb., grapes for $1.29/lb., oranges for .89 lb., carrots for .39 lb., potatoes for .38 lb. and onions for .29 lb. You purchase 2 lbs. of each of the fruits and 3 lbs. of each of the vegetables.

   a. What is the total cost of the produce purchased?

   b. Insects infested the apple orchards in Washington. Many producers chose not to treat for the insects. Because of the losses the apple price rose 20% per pound to the consumer. Along with the insect problem in the apples, the potato production in Minnesota and North Dakota was cut in half due to a fungus problem left untreated because of a lack of chemical. Of the potatoes harvested, most were of poor quality and small. This caused the per pound price to double. When buying the same quantities of the fruits and vegetables, what is the total cost of the produce?

   c. What was the cost increase to the consumer due to the untreated insect and fungus problems?

2. Colorado Growers John and Stan each have a quarter section of wheat with tansy mustard which should be sprayed to avoid a yield loss. Grower John contacted Pilot Bob to order his quarter sprayed with the herbicide at a cost of $6.50 per acre. Grower Stan decided not to spray his wheat. When harvested, Grower John's wheat yielded 55 bushels/acre and Grower Stan's yielded 39 bushels/acre. Each grower sold their wheat for $3.25/bushel.

   a. What did it cost Grower John to have his field sprayed?

   b. How much money did Grower John receive when he sold all his wheat?

   c. How much did Grower Stan receive when he sold all his wheat?

   d. What was the difference between the amount each grower received from the sale of their grain?

   e. Was it a wise decision for Grower John to spray? Why?

3. The sizes of the hoppers vary in agricultural aircraft.

| | | | |
|---|---|---|---|
| Cessna Ag Husky | 280 gallons | Hiller 12E Helicopter | 110 gallons |
| Piper Pawnee | 150 gallons | Thrush Aero Commander | 400 gallons |
| Alr Tractor | 350 gallons | Cessna Ag Wagon | 200 gallons |
| 450 Ag Cat | 300 gallon | Dromader | 600 gallons |
| Bell Jet Ranger Helicopter | 160 gallons | Piper Brave | 275 gallons |

   a. Make a graph to illustrate the above information in an organized manner.

   b. Convert the gallons to liters.

   c. Convert the gallons to cubic feet.

4. Water, at various gallonages per acre, is the primary carrier for the chemicals aerial applicators spray. If Pilot Bob sprays 80 acres with a chemical requiring 10 gallons/acre of total solution (water and chemical), what is the total gallonage amount? 5 gallons/acre? 2 gallons/acres? 1 gallon/acre?

5. Pilot Ann sprayed 1/8 of a half section with an insecticide. How many acres did she spray? (replace 1/8 with 1/6, 1/4, 1/3, 1/2, etc.)

6. Pilot Bob flies to the field in his Cessna Ag Wagon at a speed of 105 mph. It takes 10 minutes to get to the field. How far was the field from the airport?

**SUGGESTED FOR GRADE 7 & 8**

1. A grower ordered herbicide, at the rate of 1- pints/acre to be applied to a full quarter section of soybeans.
   a. How many gallons Of chemical are needed to complete the job?
   b. If Pilot Bob applies a total Of 5 gallons of spray solution (and water), how many total gallons of solution will be applied?
   c. When using a Thrush with a 400 gallon hopper, how many loads will it take to do the soybean field?
   d. If the chemical costs $48.00 a gallon and pilot Bob charges $4.00 per acre for the spraying, what is the per acre cost to spray the soybean field?
   e. What will it cost the grower for the entire job?
   f. If sprayed, the potential yield of this soybean field is 30 bushel to the acre, untreated, the expected yield would be 24 bushel to the acre. Soybeans sell for approximately $7.00 per bushel. What is the dollar value of the crop loss if the grower would have chosen not to spray?
   g. Did the spraying pay for itself?
   h. How would consumers be affected ifsoybean herbicides were banned?

2. If Pilot Bob bought 50 gallons of fungicide and it is to be applied at 4 ounces per acre, how many acres can be sprayed with the 50 gallons?

3. Pilot Bob can spray 40 acres per load with his Cessna Ag Wagon and has 475 acres of cotton to spray.
   a. How many equal loads are there to do and how many acres in each?
   b. If each load takes 45 minutes, how long will it take?

4. Pilot Ann sprayed 4 less than 3 times as many acres as Pilot Al. Pilot Al sprayed 92 acres. How many acres did Pilot Ann spray?

5. An Ag aircraft consumed 35 gallons of gas per hour, at a cost of $1.35 per gallon, and sprayed 750 hours during a season. How much fuel was consumed and what was the cost?

6. To get to a field from the airport, Flagger Amy must travel 5 miles south and then travel 12 miles west. Pilot Bob, in his Pawnee, flies directly to the field from the airport.
   a. How many miles does Pilot Bob fly?
   b. Pilot Bob, in his Pawnee, travels at 100 miles per hour and the flagger at 45 miles per hour. How long does it take each of them to get to the field?
   c. Pilot Bob wants to arrive at the field 5 minutes after Flagger Amy. How many minutes should he wait before he takes off?
   d. Why would Pilot Bob want to avoid arriving at the field before Flagger Amy?

**SUGGESTED FOR GRADE 9**

1. An Iowa grower ordered a 73 acre field of soybeans to be treated with an insecticide at a rate of 6.4 ounces per acre and a 2 gallon/acre total spray solution (insecticide and water).

a. How many gallons of chemical are needed for the entire job?

b. How many gallons of total solution will be loaded into Pilot Bob's aircraft?

c. The chemical was mixed at a rate of 5.3 ounces/acre instead of the ordered rate. How much chemical must be added?

d. Pilot Bob returned from the 73 acre field with 20 gallons of total spray solution (chemical at 6.4 ounces/acre and water), in the hopper. The next order was for a 52 acre field of soybeans to be treated with insecticide at a rate of 6.4 ounces/acre. How much chemical will have to be added to the spray solution in the hopper to do the 52 acre field?

e. Pilot Bob charges $85.00/gallon for the chemical and $4.00/acre for the application (flying). What was the cost to the grower to treat the 52 acre field?

2. Pilot Bob purchased 4 new Ag Cats at a cost of $429,600.00. If he was given a 10% discount on 2 of the airplanes and a 22% discount on another, what was the cost of each aircraft?

3. When Pilots Bob and Ann sprayed on Thursday, Pilot Bob flew three times as many loads as Pilot Ann. On Friday, Pilot Bob flew 2 fewer loads than he did on Thursday while Pilot Ann flew 6 more than she did on Thursday. If they flew the same number of loads on Friday, how many loads did each fly on Thursday?

4. Pilot Bob flies his loaded Piper Pawnee to the field at 90 mph and when empty, returns to the airport at 100 mph. The total ferry time (time it took to fly to the field and back to the airport, not spraying time) was .38 hours. How long did it take to fly to the field and how far was it?

5. A grower requested Pilot Bob to spray an insecticide on a 200 foot border around the south 'i of the southwest quarter of his 640 acre section. How many acres will Pilot Bob spray?

Chemical #1 - 4# active in gradient per gallon cost - $48.00/gallon
Chemical #2 - 4# active ingredient per gallon cost - $80.00/gallon
Additive A - used @ rate shown cost -$8.00/gallon
Additive B - used @ rate shown cost - $14.00/gallon
(spray at 5 gallons of total solution/acre)

| | | *RATE* | | | *% WEED CONTROL* | | |
|---|---|---|---|---|---|---|---|
| *Treatment of Soybeans* | *Cost* | *AI (lb/A)* | *Grant Foxtail* | *Lambs-grt.* | *Pig-weed* | *Velvet-leaf* | *Yield (bu/a)* |
| *1. Chemical #1 + Chemical #2 +Additive A* | | *.75+.1875 +1.0 qt.* | *91* | *98* | *88* | *99* | *40.3* |
| *2. Chemical #1 + Chemical #2 +Additive B* | | *.75+1.875 +1.0 pt.* | *92* | *98* | *89* | *99* | *42.6* |
| *3. Chemical #1 + Chemical #2 +Additive B* | | *.75+1.875 +.5 pt.* | *92* | *98* | *88* | *98* | *43.4* |
| *4. Control* | | | *0* | *0* | *0* | *0* | *18.4* |

**Assume soybeans sell for $7.00/bushel.*

6. From the above chart, answer the following questions:

a. Figure the chemical cost of each treatment and record it in the cost column.

b. On the average, which treatment had the lowest percentage of weed control?

c. Did the least expensive treatment produce the best yield?

d. If the soybeans are sold, considering the cost of the chemical, how much more per acre profit would the grower realize on treatment #3 verses the control? Did the spraying pay for itself?

**SUGGESTED FOR HIGHER MATH STUDENTS**

l. A rectangular field is a half mile long and a quarter mile wide. The four sides of the field are enclosed by three rows of trees. The width of the three rows of trees is 50 ft. What is the area of the remaining portion of the field? If aerial spray application costs$4.00 per acre to apply, what will be the total cost of spraying the open portion of the field? (43,560 sq. ft. = one acre)

2. While applying aerial spray, an airplane flies at 95 mph (140 ft./sec.). If it takes the pilot 84 seconds to turn around and start spraying the next swath (a swath is the amount of ground covered with spray on one run of the plan and is about 60 ft. wide), how long will it take to spray a field that is a half mile wide and 3/4 of a mile long?

3. Pilot Bob asked Flagger Amy to measure the remaining part of the field sprayed. Amy knows that if she steps off a strip a half mile long that the strip contains 4 acres. The field is 3/4 of a mile long and Amy steps off 31/2 strips. How many acres remain to be sprayed?

4. Flagger Ron is driving a pickup truck with wheels that have a radius of 9". If he is to mark a swath width of 66 feet, how many wheel revolutions should he allow between marks?

5. Flagger Amy is marking swaths on a rectangular field. She is driving a pickup with wheels having a radius of 9". The road she is driving on makes an angle of 30 with the end line of the field. How many wheel revolutions should she allow as she travels on the road so as to mark 66 feet on the end of the field?

6. Flagger Ron buys new wheels for his pickup. The old radius of the wheels was 9" and the new radius of the wheels is 10". If Ron forgets to change his marking system, how many acres will he be off in measuring the field that is a half mile long and he has marked 20 swaths at 66 feet per swath?

7. Flagger Ron makes $3.80 per hour plus 1% of the application cost of $4.00/acre. Pilot Bob is going to increase his wage to $3.95 per hour plus 1.2% of the application cost. If Ron can measure 200 acres in an hour, what will be his new hourly wage and what is the percentage increase over his present salary?

8. Pilot Bob can spray a given field in 3 hours and Pilot Ann can spray the same field in 2.5 hours. How long will it take both pilots to spray the given field?

9. If Pilot Bob can spray a given field in 4 hours and Pilot Bob and Pilot Ann can spray the same field together in 1.75 hours, how long does it take Pilot Ann to spray the field?

10. An Alr Tractor has an airspeed of 125 mph and is to be ferried from Wahpeton, North Dakota to Timber Lake, South Dakota. If the bearing to be flown is $220^0$ and a 30 mph wind is blowing from $320^0$, find the heading to be flown and the ground speed of the airplane.

11. Flagger Ron notices that Pilot Bob has just started spraying at the opposite end of the field and is heading directly towards him. Ron also notices that at the same time a truck is traveling on the road Ron is marking from which is perpendicular to the line of flight. The airplane is traveling at 95 mph (140ft./sec.) and the field is a half mile long. The truck is traveling 55 mph (81 ft./sec.) and is a quarter mile away from Ron. How fast is the line of sight between the airplane and the truck changing 10 seconds later? 17 seconds later?

12. Pilot Bob is flying on a course perpendicular to the leading edge of a field to be sprayed and at an altitude of 300 feet above the ground. When he is 1/2 mile from the field, he notes that the angle his eye makes with the left and right edges of the field is 50'. How wide is the field?

13. Pilot Ann is flying on a course perpendicular to the leading edge of a field to be sprayed and at an altitude of 300 feet above the ground. When she is 1/2 mile from the field she noted that the angle her eye makes with the leading and back edges of the field is 5'. How long is the field?

14. Spray is being applied to a field by a Cessna Ag Husky. If the volume of spray remaining in the airplane tank during application is determined by the equation v(t) = 400-t2/50 -1/2tgallons (t is time measured in seconds), find the instantaneous rate of change of the volume of spray at any time, t(t>0). Find the instantaneous rate of change of the volume of spray for t = 50 seconds, fort = 100 seconds.

15. Pilot Bob's Aerial Spray Company estimates it's gross income from spraying by the formula dS/dt = 2000(t - 2)(2/3), where S dollars is the gross income from spraying t years from now. If the gross income from this years spraying is $246,000 what should be the expected gross income derived from spraying 2 years from now? 5 years from now?

**BUSINESS MATH**

The basic expenses of an aerial applicator include:
Agricultural aircraft - $30,000 to $200,000 (used and new) Yearly aircraft maintenance - $2,000 to $5,000
Fuel - Aviation gas $1.20 to 1.30, diesel for turbine aircraft .60 to .80 gallon (variable)
Oil - $3.25 to $3.70/gallon
Chemical for resale - ranges from $5.00 to $100/gallon
Equipment - vehicle, loading equipment, ramp for loading/variable with style, area and age of equipment
Hangar for aircraft storage - variable with size, whether build or purchase an existing hangar, area erected (private or public land)
Office space - may be in home, attached to hangar, separate building
Wages - pilot(s), flagger, loading personnel, bookkeeper/variable with experience, location of business and number employed
Insurance - variable with type purchased and previous history
Office expenses - variable but could include copier, computer, but would include office supplies, telephone expense, etc.
Utilities - water, would vary if located on privately owned land or at a municipal airport, electricity, etc. An operator could lease the following - aircraft, equipment, hangar, office space

The income of an aerial applicator consists of the following:

Labor charges for spraying the field - usually a per acre price ranging from $3.25 to $8.00 per acre depending upon the location of the operator, the type of work being done, and the risk involved. Profit received from chemical sales - this is variable depending upon the type of chemical applied.

1. The cost of a 30 gallon drum of insecticide is $2,400.00. When purchased in a gallon container the cost is $81.50/gallon.

a. If an applicator needs to purchase 60 gallons, what container size should he purchase?

b. What is the total savings by purchasing in the above container size?

c. If he marks the insecticide up 3.5%, what does it sell for per gallon?

d. If insecticide is applied at the rate of 6.4 ounces/acre, what is the per acre profit?

2. An applicator has the following expenses: bookkeeper-37.5 hrs. at $7.00/hr.; pilot-paid for 8,235 acres at $.75/acre; flagger-62.2 hrs. of labor, 40 hrs. at $4.50/hr. plus time and a half for overtime; gas-49 hrs. of flying using 35 gallons of gas per hour at $1.27/gallon; chemical-for 8,235 acres at the rate of 6.4 ounces per acre costing $80.00/gallon; 3 months interest on $35,000.00 at an annual rate of 12%. If he charges $8.50 an acre, how many acres does he have to spray to cover the above expenses?

## MATHEMATICS ANSWERS

### SUGGESTED GRADE 6

1. a. $9.14
   b. $10.60
   c. $1.46

2. a. $1,040.00 (note 1/4 section equals 160 acres)
   b. $28,600.00
   c. $20,280.00
   d. $8,320.00
   e. yes, Grower John's crop was much better and he was able to make a greater gross profit. The spraying easily paid for itself.

3. a. as instructor approves - any organized graph
   b. use conversion of 1 US gallon = 3.785 liters
   c. use conversion of 1 cubic ft = 7.4805 gallons

4. 800 gallons, 400 gallons, 160 gallons, 80 gallons

5. 1/8 of 1/2 section = 40 acres (full section is 640 acres)

6. 17.5 miles r x t = d

### SUGGESTED GRADES 7 & 8

1. a. 30 gallons
   b. 800 gallons
   c. 2 loads
   d. $13.00 per acre
   e. $2,080.00
   f. $6,720.00
   g. yes
   h. Yields would be reduced and in time costs to the consumer would rise on any products which use soybeans or their by-products.

2. 1,600 acres

3. a. 12 loads of 39.58 each
   b. 9 hours

4. 272 acres
5. 26,250 gallons costing $35,437.50
6. a. 13 miles
   b. Pilot Bob-. 13 of an hour or 7.8 minutes; Flagger Amy-.38 of an hour or 22.8 minutes
   c. 20 minutes
   d. multiple answers-to save fuel because he would have to fly around while waiting for Flagger Amy.

### SUGGESTED GRADE 9

1. a. 3.65 gallons
   b. 146 gallons
   c. 80.3 ounces (2 qts. and 16.3 ounces)
   d. 2.1 gallons
   e. $429.00

2. $120,000, $108,000, $108,000,

3. Pilot Bob - 12 loads; Pilot Ann - 4 loads

4. .20 hours to fly 18 miles
5. 36.36 acres

6. a. #1) $14.75 #2) $14.50 #3) $13.625
   b. #1
   c. yes
   d. $161.37/acre

### SUGGESTED HIGHER MATH STUDENTS

1. $284.55
2. 80.95 min.
3. 21 acres
4. 14 revolutions
5. 16.2 revolutions
6. 8.9 acres
7. 35%
8. 1.36 hrs.
9. 3.1 hrs.
10. $234^0$ 123 mph
11. -160.3 ft./sec., -124 ft./sec.
12. 2462 ft. or .47 miles
13. 1.7 miles
14. -5/2 gal/sec., -9/2 gal./sec.
15. $249,810 (2 yrs.)-$257,289 (5 yrs.)

### BUSINESS MATH

1. a. 30 gallon drum size
   b. $90.00
   c. $82.80
   d. $.13/acre
2. 5,080.52 acres



Teacher-Answers 1005 E Street, S.E.. Washington, DC 20003 This Information current 1990.

**OVERVIEW:**

Present day agricultural aviation utilizes modern technology in various ways. Applications of science enter into all facets of the industry.

Ag aviation depends on many aspects of current scientific information in the areas of aircraft design and improvement, chemical research, biological development, and environmental preservation.
This incorporation of scientific knowledge enables aerial applicators to assist in the affordable production of high quality food and fiber, and to explore other unique methods in which the ag pilot's skills and the aircraft's abilities can be utilized. The following suggestions allow for the integration of the positive aspects of the sciences into the industry. The National Agricultural Aviation Association continually strives to update information, and educate the urban populations about the needed role of aerial applicators in the agricultural and industrial communities.

Teachers are encouraged to use the resource material to find information with which to expand on problems suited to the area of study.

**MATERIALS AND RESOURCES:**

For this section we suggest contacting the following resources for additional materials:
Numbers 14-18, 20, 25-27, 31, 33, 38, 42.

**SUGGESTED ACTIVITIES:**

Investigate the properties of selective herbicides in which certain plants (crops) are able to metabolize the chemical compound which adversely affects the target plants (weeds).

Select an agricultural crop grown in a specific area of the U.S. , and trace back the influences that controlled breeding methods (such as hybridization, inbreeding and mass selection), have had on yield potential and resistance to disease.

Conduct a lab on weed competition. Plant two plots of desired "crop", add dandelion seeds to one plot. Make a chart noting the length the germination times and the rapidness with which the weeds and crop develop. Record your observations of the overall condition of the weed infested crop compared to the controlled crop. Analyze the ways that the weeds compete for moisture, soil nutrients, and sunlight. Discuss how your findings relate to crop production on a large scale.

Using bindweed as an example, investigate seed dormancy and the difficulty in controlling noxious weeds.

Investigate ways to control various plant diseases caused by fungi (Wheat Rust). How do insects contribute to the spread of plant disease?

Consider the overwhelming ability for weeds and insects to continually adapt to their environments and the use of pesticides. Discuss adaptation and variation.

Conduct a lab comparing plant uptake of a herbicide applied to the soil verses the same herbicide applied to the leaf. (Systemic vs. Contact)

2,4-D is considered to be one of the most widely used synthetic auxins in the U.S. What naturally occurring auxin does it simulate, and how does it work?

What are pheromones? Investigate the agricultural use of synthetic pheromones for insect control.

How is it possible that some pesticides can be so selective as to be harmless to warm blooded animals and deadly to cold blooded species?

Discuss toxicology testing on animals and how LD ratings are established.

Examine the grasshopper. Consider the unique anatomy and adaptability of the insect. Discuss the methods of control currently used.

Many public health programs include mosquito control. Investigate the life cycle of the mosquito. Discuss the need for control and the most effective times to spray.

In many areas, the trend toward organically grown fruits and vegetables is increasing. The growers of this produce use biological control methods for combating insects. Investigate different types of biological control methods. Is biological control always economical in large scale agricultural situations?

Discuss the reasons behind the growing popularity of fish in the American diet. Examine the use of ag aircraft to disperse food at catfish farms in the South, and to relocate trout fingerlings to high mountain lakes.

Define depth perception? Of what significance is this ability to an Ag Pilot. How about peripheral vision acuity?

What physiological changes occur within the body during an "adrenaline rush?"

Would it be safe for an Ag Pilot to fly with an ear infection? Explain.

What is a cholinesterase test? Who should take one and why?

Discuss the importance of wearing protective clothing when working in ag aviation. Some of the common safety equipment and the reasons for use are:

Rubber gloves, goggles, respirators, disposable coveralls, rubber boots - to avoid the risk of pesticide poisoning due to dermal absorption or inhalation of chemicals.

Nomex flightsuits - to prevent burn damage from fire in case of an accident.

Helmets - to decrease the possibility of hearing loss and for head protection in the event of an accident.

## EARTH SCIENCES

### METEOROLOGY

Q. How is Ag Aviation affected by wind, temperatures, storm patterns and other weather?

A. Light winds are essential for proper applications of pesticides by air. They allow for good coverage of the crop while providing the pilot with an undisturbed flight path when executing a standard dispersal pattern across the field (starting from downwind edge of the field and working into the wind with each swath). However, a point of diminishing return is met when the wind intensifies and causes problems with off target crop drift. Aerial application has to stop. High temperatures also can be the cause for shutdown of application due to the inability of the chemicals to reach the plant before evaporation occurs. Humidity levels at the time of application can sometimes vary the performance of the selected product. In addition, the effectiveness of some pesticides are hampered by the onset of moisture shortly after being applied, while the performance of other chemical formulations are enhanced by precipitation.

### CLIMATOLOGY

Q. How do wide spread, long term weather changes concern Ag Aviators?

A. Consider the "dust bowl" of the 1930’s, prolonged drought and high wind conditions led to massive soil erosion on the Great Plains. Today, Ag Aviators can assist growers in no-till and minimum-till farming practices. Using herbicides instead of plows to control the growth of unwanted plants on fragile soils during dry fallow conditions, farmers are able to conserve soil moisture for future crops by maintaining an undisturbed surface which is protected by standing stubble.

### ECOLOGY

Q. Our water resources are priceless. How does Ag Aviation affect the environment and possible water and air contamination? Discuss and compare the probability of Ground Water contamination through agricultural pollution by means of chemigation, ground, aerial, or other methods of pesticide application.

A. Refer to Resource listing numbers 20, 39, 42, 45.

### AGRONOMY

Q. Currently the American farmers comprise only 2% of the U.S. population, yet they lead the world in food and fiber production. In no other part of the world do so few economically produce so much. In many instances Ag Aviation is vital to crop production. How does Aerial Application assist the modern farmer in producing high quality, affordable products for consumers?

A. Refer to Resource listing numbers 1, 4, 20, 42.

The exploration of pesticides and their part in agricultural production.

Using a Label from a Household Pesticide (insect repellent, lawn weed and feed, flea collar, fly spray, mouse bait) determine the formula for each ingredient using a chemical dictionary, handbook, or the Merck Index.

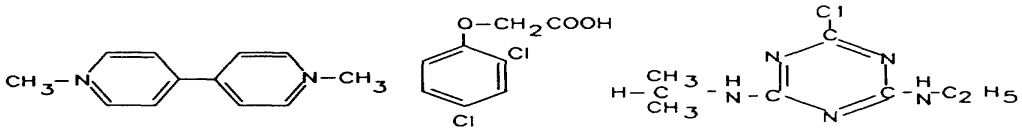
State the difference between Hydrocarbons and Chlorinated Hydrocarbons.

Discuss the difference between Hydrocarbons and Chlorinated Hydrocarbons.

What are Organophosphates? Give some examples.

Match the following molecular structures to their correct generic names.

2, 4-D Atrazine Paraquat



Investigate the research and development processes of Agricultural Chemical manufacturers. How long does it take for a pesticide to be approved for use by the Environmental Protection Agency? What are the criteria that must be met? What types of new innovative chemicals are being currently tested and marketed? How are they ecologically safer than products used in the past?

Discuss the ability of scientists to measure residue levels; how is it done, how are safe levels established, what margins of risk are acceptable?

Determine the need for different formulations (liquid, dry flowables, etc.) of Agricultural Chemicals.

Currently, returnable containers for pesticides are being made more widely available by Ag Chem manufacturers. Why is this important?

Why is heated storage for most pesticides preferred?

What would be the possible outcome of tank mixing products that weren't labeled for compatible solution? Knowing how to read Pesticide Labels is very important, improper use of chemical compounds can be dangerous.

Pesticide Labels give instructions on First Aid and cleaning of equipment. Using sample Labels find these directions and discuss the differences between several chemical products.

Discuss the need for spray solution additives.

1) Surfactants
2) Drift Retardants
3) Bonding Agents
4) Insects Attractants

Consider the composition of the slurry used for fighting forest fires. Agricultural Aircraft are used in various forestry situations.

**Principles of Flight:**

Discuss the four basic forces governing straight and level flight of an aircraft:

**Lift** -Lift is the upward acting force produced by air flowing over the surface of the airfoils (wings). The airfoil produces lift by its shape, which usually is designed so that the distance over the top side of the wing is longer than the distance along the bottom side. Bernoulli's Principle states that air pressure decreases as airspeed increases. Therefore, as air travels around the airfoil the air molecules are moving faster over the top than the bottom, air pressure is reduced above the wing and the wing will move up into the low pressure area.

1) Demonstrate Bernoulli's Principle by holding the edge of a piece of paper between the thumb and forefinger, letting the rest of the paper curve over the top of the hand to form an airfoil. Blow over the top of the curved surface.
2) Discuss the need for airfoil control surfaces such as flaps, ailerons, and elevators. How do they affect lift?

**Gravity** -Gravity, or weight of the aircraft, is the downward acting force which must be overcome by lift in order for the airplane to fly.

3) Drop two objects of different weights and sizes from the same height at the same time. Discuss the results.
4) Discuss the effects of gravity and inertia on the pilot during steep turns.
5) Explore low speed/high lift wing design. Of what importance is this to agricultural avia tion? Consider that many ag planes are capable of carrying several thousand pounds of material in the hoppers.

**Thrust** -Thrust acts in a forward direction and is the result of the force produced by the aircraft engine.

6) Launch paper airplanes with varying amounts of force to show that the speed of movement is related to thrust. (Newton's Second Law)

**Drag** -Drag is the backward, or retarding force produced by air resistance. Aerodynamic drag must be overcome by thrust in order for an aircraft to take off and accelerate.

7) Relate the concept of drag to the experience of putting your hand, palm facing forward, out of the window of a moving vehicle. (Newton's Third Law) What is the action of wind against the hand? What happens if you turn your hand palm down? Why is streamlining an important consideration in aircraft design?

Construct various types of paper airplanes and fly them. Investigate the similar as well as the different performance properties of each one. Determine the causes of the differences. For example, why one design is very aerobatic while another has long range glide capabilities?

# Notes

**GLOSSARY**

Acre - A measurement of land totaling 43,560 sq. ft.
Active Ingredient - The agent in a product primarily responsible for the intended effects, and which is shown as the active ingredient on the pesticide label.
Adjuvant - Any substance in a pesticide formulation which enhances the effectiveness of the pesticide.
Aerodynamics - Study of the forces of air acting on objects in motion relative to air.
Aerosol - Pesticide formulation under pressure. Usually propelled onto target by gas.
Ag Aircraft - Fixed wing airplanes or rotocraft designed for use as aerial dispersal equipment. There are several manufactures producing various types of ag aircraft to meet different needs. Piper Pawnee and Brave, Cessna Ag Truck and Husky, Air Tractor, Ayres Thrush, Weatherly, Melex Dromader, and Schweizer Ag Cat are some of the planes. Several brands of helicopters are designed for use as ag aircraft also such as Bell Jet Ranger and Hiller 12E.
Agitation - The process of stirring or mixing in a sprayer.
Agrichemical - Pesticide formulations used to enhance agricultural production.

Agronomy - The science of crop production and soil management.
Aileron - Control surfaces hinged at the back of the wings which by deflecting up or down helps to bank the airplane.

Airfoil - A streamlined surface designed in such a way that air flowing around it produces useful motion.

Airplane - A mechanically-driven, fixed-wing, heavier-than-air craft.
Airspeed - Speed of the aircraft relative to the air through

Altimeter - An instrument for measuring in feet the height of the airplane above sea level.
Altitude - The vertical distance from a given level (sea level) to an aircraft in flight.
Antagonism - Opposing action of two or more chemicals such that the action of one is impaired or the total effect is less than that of one component used separately. (See synergism).

Attitude - Position of the airplane relative to the horizon, a climbing attitude, straight-and-level attitude, etc.
Aviation - A term applied to all phases of the manufacture and operation of aircraft.
Automatic Flagger - A device attached to the ag aircraft and controlled by the pilot which releases weighted, biodegradable, paper streamers which mark swaths.

Auxin - Growth hormone in plants.
Bank - A flight maneuver in which one wing points toward the ground and the other to the sky.
Barnstormers - Usually post WWI pilots notorious for touring the rural areas staging theatrical aviation stunts, such as aerobatics and wing walking, etc.
Biplane - Aircraft with single or paired wings at two different levels.
Boom - A section of pipe or tubing to which several nozzles are affixed to apply pesticides over a wide area at one time.
Botanical Pesticide - A pesticide made from plants. Also called plant-derived pesticides.
Broadleaf Weeds - Plants with broad, rounded, or flattened leaves.

Calibration - Adjusting the spray dispersal equipment to apply the desired rateof pesticide.
Carrier - The inert liquid or solid material added to an active ingredient to prepare a pesticide formulation.
Certified Applicator - Commercial or private person qualified to apply restricted use pesticides as defined by the Environmental Protection Agency (EPA).

Chemigation - The application of pesticides through an irrigation system.
Cholinesterase - An enzyme produced by the body which is necessary for proper nerve function that is destroyed or damaged by organic phosphates or carbamates taken into the body by any path or entry.

Cockpit - The portion of the inside of the airplane occupied by the person(s) operating the airplane, and containing the instruments and controls.
Compass - An instrument indicating direction. which it is moving.
Compatible - When two or more chemicals can be mixed without affecting each other's properties, they are said to be compatible.
Concentration - The amount of active ingredient in a given volume or weight of formulation.
Contact Herbicide - A herbicide that causes localized injury where it contacts plant tissue.

Crosswind - Wind blowing from the side, not coinciding with the path of flight.

Dead Stick lLanding - Landing made without the engine operating.
Defoliant - A chemical which causes the leaves to drop from a plant.
Deposition - Quantity of the pesticide reaching the target area.

Dermal - Of the skin; through or by the skin.
Dessicant - A chemical substance which accelerates drying.
Dormancy - Period of inactivity, not growing. In the case of plants, it is after the leaves fall or growth stops and before the buds open in the spring. Also, the period when seeds fail to sprout due to internal conditions.
Dormant - State in which growth of seeds or other plant organs stop temporarily.
Droplet - Particles of spray solution emitted from the nozzle on the boom. The size of the droplet is affected by nozzle type, position and pressure.
Dry Flowable - Pesticide formulated into dust-free, highly concentrated, water-dispersible granules.

Dump - Mechanism located in cockpit of ag aircraft which when used opens the bottom of the hopper so the spray solution is quickly emptied. (Used in fire bombing, or an emergency situation, or when emptying the hopper during / after cleaning).
Economic Threshold - The density at which control measures should be applied to prevent an increasing pest population from reaching the economic injury level.
Elevation - The height above sea level of a given land prominence, such as airports, mountains, etc.
Elevators - Control surfaces hinged to the horizontal stabilizer which control the pitch of the airplane, or the position of the nose of the airplane relative to the horizon.
Emulsifiable Concentrate (EC) - A single-phase liquid system that forms an emulsion when mixed with water. May require mild agitation to maintain emulsion.
Emulsion - A preparation consisting of droplets or particles of liquid or sometimes other matter dispersed in a second liquid; as an emulsion of oil and water.
Engine - The part of the airplane which provides power or propulsion, to pull the airplane through the air.
Fallow - Cultivated land left idle and unplanted during a growing season.
Ferry - To transport (fly) aircraft from one location to another.
Fiber - A natural filament capable of being spun or woven.
Fin - A verticle attachment to the tail of an aircraft which provides directional stability. Same as vertical stabilizer.
Flagger (Flagman) - A person who marks the swaths for an ag pilot using equipment or by walking.
Flag(s) - A rectangular piece of fabric used as a signal; to mark for an ag pilot; a weighted, biodegradable paper streamer dropped from the ag plane to mark swaths.
Flaps - Hinged or pivoted airfoils forming part of the trailing edge of the wing and used to increase lift at reduced airspeeds.
Flowable Formulation - A two-phase concentrate that contains solid herbicide suspended in liquid which is capable of suspension in water. It needs only moderate agitation.

Foliar Application - Application of a herbicide to the leaves or foliage of plants.
Fungicicide - A chemical which kills or inhibits fungi (all non chlorophyll-bearing thalophytes such as rusts, smuts, mildews, and molds).
Fuselage - The streamlined body of an airplane to which the wings and tail are fastened.
Gear - The understructure of an airplane which supports the airplane on land or water; wheels, skis, pontoons. Retractable gear folds up into the airplane in flight. Gear that does not retract is called "fixed'. Ag aircraft generally have fixed gear.

GPA - Gallons per acre
Granular - A dry formulation of herbicide and other components in discrete particles generally less than 10 cubic millimeters in size.
Gravity - Force toward the center of the earth.
Hangar - Building in which aircraft are stored or sheltered.
Hazard - Obstructions, objects or threats to the safety of the passenger and aircraft.
Helicopter - In reference to agricultural aircraft, the helicopter is equipped with spray equipment and used to apply pesticides, etc., the same as fixed-wing aircraft.
Herbicide - A chemical used to control, suppress or kill plants or severly interrupt their normal growth processes.
Hopper - The tank on an ag aircraft which holds the spray solution.
Humidity - Amount of invisible moisture in a given mass of air.
Insecticide- Any material used to control insects such as mosquitoes and grasshoppers.
Knot - A measure of speed, one knot being one nautical mile (6,080.2 ft) per hour.
Label - The printed information attached to or on a pesticide container.
Land - The act of making the airplane descend, lose flying speed, and make contact with the ground or water, thus ending the flight.
LD50 - The dose (quantity) of a chemical(s) calculated to be lethal to 50% of the organisms in a specific test situation. It is expressed in weight of the chemical (mg) per unit of body weight (kg) and the toxicant may be fed (oral LD5O), applied to the skin (dermal LD50) or administered in the form of vapors (inhalation LD30).
Lift - An upward force caused by the rush of air over the wings, supporting the airplane in flight.
Meteorology - The scientific study of the atmosphere.

Micrometer (um) - A unit of length equal to 1/25,400 of an inch, or 1/1,000,000th of a meter.

Monoplane - An airplane having one set of wings.

Nomex - A fire retardant material used in making some types of flightsuits.

Non-target (Off-target) - Any area spray solution is not to be applied to.

Noxious Weed - A plant defined as being especially undesireable or troublesome.

Nozzle - Located on the boom, the final object through which the spray solution is dispersed.

Organophosphate - A synthetic organic pesticide containing carbon, hydrogen, and phosphorus; parathion and malathion are two examples.

Pattern - The distribution of the spray solution of an ag aircraft.

Pattern Test - A check of the distribution of the spray solution of the ag aircraft using specialized equipment to determine if the distribution should be improved.

Persistent Herbicide - A herbicide which, when applied at the recommended rate, will harm susceptible crops planted in normal rotation after harvesting the treated crop, or that interferes with regrowth of native vegetation in noncrop sites for an extended time.

Pesticide - A general term used to describe items which control a wide range of pests.

Pheromones - Chemicals produced by insects and other animals to communicate with and influence the behavior of other animals of the same species.

Pilot - Person who controls the plane.

Postemergence (Post) - Applied after the specified weed or planted crop emerges.

PPB - Parts per billion. A way to express the concentration in foods, plants, and animals. One part liquid. per billion equals 1 pound in 500,000 tons.

PPM - Parts per million. A way to express the concentration of chemicals in foods, plants, and animals. One part per billion equeals 1 pound in 500,000 tons.

Precipitation - Any falling visible moisture; rain, snow, sleet,shail.

Preplant Application - Applied on the soil surface before seeding or transplanting.

Pressure - Force in terms of force per unit area.

Propeller - An airfoil which the engine turns to provide the thrust, pulling the airplane through the air.

PSl - Pounds per square inch.

Pump - The device on an ag aircraft which produces the desired pressure for the spray solution.

Pyrethroid - Naturally occuring insecticide found in the flowers of plants belonging to the chrysanthemum family.

Rate - The amount of active ingredient or acid equivalent applied per unit area or other treatment unit.

Respirator - A face mask used to filter out poisonous gases and dust particles from the air so that a person can breathe and work safely.

Rodenticide - A substance intended to prevent, destroy, repel or mitigate small gnawing animals.

Rudder - Control surface hinged to the back of the vertical fin.

Runway - A surface or area on the airport designated for airplanes to take-off and land.

Seat - Term of employment for an aviator.

Section - A measurement of land, one mile by one mile square totalling 640 acres.

Seed Protectant - A chemical applied to seed before planting for pest control.

Selective Herbicide - A chemical that is more toxic to some plant species than others

Slipstream - Current of air driven back by the propeller.

Slurry - Watery mixture of insoluble matter, could be a pesticide or fire retardant.

Smoker - A mechanical device on an ag aircraft which ejects stored paraffin based oil into the exhaust of the aircraft. The smoke produced aids the pilot in determining many factors such as wind velocity and direction, and the existance of an inversion.

Soil Sterilant - A chemical that prevents the growth of all plants and animals in the soil. Soil sterilization may be temporary or permanent, depending on the chemical.

Spray - The compound and carrier; act of applying a liquid solution.

Spreader- Achemical which increases the area that a given volume of liquid will cover on a solid or on another of chemicals

Spreader - Equipment on ag aircraft used to disperse dry material.

Stabilizer - Horizontal surface which stabilizes the airplane around its lateral axis.

Stall - The reduction of speed to the point where the wing stops producing lift.

Sticker - A material added to a pesticide to increase its adherence.

Surfactant - A material that favors or improves the emulsifying, dispersing, spreading, wetting or other surface modifying properties of liquids.

Suspension - A mixture containing finely divided particles dispersed in a solid, liquid or gas.

Swath - The width of the area covered by a pesticide application making one sweep or one trip across the field or another treated area.

Synergism - A complementary action of two or more chemicals such that the total effect is greater than the sum of the independent effects. (See antagonism).

Systemic - Compound that is abosrbed and translocated throughout the plant or animal rendering it toxic to pests.

Tachometer - Instrument which measures the speed at which the engine crankshaft is turning, hence propeller speed in r.p.m.'s (revolutions per minute).

Tail - The part of the airplane to which the rudder and elevators are attached. The tail has vertical and horizontal stabilizers to keep the airplane from turning about its lateral axis.

Tail Dragger - Landing gear of the conventional type (most ag aircraft have this) i.e., 2 main wheels forward and 1 auxiliary wheel aft.

Take-off - The part of the flight during which the airplane gains flying speed and becomes airborne.

Tank Mix Combination - Mixing for two or more pesticides or agricultural chemicals in a spray tank at application time.

Target Crop - The field, plants, animals, or pests intended to be treated with a pesticide application.

Temperature Inversion - When the air is coolest at ground level, warms with an increase in elevation, then gets cooler again. This normally occurs in the early morning and late evening. An undesirable spray condition which permits droplets smaller than 100 um to float or rise rather than fall on target.

Thrust - Forward force.

Tolerance - (l) The ability of a living thing to withstand adverse conditions, such as pest attacks, weather extremes, or pesticides. (2) The amount of pesticide that may safely remain in or on raw farm products at time of sale.

Toxicity - The degree a given substance injures plants or animals. Toxicity is classified as acute (immediate) or chronic (long term). Toxicity to animals varies with species, age, sex, method administered, nutritional state and chemical formulation. (See LD50).

Translocated Herbicide - A herbicide that moves within the plant. Translocated herbicides may be either phloem mobile or xylem mobile, but the term is frequently used in a more restrictive sense to refer to herbicides that are moved in the phloem.

Tricycle Landing Gear - Airplane's landing wheels, two under the wings and one under the nose.

Turbulence - Irregular motion of air; uneven currents of air.

Turn - Maneuver which the airplane makes in changing its direction of flight.

ULV (Ultra Low Volume) - Formulation applied at 0.5 gallons or less per acre.

Updraft - Vertical currents of air.

Vapor Pressure - The property which causes a chemical to evaporate. The lower the vapor pressure, the more easily it will evaporate.

Velocity - Speed.

Vertical - Ninety degrees from the horizon.

Viscosity - A property of liquids that determines whether the they flew readily. Viscosity usually increases when temperature decreases.

Visibility - Distance toward the horizon that objects can be seen and recognized. Smoke, haze, fog, and precipitation can hinder visibility.

Volatile - Evaporates at ordinary temperatures when exposed to air.

Vortex - A circular, whirling movement of air forming a space in the center toward which anything caught in the vortex tends to move.

Weed - A plant growing where it is not desired. Plants are considered weeds when they interfere with activities of man or his welfare.

Wetting Agent - Substance that reduces interfacial tensions and causes spray solutions or suspensions to make better contact with treated surfaces. (See surfactant).

Wettable Powder - The powder form of pesticide which is normally mixed with water to form a suspension just prior to application.

Wind - Air in motion, important to aviation because it influences flight to a certain degree.

Windmill Driven - Power supplied by the movement of air, in reference to how the dispersal system pump is driven on some ag aircraft.

Wind Sock - A cone-shaped, open-ended cylinder of cloth to catch the wind and show its direction.

Wings - Part of the airplane shaped like an airfoil and designed in such a way to provide lift when air flows over them.

## AGRICULTURAL AVIATION FACTS AND TRIVIA

In 1988, an American farmer provided food for 114 people. In 1950, the average producer fed 24 people.

Americans spend 13% of after-tax income on food, including food consumed away from home. This compares with 23% spent for food in 1951. It also compares with 30% in the Soviet Union, 18% in Japan, 23% in Germany, 35% in Equador and 65% in China.

Without the use of agricultural chemicals the world food supply would be reduced by 40-50% and the cost of food would increase by 50-75%. Shortages and lower quality food and fiber would be common.

Development of new pesticides requires eight years of time and investments of up to $35 million. This is only research cost, it does not include manufacturing expenses.

Huff-Daland Dusters, Inc. was the first commercial aerial application company; they built their own special dusting aircraft. Later this company became known as Delta Alr Service, the forerunner of Delta Airlines.

Many ag planes have smokers installed. These devices are used to emit smoke from the aircraft so that the pilot can check for wind direction.

The frozen vegetable that Americans spend the most money on is the French fried potato.

Water weighs 8.33 pounds per gallon. There are 128 ounces in one gallon of liquid. Many aerially applied liquid products are dispersed at the rate of one gallon (total volume) per acre, and there are some solutions applied at 8 ounces or less per acre!

An aircraft with one set of wings is called a monoplane, where as an aircraft with two sets of wings is referred to as a biplane.

Total American agricultural production is currently more than two times greater than it was in the 1930's even though the production acreage of arable land has not increased substantially since then.

The advances in the chemical age of farming have made possible more progress in food and fiber production during the last 35 years than occurred in all previous years of man's history.

Agronomists identify about 2,600 species of weeds, of which 800 are known to cause economic loss to crops.

Ninety percent of all rice grown in the U.S. is seeded by air, over 2.25 million acres a year! Approximately 100 acres per hour can be seeded by ag aircraft.

An independent health survey of ag aviation recently investigated the possible effects of pesticide exposure on reproductive mortality and morbidity. The study included 347 males/females in ag aviation and 279 males/females in brother/sister families of ag aviators. There were no significant differences in numbers of pregnancies, live births, miscarriages, or birth defects. In fact the incidences of mortalities and morbidities were slightly higher in the population which was not repetitively exposed to agrichemicals.

Over 35,000 people die of starvation everyday according to the World Health Organization, 1 billion suffer from illnesses caused by malnutrition.

An analytical chemist measures one substance within another. The detection ability increased a million-fold from 1950, when the detection ability was at one part per million, to 1975, when the detection ability was one part per trillion. Some substances now can be measured at one part per quadrillion.

For reference: 1 part per million (1 ppm) is equivalent to 1 inch in 16 miles
1 part per billion (1 ppb) is equivalent to 1 aspirin dissolved in 100,000 gallons of water
1 part per trillion (1 ppt) is equivalent to the weight of 1 flea on 360,000 elephants

The application of pesticides at the rate of one pound per acre is the equivalent of spreading one teaspoon of sugar evenly over 5,000 bowls of cereal.

These sources can supply additional information or direct you to a more suitable source from which to obtain specific information or a classroom speaker. Please contact the listing with your request. If you encounter difficulty obtaining information, contact the National Agricultural Aviation Association Office (address below) or Cynthia Schreiber-Beck, Box 843, Wahpeton, ND 58074, telephone (701) 642-5777.

Your school's film/video library may contain appropriate titles to supplement the information contained in the guide, (example - film or video on the cotton industry). You could enlist the Department of Agriculture and Department of Education in your state to assist you in finding excellent materials to enhance this curriculum guide as well as other units you teach.

**AGRICULTURE**

Educational Programs and Materials

1. **Ag In the Classroom:** United States Department of Agriculture; Office of the Secretary; Room 234-W; Washington, DC 20250; 202-447-5725.
2. **Agricola**: Reference Branch; National Agricultural Library. Room 111; 10301 Baltimore Blvd.; Beltsville, MD 20705; 301-344-4479.
3. **American Agri-Women**: Route 2, Box 191; Mayetta, KS 66509.
4. **National Farm-City Council**: 225 Touhy Ave.; Park Ridge. IL 60068.
5. **Agriculture Council of America**: 1250 "Eye" St. N.W.; Washington. DC 20005.

Resources

6. County Extension Service Personnel
7. Farm Bureau in your area or state.
8. Grower. Farmer. Rancher from your area.
9. Related Industry Personnel.
10. State Agricultural Associations (ex: State Wheat Growers Association).
11. State Department of Agricultural.
12. State Department of Education.
13. State University Ag. Extension Service.

**AGRICULTURAL AVIATION**

Agricultural Aircraft Manufacturers

14. **Air Tractor, Inc**.: P.O. Box 485; Olney. TX 76374; 817-564-5616.
15. **Ayres Corporation**: P.O. Box 3090; Albany. GA 31708; 912-883-1440.
16. **Melex USA, Inc.**: 1221 Front St.; Raleigh, NC27609; 91 9-828-7645.
17. **Schwelzer Aircraft Corp**.: P.O. Box 147, Elmira, NY 14902; 607-739-3821.
18. **Weatherly Aviation Co. Inc**.: 50 Skylane Drive; Hollister. CA 95023; 408-637-5534.

Associations and Museums

19. **State or Regional Agricultural Aviation Assoc.** (for address contact National Agricultural Aviation Association).
20. **National Agricultural Aviation Association (NAAA)**: 1005 E Street, S.E.; Washington, DC 20003.
21. **National Agricultural Aviation Museum and Hall of Fame**: 1150 Lakeland Drive; Jackson, MS 39216; 601-359-3642.

Books

22. **Crop Dusters** by Henry Rasmussen, Osceola, WI; Mo torbooks International, 1986.
23. **Fire Bombers** by Philip Wallick, London, England: Osprey Published Limited, 1987.
24. **Low & Slow**-An Insider's History of Agricultural Aviation by Mabry Anderson. Clarksdale, MS: Low & Slow Pub lishing Co., 1986.

Periodicals

25. **Agricultural Aviation,** Official Publication of the NAAA. Resource of current events, equipment used, people and products in the ag aviation industry. Address: 1005 E. Street, S.E.. Washington, DC 20003.
26. **Ag Pilot International**, Resource of current events in ag aviation worldwide. Address: 405 Main Street, Mount Vernon, WA 98273.

**AVIATI0N**

Educational Programs and Materials; Information

27. **Academy of Model Aeronautics**: 1810 Samuel Morse Drive; Reston, VA22090; 703-435-0750; (model aircraft).
28. **Air Force Office of Youth Relations**: Kelly Air Force Base; Texas 78241-5000.
29. **Civil Air Patrol (CAP)**: Building 714; Maxwell AFB, AL 36112-5572; 205-293-6019; (aerospace education).
30. **Experimental Aircraft Association**: Education Department; EAA Aviation Foundation; Oshkosh, WI 54903-3065.
31. **Federal Aviation Administration (FAA)**: Aviation Edu cation, APA-1 00; 800 Independence Avenue, SW; Wash ington, DC 20591; (educational materials & films).
32. **General Aviation Manufacturers Association (GAMA)**: 1400 K Street NW, Suite 801; Washington, DC 20005; 202-393-1500; (general aviation).
33. **National Aeronautics and Space Administration (NASA)**: Educational Programs Office Code SE; 600 Independence Avenue; Washington. DC 20546; 202-453-1000.
34. **Office of Education,** 0-700; National Air and Space Mu-.seum; Washington, DC 20560.
35. **United States Space Foundation**: 1525 Vapor Trail; Colorado Springs. CO 80916.

Resources

36. State Aeronautics Department (each state does not have).
37. State Department of Transportation.

**ENVIRONMENT**

Educational Programs and Materials

38. **The Alliance for a Clean Rural Environment (ACRE)**: Suite 900; 115515th Street, NW; Washington, DC 20005; Fax: 202-463-0474. 800-545-5410.
39. **United States Environmental Protection Agency (EPA)**: Washington, DC 20460.
40. **USDA/Forest Service**: P.O. Box 96090, 3235 South; Washington, DC 20090-6090; 202-447-6605.

Resources

41. United States Forest Service Representative

**PESTICIDES**

Educational Programs and Materials

42. **National Agricultural Chemicals Assoc. (NACA):** The Madison Building; 1155 15th St. NW; Washington. DC 20005.
43. **Oklahoma Farm Bureau**: Information Director; P.O. Box 53332; Oklahoma City. OK 73105.

Resources

44. Agri-Chemical Company Representative.
45. State Department of Agriculture, Pesticide Division.
46. State University Agricultural Extension Service.

**CRITIQUE OF NAAA CURRICULUM GUIDE**

Thank you in advance for your use and critique of this curriculum guide. You, as an educator, are an invaluable source to teach current and accurate information about the agricultural aviation industry. The questions below are to aid in determining the usefulness of this packet, if and where changes should be made, and where more emphasis is required.

Please complete the following:

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*Your comments/criticisms/suggestions are all we have to learn from. Please add them here. Thank you again for your help.*

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